IMPACTS OF DROUGHT IN PASTORAL COMMUNITY AND THEIR COPING STRATEGIES IN CASE OF GUMBI BORDODE WOREDA, WEST HARARGHE ZONE, OROMIA REGIONAL STATE, ETHIOPIA

MA THESIS

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DEDICATION

I dedicated this Thesis to my beloved Mother Mersha Assefa, my beloved brother Gulilat Amare, and to my beloved sister Etenesh.

STATEMENT OF THE AUTHOR

By my signature under signed, I declare and affirm that this thesis is my own work. To the best of my capacity and level of honesty, I have followed all ethical and technical principles of scholarship in the preparation, data collection, analysis and interpretation of the Thesis. Any scholarly matter that is included in the Thesis has been given recognition through citation.

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BIOGRAPHICAL SKETCH

The author was born on Janawary7, 1987 E.C in Gewgaw Dingate Kebele, Gemechis Woreda, West Hararghe Zone, Oromia Regional state from his father Getachew Mergiya and mother Mersha Assefa at Gemechis district, West Hararghe Zone, Oromia Region, Ethiopia. He attended elementary education at Chiro Primary School and secondary education at Chiro Chercher Secondary School. After completing my Secondary School in June 1996 E.C, he joined Agricultural TVT College of Chiro September1997 E.C and graduated with Diploma in Natural Resource1999 E.C. After completing that he joined Haramaya University in September 2000E.Cand graduated with BSc degree in Rural Development and Agricultural Extension in June 25, 2002E.C.

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TABLE OF CONTENTS

LIST OF TABLE

List of Figure

ABBREVIATIONS AND ACRONYMS

ASAL	Arid and Semi-Arid Lands
CDAL	Community -Based Drought Adaptation Index
CSI	Cope Strategy Index
CV	Coefficient of Variation
DEWS	Drought Monitoring and Early Warning System
EM	Emergency Events Data Base
FAO	Food and Agricultural Organization of the United Nations
FCI	Forage Condition Index
FGD	Focus Group Discussion
GDP	Gross Domestic Product
HCSA	Household-Coping Strategy Assessment
IPCC	Intergovernmental Panel for Climate Change
LCI	Livestock Condition Index
LVI	Livelihood Vulnerability Index
NMI	National Meteorology Institute of Ethiopia
NGO	Non-Governmental Organization
PARIMA	Pastoral Risk Management
PDSI	The Palmer Drought Severity Index
PLRI	Pastoral Livelihood Resilience Index
PRA	participatory Rural Appraisal
SCRI	Social Capital Resilience Index
SLA	Sustainable Livelihoods Approach
SPI	Standardized Precipitation Index
SSA	Sub-Saharan Africa
UNEP	United Nation Environment Program
USGS	United States Geological Survey
VACI	Vulnerability and Adaptive Capacity Index
VAI	Vegetation Health Index
VECD	Vulnerability, Exposure and Consequences to drought
VSF	Veterinaries Sans Frontiers

Impacts of Drought in pastoral community and their Coping Strategies in case of Gumbi Bordode Woreda, West Hararghe Zone, Oromia State, Ethiopia

Abstract

Drought is a natural event that affects both humans and animals. This study aimed to analyze rainfall, temperature, drought, and the impact of drought, as well as the adaptation strategies of pastoral households in Gumbi Bordodde Woreda, West Hararghe Zone, Ethiopia. Historical climate data from the National Meteorology Agency (1991-2020) was used, alongside primary data gathered from household key informants through interviews, focus group discussions, and observations. Data analysis was conducted using the Statistical Package for Social Sciences (SPSS), while rainfall and temperature data were characterized using Drinc C and XLSTAT software. The results showed that the average annual rainfall was 761mm, with Belg and Kiremt rainfall amounts of 269mm and 410mm, respectively, and corresponding coefficients of variation (CV) of 105%, 98%, and 50%. The Belg rainfall amount exhibited a significant decreasing trend, while Kiremt and Bega rainfall amounts showed no significant increase. The mean maximum and minimum temperatures were as follows: annual (30.72°C, 15.39°C), Belg (29.12°C, 12.39°C), Kiremt (31.64°C, 17.79°C), and Bega (31.39°C, 16°C). The Belg and Bega maximum temperatures showed significant warming trends, whereas Kiremt and annual maximum temperatures showed non-significant warming trends. Regarding the Standard Precipitation Index (SPI), the frequency of dry clusters was higher in the Belg season (13%) compared to the Belg-wet cluster (7%), while the Kiremt season had a lower frequency of dry clusters (10%) compared to the wet cluster (23%). The annual dry cluster (13%) was also less frequent than the annual wet cluster (20%). The survey revealed that 78% of household heads were male, 74% were aged between 20-60 years, and 77% were married. About 52% of household heads were illiterate. In terms of farm size, 70% of respondents owned between 0.5-1.5 hectares of land, with most households owning Between 10 to 20 livestock. The main adaptation strategies for drought and climate variability included crop diversification (72%), constructing flood diversion channels for irrigation (66%), selecting drought-tolerant crops and livestock breeds (48%), saving pastures (36%), and soil and water conservation practices (30%). The majority (53-91%) of respondents reported negative impacts of climate change, variability, and drought on agriculture, the environment, and human life. Key factors influencing adaptation strategies included income sources, age, farm size, education, access to climate information, family size, and livestock holdings. Income had a positive impact on the construction of flood diversion channels, while age had a negative impact. Farm size, education, and income positively affected the selection of drought-tolerant crops and livestock breeds. Access to climate information positively impacted pasture collection and saving, while family size negatively affected soil and water conservation practices but had a positive impact on crop diversification. Overall, the study found that frequent drought occurrences, low and highly variable rainfall (CV = 105%), and rising temperatures pose significant challenges for agricultural production in the study area. The study recommends promoting income diversification as an essential adaptation strategy.

Key words: *Adaptation option, Drought, Farmers Perception, Rainfall, Temperature trend.*

1. INTRODUCTION

1.1. Background of the Study

Drought, a prolonged dry period caused by a deficiency in precipitation and water resources, presents significant global challenges, affecting agriculture, food security, and economic stability (Kemal et al., 2020). Numerous countries are susceptible to the far-reaching effects of drought (Trnka et al., 2018), which is considered one of the most complex and destructive natural hazards (Mahyou et al., 2010). With anticipated climate change, the intensity and frequency of droughts are expected to worsen (Eze et al., 2020). This will likely lead to an increase in the duration, severity, and geographical spread of affected areas, impacting society, economies, and the environment (Yuan et al., 2017). In Africa, drought is a recurring phenomenon, frequently lasting years, and resulting in substantial socioeconomic and environmental consequences (Dutra et al., 2013).

Estimates on the impacts of drought indicate that between 1998 and 2017, the phenomenon, following a flood, affected over 1.5 billion people, with around 21,563 lives lost (EM-DAT, 2018). The Horn of Africa, in particular, experiences frequent droughts that lead to the loss of lives and large-scale displacement. As such, drought remains a significant source of human suffering and a major hindrance to pro-poor livestock development in sub-Saharan Africa, especially within pastoral and agro-pastoral systems (HPG, 2006). With 58% of Africa's economy dependent on agriculture, the region is highly vulnerable to climate change (Adugna et al., 2019). Sub-Saharan Africa (SSA) is widely regarded as the most drought-prone area on the continent, with over 363 million people affected by droughts between 1980 and 2014. In Ethiopia, drought has become a recurrent challenge, affecting agriculture, ecosystem sustainability, water resources, forests, energy supply, transportation, food availability, and other human activities (Kogan et al., 2019; Wassie, 2020). From 1950 to 2017, Ethiopia experienced 34 drought events, demonstrating a recurring cycle of meteorological and agricultural droughts every two years (Ashenafi et al., 2021). Such occurrences increase the vulnerability of the population, disrupting livelihoods and contributing to both chronic and temporary food insecurity (Ahmadalipour, 2017; Mpelasoka et al., 2018).

The Oromia region, like other parts of Ethiopia, faces growing challenges due to drought. However, research has mostly concentrated on historically drought-prone areas, leaving regions with insufficient data—yet still affected by recurrent droughts—largely overlooked (Bereket et al., 2022). Factors such as rapid population growth and limited economic development further exacerbate the demand for land and water resources, intensifying the effects of climate change (Adugna et al., 2019).

Pastoralism, a livelihood system reliant on the interaction of people, natural resources, and livestock, is practiced predominantly in arid and semi-arid lowlands and sub-humid regions (below 1,500 m.a.s.l.), covering about 60% of Ethiopia's land area (Chanyalew, 2015).

In Oromia, pastoralism is practiced in 7 zones and 42 woredas, covering 152,070 km^2 of savanna-type grasslands that support cattle, camels, and small ruminants (Oromia Pastoral Area Development Commission, 2018). The Ethiopian pastoralist system is highly vulnerable to climate change impacts, as its livelihood is dependent on key natural resources like water and pasture (Fratkin, 2014). While pastoral communities have been adapting to climate change for centuries, recent trends of increasing drought frequency and high rainfall variability, compounded by poor socioeconomic conditions, have reduced their ability to adapt effectively (Ayal & Leal Filho, 2017). This study aimed to assess the socioeconomic impacts of drought on pastoralist households and examine their coping strategies during drought events. It emphasizes the need for scientific information to aid local stakeholders in developing effective coping responses to drought challenges. The research was focused on identifying the impacts of drought and coping strategies employed by pastoral households in the Gumbi Bordodde Woreda, West Hararghe Zone.

1.2. Statement of the Problems

Drought has a profound impact on agriculture, health, and the economy in the Horn of Africa, particularly in Ethiopia (Bereket et al., 2022). This results in increased unemployment, especially among youth, and a heightened risk of food insecurity (Kemal et al., 2020). Sena (2019) highlights the recurrent nature of drought and its broad effects on agriculture and vulnerability factors. In their analysis of drought coping strategies, Emiru et al. (2023) emphasize both proactive and reactive measures aimed at improving disaster preparedness. Their study explores how households respond to the impacts of droughts and floods, pointing out that informal measures tend to be less effective (Adan, 2024). While the provided text discusses the impact of drought on rural livelihoods and youth unemployment, it fails to specifically address the vulnerabilities of other populations, such as women, children, and marginalized communities, who may be disproportionately affected. Understanding how these groups cope with drought can help in designing more targeted interventions. Studies, like that of Matlou et al. (2021), highlight geographical and demographic gaps in research, indicating that certain regions or population groups may not be adequately represented or considered. Furthermore, the statement touches on the gaps in policy responses and the need for both short-term and long-term strategies to strengthen community resilience.

Existing literature on drought impacts and coping strategies reveals several research gaps that warrant further investigation. Although studies like Bereket et al. (2022) provide valuable insights into the situation in Ethiopia, there is a lack of comprehensive research covering different regions. To address this gap, further research should explore the differential impacts of drought across various geographic and climatic contexts. Longitudinal studies are also needed to track the evolving effects of drought over time, helping to understand the cumulative impacts and the sustainability of coping strategies. While participatory research methods, such as those used by Ayana et al. (2019), provide a more inclusive approach, much of the current literature focuses on biophysical aspects of drought, overlooking social dynamics. Future studies should take a holistic approach, incorporating community networks, cultural practices, and governance structures to evaluate the effectiveness of coping strategies. Additionally, gender-specific vulnerabilities and coping strategies should be examined more thoroughly, taking into account the roles, responsibilities, and resource access of both men and women in the face of climate change. There is also a gap in exploring how technological innovations, such as precision agriculture, mobile applications, and water management tools, can mitigate the impacts of drought on livelihoods. These technologies could provide valuable insights into sustainable coping strategies. The complex nature of drought impacts calls for interdisciplinary research that bridges natural sciences, social sciences, and economics, facilitating a more comprehensive understanding of both the impacts and coping strategies.

Indigenous knowledge systems have proven resilient during droughts, yet their contribution to household resilience remains underexplored. It is crucial to engage with local communities to document and integrate indigenous coping strategies into broader adaptation frameworks. Addressing these research gaps will contribute to a more nuanced understanding of drought impacts on households, facilitating the development of context-specific and sustainable coping strategies. This study aimed to identify the impacts of drought and coping strategies among pastoral households in Gumbi Bordodde Woreda of West Hararghe Zone.

1.3. Objectives of the study

1.3.1. General objective

The general objective of the study was to examine the Impacts of Drought in pastoral community and their Coping Strategies in case of Gumbi Bordode Woreda, West Hararghe Zone.

1.3.2. Specific objectives

The specific objective of the study was to:

1. Analyze rainfall patterns, temperature climate variables and drought occurrences over the past 30 years in the study area.

2. Identify the impact of drought on household pastoral livelihoods in the study area

3. Identify major drought coping strategies employed by households in study area.

1.4. Research Questions

The study provides answer to the following research questions:

1. What are the current patterns and trends in rainfall and temperature in the study area?
2. How has socio-economic drought impacted households in the study area?
3. What are the major drought coping strategies employed by households in the study area?

1.5. Significance of the Study

The study's insights can inform the development of localized policies and interventions aimed at mitigating the socio-economic effects of drought. Policymakers can use the findings to modify initiatives that address the specific needs of Gumbi Bordodde Woreda. This knowledge is essential for sustainable development and adaptation planning. The results of the study were help local authorities and development agents formulate proper intervention coping Strategies. By understanding coping mechanisms employed by households during droughts, the study can empower the community. This information can be shared within the community to ease mutual support and foster a sense of collective resilience. Moreover, the study acts as reference guide for researchers undertaking similar study in other areas.

1.6. Scope of the study

The research is geographically focused on Gumbi Bordodde Woreda, with a methodological emphasis on a specified time frame covering 1991-2020 used. Drought events also happen over longer period of years. The study aims to provide a comprehensive understanding of long-term impacts and coping Strategies developed by households. The research was conducted in three selected pastoralist kebeles (*Obenisa, Buri Ariba, Goda Calle*) in Gumbi Bordodde Woreda, West Hararghe Zone. Meteorological data from Gumbi-Bordodde Station was be used temperature and precipitation to analyze the socio-economic impact of drought in the area, Conceptually the study was delimited to impacts of drought and coping Strategies among pastoral households of Gumbi Bordodde woreda, west Hararghe zone. Methodologically the study was be delimited mixed research approach with utilized descriptive research design.

1.7. Definitions of key Terms

Coping Strategies: are short-term responses to sudden food shortages, aimed at meeting immediate physiological, social, economic, and political needs, often involving planning for the future.

Drought: is a prolonged deficiency of precipitation, leading to insufficient water to meet human activity needs over a season or longer.

Impacts: The effects, consequences, or influence resulting from a particular action, event, or phenomenon. In the context of drought and pastoral households, impacts may refer to various changes or challenges experienced by communities, ecosystems, or individuals.

Pastoralism: Pastoralism involves raising livestock with nomadic movement for fresh pasture and water. Pastoralist refers to individuals practicing or associated with this livelihood, encompassing cultural identity and livelihood system.

Socio-economic impacts: assess the effects of events on social and economic conditions. In drought, this includes effects on income, employment, and overall well-being. The Social Capital Resilience Index (SCRI) gauges social network strength, community cohesion, and collaboration, providing insights into coping strategies during drought events.

Socio-economic drought: Characterized by abnormal water shortage impacting the socio-economic conditions of a region, it arises when water demand surpasses supply due to weather-related water supply deficits.

2. LITERATURE REVIEW

The impacts of drought on pastoral households represent a multifaceted challenge that intertwines environmental, economic, and social dimensions. As climate change continues to intensify, arid and semi-arid regions inhabited by pastoral communities face increasing vulnerability to prolonged and severe drought events. These events disrupt traditional livelihoods primarily dependent on livestock, exacerbating water scarcity, reducing forage availability, and threatening the overall resilience of pastoralist communities. Therefore, this chapter is discussed about the review theoretical as well as the empirical of the study, and Conceptual framework, and research gap to be filled by the study.

2.1. Conceptual Review

2.1.1. Concepts of Drought, Pastoralism and Coping Strategies

Concepts of Drought

Drought is an abnormal shortage of water, typically occurring throughout the summer months over an extended period (Kemal *et al*., 2020). It can cause crop failure, depletion of municipal water sources, increase in forest fire risk and insufficient water flow through waterways (Nolwandle Z. M., 2019). Drought occurs in virtually all climatic zones, but its characteristics vary significantly from one region to another and its definition varies from region to region and may depend upon the dominating perception, and the task for which it is defined. It originates from a deficiency of precipitation over an extended period of time, usually a season or more (Munang *et al*., 2013).

Drought is caused by a deficiency of precipitation overran extended period of time (usually a season or longer) resulting in water shortage for an economic activity, a group of society, or an environmental sector ((NDMC, 2016). Since drought cannot be viewed solely as a physical phenomenon, it is usually defined both conceptually and operationally. Such as drought is a protracted period of deficient precipitation resulting in extensive damage to crops, leading to the loss of yield is a conceptual definition of drought that may be important in establishing drought policy.

Concepts of pastoralism

Pastoralists are not exclusively dependent on livestock, their livelihoods are diverse, incorporating various income-generating strategies such as trade, natural resource harvesting, and agriculture. This diversification is crucial in challenging and unpredictable environments where environmental factors vary widely (Krätli *et al.*, 2013). Inhabitants of arid lands face significant environmental variability, with essential nutrients for livestock dispersed unpredictably due to irregular rainfall patterns. Pastoralists who embrace mobility to navigate this variability can provide better nourishment for their animals. Pastoral livelihoods integrate variability into production processes, influencing inputs, breeding, land tenure, marketing strategies, and connections with other livelihood systems. Mobility, seen as a production strategy rather than just a coping mechanism, holds substantial consequences for other variables (Krätli and Toulmin, 2020).

Pastoralism often emerges as the optimal subsistence livelihood, offering adaptation to irregular climates and reducing risks in semi-arid regions (O'Neil, 2011). Ethiopia boasts the largest livestock population in Africa, with cattle being a common asset for many households. However, the decline in livestock population may drive pastoralists to explore alternative income sources, potentially causing environmental harm (FAO, 2018). Efforts should focus on developing policies that enhance livestock productivity to encourage responsible rangeland ecology (Riginos *et al.* , 2012). Protection among high-income pastoralists. The trend toward sedentarization may lead to a loss of diversity in pastoral practices, transitioning from multiple pastoralism to solely pastoral farming or agro-pastoralism. This shift could have adverse consequences for pastoral societies worldwide, emphasizing the importance of preserving the practices of pastoralism.

In addition to this, research findings over the past two decades underscore the economic significance of pastoralism and its role in ecosystem preservation (Tsegaye *et al,* , 2013). Despite lower annual household incomes for pastoralists compared to semi-pastoralists and agro-pastoralists, the integration of livestock production and dry land farming could enhance or sustain livelihoods. Pastoralists face the challenge of weather dependence, particularly in pastoral rangelands, making them more adaptable to survival in dry regions. While various development platforms advocate for agro-pastoralism, sustaining pastoral development requires maintaining livestock mobility through proper infrastructure and policies that grant pastoralists access to essential social services (Sonneveld *et al*., 2017).

Concepts of coping strategies

As Gidey *et al*. (2023) noted that communities that have lived under drought situations for many generations develop coping strategies to lessen the impact of drought. Recently, people in southern Africa have developed effective responses to alleviate the ravages of drought on their communities. These indigenous responses go a long way in alleviating food shortages caused by droughts (Wisner *et al*., 2004).

The study of coping strategies within the context of drought draws on the broader literature of disaster management and resilience (Wisner *et al.,* 2004). Conceptualize coping strategies as the actions taken to avoid, minimize, or tolerate the impact of a hazard. (Adger, 2000) Extends this concept, emphasizing the dynamic nature of coping strategies and the importance of social, economic, and institutional resources in shaping adaptive capacity. Considering the temporal scope of 2018-2023, recent advancements in drought research have integrated climate change considerations. Authors like (Dai, 2013) and (Trenberth *et al*., 2014) discuss the influence of climate change on the frequency and intensity of drought events. The inclusion of this temporal dimension ensures a contemporary understanding of how changing climatic conditions may impact the dynamics of drought, livelihoods, and coping strategies.

2.2. Global Overview of Pastoralism

Nomadic and transhumant rearing of domesticated animals are generally two essential forms of pastoralism, with pastoral farming/enclosed ranching as the third form of pastoralism in the broad meaning (Wane, 2006). According to the blench (2001) Most of the burden of pastoral activities is borne by women, and empowering women remains a challenge in most of the pastoral regions across the world.

The origin of pastoralism can be dated to 6000 B.P. in the Andes of South America, and even as early as 9000 B.P. in Northeast Africa (MacDonald, 2000). A multiple center origination is more probable than a single-center origination for explaining the spread of pastoralism worldwide. Currently, extensive pastoralism occurs on about 25 % of Earth‘s land area, mostly in the developing world, from the dry lands of Africa and the Arabian Peninsula to the highlands of Asia and Latin America (Odhiambo, 2006). In Africa, it has been estimated that 20-40 million agro-pastoralist and pastoralist people depend on livestock as their major source of food and money (Gebremichael *et al.*, 2010). The estimates for the pastoral population in Ethiopia vary. Where more than 60 per cent of Ethiopia‘s territory in the arid and semi-arid lowlands is inhabited by nomadic pastoralists (Markakis, 2004; Gebremichael *et al.,* 2010). As Gebremichael *et al*., (2010) estimates that 12-15 million pastoralist people are thought to live in these areas; whereas Virtanen and Gemechu (2011) study showed that pastoralism provides the main livelihood for close to 15 million people spread across seven regions of the country. According to (Nori and Davies, 2007) globally, pastoralism is critically important in supporting huge human populations, providing tremendous ecological services, maintaining long-standing civilizations, and making significant contributions to subsistence economy in some of the world ‘s poorest regions.

However, the practices of pastoralism and agro pastoralism have been overwhelmed by agricultural expansion, industrial development, climate change and sedentary livestock farming in recent decades. Pastoral societies across the world were have more unpleasant fates with the stress of global change in the future (Blench, 2001).

2.3. The History of Drought in Ethiopia

Droughts are one of the highest natural disasters globally having major impacts on environmental, economic and social conditions (Morid *et al*., 2006; Paulo *et al*., 2012). A recent global review on droughts and aridity by Dai (2011), indicated that large-scale droughts have frequently occurred during the past 1000 years across the globe. The available estimates on drought impacts suggest that, during the period 1998-2017 following the flood, which affected a further 1.5 billion resulting in a huge toll to humanity, killing about 21,563 people droughts affect 2.4 Economic losses (billion US$). African countries, the analysis of droughts during 1900-2013 indicated that droughts have intensified in terms of their frequency, severity and geospatial coverage over the last few decades. The droughts that occurred in 1972-1973, 1983-1984 and 1991-1992 were most intense and widespread. All of the regions witnessed severe droughts in the last few decades, for instance, the 2010-2011 drought in East Africa 1999-2002 drought in North Africa, 2001-2003 drought in southern Africa and persistent droughts in Sahel during 1970s and 1980s (EM-DAT, 2018).

Especially horn of Africa, have been repeatedly affected by severe droughts that cause loss of human life and large-scale displacement of populations; in addition, the drought greatly limited crop production, pastures growth and water availability (Masih *et al.*, 2014). As Mesfin (1984), Pankhurst (1986) and Dejene (1990) wrote an extensive account and assessment on droughts and its social, economic and environmental impacts in certain hot spot regions in Ethiopia. In the first reference, four major droughts with a wide range of impacts of historic significance were recorded; (i) The devastation of oxen by render pest in the 1888-1892, (ii) The Tigray famine of 1958 which killed over 100,000 people, (iii) The *Wag- Lasta* famine of 1966, and (iv) The *Wollo* Famine of 1973/74. These droughts affected large number of people over the years. The number varied significantly between 2 million in 1972 and 14 million in 2002/3 with a significant and sharp increase in 1976-1977, 1982-1984 and 1991-2002. The 2015 drought left over 10 million people (10%) in 2016 and it was reported as the strongest drought in the past fifty years (USGS, 2016). The number of people that needed food aid varied by region; Tigray, Afar and Somali Regions were hard hit and the population affected was 24%, 25% and 21%, respectively. More food aid was required in Oromia followed by Amhara and Tigray Regions. In terms of large geographic coverage, more areas were affected in Afar and Somali Regions. Children, largely in pastoralist areas, were more affected by the drought as it decimated nearly 50% of the livestock in the regions.

The UN Office for the Coordination of Humanitarian Affairs (UNOCHA) reported that an estimated USD 3.9 billion was required to effectively respond to this emergency situation (UNOCHA, 2016). The population affected by the droughts based on the number of people receiving emergency food aid over the last fifty years in Ethiopia nearly 4 to 5 million people on average require food aid each year even under normal rainfall year in most parts of the country, and the areas most affected are in central, northern and eastern and southern lowlands (Getachew, 2018).

2.4. Pastoralism and Drought

There are several types of droughts which are defined by different parameters. There are four types of droughts namely; meteorological drought, agricultural drought, hydrological drought and socio-economic drought (Rathore, 2009). Meteorological drought is deficiency of rainfall which can be observed immediately (Panu and Sharma, 2002). Agricultural drought is measured in terms of deficiency in soil moisture, rainfall, ground water and reduction in crop yield (Wilhite, 2000). Hydrological drought is deficiency in water availability in surface and subsurface water reservoirs. While, socio-economic drought is final phase of drought that is caused by prolong shortage in agricultural production and food thus affecting overall economy (Guo *et al.*, 2019). Recently, Mishra and Singh (2010) suggested adding groundwater drought as a fifth category. Droughts, which originate from deficiency in precipitation over extended periods of time and affect approximately 60 per cent of the world’s population, are the major constraints to viable rain-fed agriculture particularly in the ASALs (Huho and Mugalavai, 2010). So, the study is more depends on meteorological drought types.

Meteorological Drought is based on the degree of dryness or rainfall deficit and the length of the dry period (NOAA, 2014). Most often think about drought in relation to precipitation, assessing the degree of dryness (in comparison to a local or regional average) and the duration of the dry period. This is known as a meteorological drought, which is highly specific to a region as average precipitation may vary considerably spatially. According to Swain, S *et al*. (2017) meteorological drought occurs when there is a prolonged time with less than average precipitation. Meteorological drought usually precedes the other kinds of drought.

Different scholars have studied the variability and trends of rainfall in different climate regions of Ethiopia's. Findings shows rainfall is decreasing and becoming more erratic in its distribution and amount. According to (Eshetu *et al*., 2016) main season (*Gannaa*) rainfall coefficient variation range was 24 at Gatira while 38.5 at Setema in south western Ethiopia, Hadgu *et al*. (2013) reported that high coefficient annual variation in main season was (CV 30%) and March to April (CV 50%) in northern Ethiopia. Moreover, Belay (2014) who reported that inter-annual rainfall coefficient variation (18 to 40%), main season (CV 17 to 39%) and March to April (CV 27 to 57%) for rift valley of Ethiopia which is high annual variability. The same author stated the analysis of coefficient of variation for March to April (Bona) season variability is higher than main season rainfall which agreed with many 14 other authors (Hadgu *et al*., 2013). Desalegn *et al*. (2018) also stated with the highest coefficient of variation, the small rainy season rainfall exhibits the highest fluctuation of rainfall distribution followed by the main rainy season and lastly annual rainfall. While Berhanu *et al*. (2014) stated the main rainfall highly variable in the country lowlands.

In case of Rainfall trend, the findings from national and regional level rainfall trends analysis reported both increasing and decreasing trends (Belay, 2014). As Wind *et al*. (2008) reported significant decline in rainfall in south western Ethiopia which increases the occurrences of drought. Similarly, Rao and Solomon (2013) who reported that analysis of the historical rainfall records in North Central Ethiopia revealed that there has been trend of decreasing rainfall, However, the trend analysis of annual rainfall showed that rainfall remained more or less constant when averaged over the whole country for 1951 to 2006 (NMA, 2007). Parry *et al.* (2007) confirmed that regional variations can be much larger, and considerable spatial and temporal variations may exist between climatically different stations. Pastorals are mainly faced with two processes during drought that adversely affect their capacity to support themselves, effectively raising the minimum herd numbers required to maintain the household. First, they face a fall in levels of productivity from their herds following losses in their livestock capital from higher mortality rates, low or zero calving rates, reduced production of milk and weight loss in animals that reduces their market value.

The pastoral and agro pastoral communities now seem to have become more vulnerable than they used to be (Helland, 2006). It is argued that recurrent drought is the key factor which causes vulnerability of pastoralists in Ethiopia (Helland, 2006; Feinstien International Center 2007; Ruijs et al., 2011). While opinions vary on the severity and frequency of drought during the last ten years or so, the report by Feinstien International Center (2007) indicates that drought continues to cause excessive loss of pastoral livestock, causes severe hardship to pastoralists and leads to repeated bouts of humanitarian assistance. Aid assistance during drought was first delivered to pastoral areas of Ethiopia in the early 1970s and since then, the dominant response has been food aid (Feinstien International Center, 2007). Climate variation remains a perennial problem to pastoralists; hence their vulnerability has to be explained with reference to a much broader set of issues. Hogg (1997) writes that the 15 situation of Ethiopia's pastoralists is now increasingly characterized by poverty, poor food security and increasing environmental risk as well as political, economic and social marginalization.

In their study in Ethiopia, Ruijs *et al*. (2011) compared the vulnerability of communities in the highland villages and lowland villages. They identified that there is a clear difference in the level of vulnerability, and households in the lowland villages are more vulnerable to climate shocks than those in the mid- and highlands. In the lowlands, exposure to drought risk is higher and coping capacities are more limited due to their large household size and low levels of income diversification and education whereas high erosion makes the highlands sensitive to climate variability. For all villages, drought is the main climate hazard. They added that, not all hazards, however, are directly related to climate. High food prices, soil erosion and animal diseases are important as well. Similarly, the World Bank also reported that, in the Ethiopian context, the farming community is the most vulnerable because of its high dependence on agriculture for its livelihood. Even within the farming community, small scale subsistence farmers and pastoralists are particularly vulnerable to climate change related hazards like drought; these hazards include shortage of food and water for humans and livestock, and diseases (World Bank, 2010).

2.5. Socio-Economic Impacts of Drought

The magnitude and severity of meteorological drought impacts on social and economic systems of any particular human society was be dependent on the underlying vulnerability of the human population and particular region exposed to the event, as well as the underlying climate and weather patterns that determine the frequency and severity of the event (Wilhite *et al*., 2007).In Gumbi Bordodde for rift valley of Ethiopia Lowland areas, prolonged and recurrent drought is the most typical corrupted events of climate change. Remarkably, drought cycle has been shortened than earlier that increases its risk (Oxfam, 2011). As a result, reproductive performance of livestock was reduced despite the fact that livestock mortality is increasing (Herrero *et al*., 2010). Specifically, the effect of drought can be conveyed as follow:

2.5.1. Range land degradation

Gumbi Bordodde Woreda is large numbers of cattle, overgrazing, bush encroachment and charcoal had led to depletion of natural resources, which ultimately led to environmental degradation and recurrent droughts. According to Eyasu and Feyera (2010) and Argaw (2015) Environmental degradation in turn affected production of animal fodder and livestock, reducing wealth and human capital. The shortfall of expected long rainy season following the peak dry season pronounced the progression to the peak drought phase. As a result, the forge seed bank would unable to germinate due to insufficient rainfall (Dirriba, 2016). In the past, grazing scarcity was a transient condition in pastoral production systems where rainfall variability drives seasonal variability in resource pattern and condition: today it has become permanent (Boku, 2010).

2.5.2. Livestock mortality and morbidity

Drought adversely affects the pastoral communities by reducing the availability of pasture and there by resulting in death of livestock (Morton, 2005). According to the Kassahun (2003), Out of the total livestock death occurred in the pastoral areas of Ethiopia; more than 80% the deaths are caused by drought. It may also directly kill livestock through lack of drinking water. Livestock mortalities from starvation and disease outbreaks affected approximately 70 percent of livestock in most Arid and semiarid lands ASAL woredas during the 2011 drought according to the (RoK, 2011) study. Huho *et al*. (2010) who observed that 2009 drought has resulted in loss of Maasai livestock in Mukogondo Division of Laikipia Woreda from starvation whereas 50% of respondents, losses their cattle more than half and 17 also Paul (2013) put in his study where more than 70% of households lost 1-20 sheep 2012 year in Marsabet county.

An assessment on livestock dynamics of pastoral households in southern lowlands has shown a declining trend or downward spiral and erosion of livestock asset (Solomon, 1999; Aklilu and Alebachew, 2009). Droughts have frequently hit the Gumbi Bordodde area, causing heavy livestock mortalities, particularly of cattle. This situation triggered immense migration of livestock from one region to another. This further resulted in increased and widespread disease outbreaks in some parts of pastoral areas. Desalegn *et al.* (2018) also stated the livestock diseases severity and prevalence was reported to increase during periods of stress, particularly drought-induced problems such as lack of water and pasture. Additionally, weakening livestock, drought may also increase their vulnerability to a range of livestock diseases, both during the dry phase and during a succeeding recovery phase when parasites may flourish in newly rainy conditions

(Morton, 2005). Some of the major outbreak's disease included try panosomiasis, pasteurolosis, blackleg and anthrax challenge the livelihoods of the communities (Gumbi Bordodde Woreda Agricultural Office 2023)

2.5.3. Impacts on livestock trade and marketing

Economic impacts of drought to pastoralists are demonstrated by deteriorating livestock body conditions and massive livestock deaths, which lead to decline in livestock prices (Huho *et al*., 2011). Pastoralist's experience declines in levels of productivity from their herds following losses in livestock capital from deaths, low calving rates, low milk production and weight loss, which consequently reduce the market value of livestock. Morton and Barton (2002) stated in their study to provide for their nutritional and energy needs, pastoral communities purchase cereals and other foods with the proceeds from sales of livestock and livestock products. However, during drought periods, pastoral communities ‘purchasing power dwindles because, pastoralists lose livestock through mortality and therefore cannot sell their stock; poor body conditions of livestock result in poor prices; and rise in grain prices prompts pastoralists to sell more stock (Fasil *et al*., 2001; Morton and Barton, 2002; Dirriba, 2016).

According to MoA (2013) the livestock sector, which is largely concentrated in arid and semi-arid lowland (ASAL) regions, contributes 12–16% of Ethiopia‘s gross domestic product (GDP) and 30–35% of the agricultural GDP. However, Pastoralists receive poor price during 18 the drought, especially if the condition of the animal is poor due to weight loss and stress caused either by drought, a long trek over difficult terrain, or both (Scott-villiers, 2006). Moreover, drought is likely to cause a disruption in flows of livestock to both domestic and export markets, possibly by gluts during drought onset and probably by scarcities during drought and post-drought phases (Barton and Morton, 2001).

2.5.4. Impacts on education and other social services

Access to infrastructure is another challenge during drought. Particularly, during drought induced migration though access infrastructure depends on the direction of migration, so, the student certainly dropout during migration and resume after returned to their homestead. However, the distance to these infrastructures such as market places, schools and veterinary post is the major challenge during drought due to mobility. (Gumbi Bordodde Woreda Agricultural office, 2023). Additionally, distances from public infrastructure and facility exacerbates the other problem like veterinary cost, livestock death, human disease, low livestock price, corruption and counterfeit buyers and ethnic conflict (Dirriba, 2016). Different publications have extensively touched on impacts of drought on pastoralists 'livelihood in Ethiopia. Most studies provide an array of similar impacts across most pastoral groups.

2.6. Coping Strategies of Pastorals to Drought.

Coping strategies refer to ways people respond to declining entitlements and food availability in abnormal seasons or years (Davies, 1996). They are short term responses to an urgent and in habitual decline in access to food and means of survival (Davies, 1996). Coping strategies are helpful in the short term; however, they may not bring a meaningful change on livelihood. Moreover, coping strategies may not be economically and environmentally sustainable. For instance, concentrating livestock in one water point, increased charcoal production and collection of fuel wood are examples of environmentally unsustainable practices, while sale of breeding and lactating livestock are examples of a coping strategy unsustainable at a household level (Barton *et al*., 2001). Different coping strategies are practiced by pastoralists depending on different stages of drought. These are illustrated as follows

2.6.1. Mobility

Historically, African pastoralists have managed uncertainty and risks associated with arid lands including drought through livestock mobility. In order to cope and adapt with the unreliable rainfall and pasture distribution, pastoralists must practice mobility. With the recent discovery of oil in Turkana and changing land tenure systems from communal to private ownership in the rangelands, mobile pastoralism is becoming increasingly constrained (Eliza *et* al., 2015).

According to (VSF, 2011) Livestock mobility was employed by most pastoralists in the County, Kenya some moving as far as Southern Ethiopia in search of water and pasture. Diriba (2016) also state herd mobility was among the most common conventional coping strategies that dictated by season and the availability of forage, as well as personal relationships, family structure, and immediate demands in search of water and pasture.

However, in recent period the Gumbi Bordodde now travel significantly greater distances to reach pasture and water. Moreover, travelling greater distances places extreme caloric demands on cattle and exposes them to disease. As a result, the choices related to herd mobility was chosen as not first option. Also, Paul (2013) mobility is still practiced although not as much as in the past. However, it was the main strategy in the past years owing to availability of vast lands and various options of permanent grazing reserves and water sources.

In Marsabit County for instance, the Gabra who are Chalbi nomads utilize the Chalbi desert margins; the north east shores of Lake Turkana and the Mega plateau in Ethiopia, while the Rendille who predominantly keep camels migrate to the fringes of Mount Kulal and towards fringes of N do to mountains (VSF, 2011). In Gumbi Bordodde pastoralist mobility is one of the long history livestock related coping strategies that dictated by season and the availability of forage, as well as personal relationships, family structure, and immediate demands in search of water and pasture. Nowadays, herd mobility was highly confronted by different factors such as expansion of farm land, land degradation and bush encroachment (Dirriba, 2016).

According to Argaw *et al*. (2015) also moving livestock is the main strategy used by the pastoral community of Gumbi Bordodde for risk management and efficient and communal utilization of range resources.

2.6.2. Destocking

Destocking is an emergent act of reducing the herd size from their flock mostly as a coping mechanism during severe drought (Hurst *et al*., 2012). The main target of destocking is to reduce livestock death, to moderate the feed competition during severe drought and to covert livestock in kind to a liquid form. Commercial destocking was an effective way to support 21 pastoralist livelihoods facing drought in a wider context of a dynamic livestock export trade (Cullis and Catley, 2012).

From the studies of Barton and Morton (2001) also destocking as the last option attributable to a probability of survival of livestock from drought and drought time livestock sales are characterized by low prices and poor livestock body condition. According to Riche *et al*. (2009) destocking is also one of the coping strategies in Gumbi Bordodde Woreda pastoralists but as the last option attributable.

2.6.3. Herd splitting and exchange

Herd-owners often respond to drought by dividing their livestock into small herds grazed separately and by prioritizing milk animals or some other category. However, this is rapidly changing, as livestock are becoming more marketable and family labor is being replaced by wage labor (Oba, 1990). Sharing of livestock within kinship networks, where animals are borrowed for subsistence purposes and reproduction is common in many pastoral societies and acts as a form of insurance for poorer households, as well as a way for wealthier households to spread risks and ensure a supply of herding lab our (Barton *et al.*, 2001). Practiced not only as means of risk spreading but also as means of maximizing use of scarce range resources. For example where there is plenty of browse and no grass, these areas are reserved for browsers (camels and goats), but where there is only grass without browse pastoralists was choose such areas for grazing of cattle and sheep. This practice shields the poorer households from the adverse impacts of drought while at the same time help the wealthier ones to spread risk during drought periods (Barton & Morton, 2001; Barton *et al.,* 2001). Although practiced by most pastoral communities, it is largely employed by the Turkana, Samburu, Rendille and Gabra pastoralists (Barton, 2001).

2.6.4. Livelihood diversification

Different livestock, livelihood diversification and market engagement strategies, reflecting differing access to market and resources, pushed by stresses and shocks (Eneyew and Bekele, 2012). In response to a rapidly diminishing rangelands resource base and the declining livestock productivity, pastoral households find themselves in a situation where they have to seek alternative income and subsistence means in order to obtain food and supplement declining supply of livestock products. Livelihood diversification has therefore become a common phenomenon in most pastoral households. Many pastoral communities in the recent past have embraced a wide variety of alternative income generating activities, usually taken on a more intense basis to cope with drought (Morton and Meadows, 2000).

The Gumbi Bordodde Woreda pastoralists uses different livelihood diversification options including strategy includes livestock diversification, early matured and drought resistant crop farming, hay making, conservation and feeding on crop residue, intercropping, temporal and spatial planting. As an alternative and complementary with pastoralism, the households are increasingly participating in farming as compared to the last four decades where almost no households involved in cultivation. Activities such as collection of firewood, charcoal burning, collection of gum Arabic among other activities are being practices.

2.6.5. Livestock diversification

This strategy involves use of a broad array of livestock species (cattle, camels, donkeys, sheep and goats), which utilize different parts of the forage and have varying resistance to drought (Kashaye *et al*., 1998). Accordingly, sheep and cattle are more sensitive to drought, whereas goats, donkeys and camels are more resistant to drought induced stresses (Ouma, 2011). Although common among some part of pastoral communities in Ethiopia, it‘s not much practical in the Gumbi Bordodde woreda Pastoral communities. But recently, pastoralists have started to include camels in their herds as a way to compensate high rates of cattle mortality (RoK, 2011; Argaw *et al*., 2015) similar to the trends observed in other African countries (Faye et al., 2012). Due to differences in their tolerance to water and feed shortage, and resistance to drought among species, multi-species herding is of vital importance in minimizing climate related risks (Doti, 2010).

Other coping strategies practiced by Gumbi Bordodde Woreda pastoralists are social assistant that is a deep-rooted ethos along with history of Gumbi Bordodde Woreda society. In East Ethiopia, clan support such as *buusaa gonofaa* (food and other resources sharing) are the most common social assistant during severe drought. It is a social assistance in which the rich or households whom livestock have survived from drought helps the households who has no and/or loss the whole livestock (Dirriba and Jemal, 2015). Borrowing is, on the other hand, a deep-rooted common strategy in pastoral area of Gumbi Bordodde to access finances for short period of time for different purposes such as food purchase, cultural affairs and other social duties.

2.7. Determinants of Drought Coping Strategy

Coping mechanism is influenced by different factors, from the factors, Sex is one factor which influence the selection of the coping strategy. According to Doyo *et al*. (2018) due to their physical and natural capability between two genders it can influence the selection of coping strategy. Dirriba and Jemal (2015) also stated that the households headed by female have more responsibilities in activities undertaken around the home than a man so more of the time male headed households have better chance than female household heads. Age is also another factor which influences the coping strategies, especially in increasing pastoral experiences toward the impacts. As the age of individual increases the burden of responsibility come with it. According to Indris and

Adam (2013) as age of the household head gets older, the burden on availability of labor force would increase and the household may have to carry out livestock production and other income generating activities causing vulnerability to food insecurity. Higher level of education is believed to be associated with access to information on improved technologies and higher productivity (Norris and Batie, 1987). Evidence from various sources indicates that there is a positive relationship between the education level of the household head and the adoption of improved technologies (Igoden *et al*., 1990; Lin, 1991) and adaptation to climate change. Also Deressa *et a*l. (2009) stated in his study Education can be influenced by all coping strategies even though it‘s not significant. Large size of family has high chance to cope towards the drought risks (Muse, 2011; Fufa, 2015; Doyo *et al*., 2018) they stated in their study that large family size has high chance to cope with both crops and livestock at drought time. Dilruba, (2012) stated that market distance also influences the selection of coping strategies, a long distance to the nearest market reduces the probability of participating livestock diversification like destocking, especially during drought time.

The number of livestock size especially, that holds large number have chance to earn and more susceptible during drought season. As Berhanu *et al*. (2008) stated in his study large livestock size pastoral, have better chance to earn more income.) the reality in Gumbi Bordodde pastoralist where the strategies of herd splitting, changing species composition, destocking, livestock migration and herd splitting is higher for the household with larger livestock holding. Credit provides opportunities to employ all possible coping strategies to overcome the devastating risk of drought impact. According to Asnake and Temesgen, (2010) where stated in their study access to credit is an important determinant for enhancing the adoption of various strategies to coping. Deressa *et al.* (2009) also implies the important role of increased institutional support in promoting the use of adaptation options to reduce the negative impact of climate change.

2.8. Empirical Review

2.8.1. Empirical studies on drought

The household economic portfolio approach, applied to an Andean community in the 1990s, reveals adjustments to drought events, changing market conditions, and new institutions, with sheep and cattle playing a prominent role as coping mechanisms during climatic stress periods (Valdivia, 2004). However, differences in the impact of these coping strategies on individuals within diverse rural livelihood strategies require distinct policy interventions for security. Study on rangeland degradation among Somali pastoralists in eastern Ethiopia underscores the failure of traditional coping Strategies due to environmental degradation and a lack of national policies. Kassahun *et al.* (2008)

Using data from the Mexican Migration Project, Hunter *et al.* (2014) model U.S. emigration from rural communities in relation to community, household, and climate factors, finding that households experiencing recent drought conditions are more likely to send U.S. migrants, especially in communities with strong migration histories. Silva *et al.'s* (2018) examination of the relationship between disaster frequency and localized poverty, Sharma *et al.'s* (2020) study on the coping Strategies in a refugee camp in Ethiopia, and Olubunmi, (2010) definition of drought as an abnormal water shortage highlights the multifaceted impacts of drought on communities, agriculture, and livelihoods.

The impact of drought on agriculture, including crop losses, livestock, and fisheries, has resulted in food price hikes, unemployment, and reduced incomes, particularly affecting small-scale households and pastoralists dependent on rain-fed agriculture. The vulnerability of these communities is exacerbated by their limited capacity to afford inputs for enhanced agricultural production (Munang *et al.*, 2013; Defferew., 2011).

2.8.2. Empirical studies on pastoralism

Pastoralists use mobility as a basic strategy for their livelihood development and risk management systems. Although African pastoral ecosystems are ancestral homeland to a substantial portion of the population for whom Pastoralism is a traditional way of life, Pastoralism is far from static. Pastoralists in many areas are adapting to trends such as new economic opportunities and better access to modern means of communication (AU/DREA, 2010). To adapt the changing climate, pastoralists and agro-pastoralists farmers have, therefore, adjusted and adapted themselves by evolving livelihoods mainly dependent on livestock and livestock-related activities and small-scale agricultural practices (Fre and Tesfagergis, 2013). Adaptation is necessary if the world is to manage the risks posed by Climate Change (Ford *et al.*, 2011; New *et al*., 2011; Stafford *et al*., 2011). There is an agreement that pastoral areas face an increased risk of drought events due to increased rainfall variability and high temperatures (IPCC., 2007). Climate change impact has pushed many of the households in the ASALs resort to a number of Adaptation strategies. It is evident that many pastorals and agro pastoral households have resorted to settling near trading centers and water points to access relief food, water without burdening their beast of burdens and to seek for casual employment and also to allow easy movement of their herds.

However, failure of such coping strategies might endanger the very own survival of the pastoralists and there is already some fear that pastoral livelihoods, especially in East Africa, are fast becoming unsustainable more rapidly than other forms of rural livelihood (Morton, 2010). The pastoralist might therefore be in danger of being the first environmental refugees. The pastoral and agro pastoral systems, therefore, needs more research on the impact of climate change (DFID, 2009). In the face of climate change and variability, populations that depend on agricultural systems may have to adjust their production technologies and practices if they are to continue meeting the food and livelihood requirements that they currently derive from these agricultural systems.

2.8.3. Empirical studies on impacts of drought

Drought has significantly impacted key sectors of the Horn of Africa's economy, including agriculture, water, biodiversity, tourism, and the social sector, leading to disruptions in livelihoods and environmental degradation (Munang *et al* ., 2013). Studies by Berhane *et al*. (2017) and Etwire *et al*.,2017 emphasize the multidisciplinary assessment of drought's impact on livelihoods, considering remote sensing, socioeconomic data, and household-level data to understand the complex interactions between drought and diverse livelihood components. In pastoral communities like *Guji* and *Borana*, drought has resulted in substantial livestock loss at the household level, contributing to food insecurity, poverty, and the need for alternative livelihoods (Béatrice *et al.,* 2009). Household responses to drought include storing crop produce, reducing expenses, and saving money, while adaptation mechanisms involve water harvesting infrastructure and water management measures (Udmale *et al* ., 2014); (Munang *et a*l., 2013).

Defferew, (2011) study on the impact of drought on livelihoods highlights the vulnerability of African agriculture to drought and coping strategies such as savings, migration, credits, and on-farm and off-farm diversification. However, coping strategies provided by institutions are weak, disproportionately affecting the poor, women, and other vulnerable groups. Matlou, (2021) Assessment of agricultural drought resilience reveals varied welfare improvements among smallholder farmers, emphasizing the importance of relief support. Sena, (2019) Review underscores the recurring nature of drought and its multifaceted impact on agriculture, livelihoods, and vulnerability factors, indicating gaps in addressing its effects despite efforts by policymakers.

2.8.4. Empirical studies on coping strategies of drought

This section reviews various empirical studies related to coping Strategies in the context of recurrent drought. Adger *et al.* (2020) analyze coping strategies, emphasizing the role of social capital. Chen *et a*l. (2018) use GIS technology to map spatial distribution, allowing targeted interventions. (Udmale *et al*, 2014) Employ time-series analysis to assess changes in coping strategies over multiple drought events. Roncoli *et al*. (2019) provide a meta-analysis of multiple empirical studies on drought impacts and coping strategies. Duba *et al.* (2021) focus on factors influencing choices of coping strategies in Southern Ethiopia. Teklegiorgis *et al*. (2021) assess the trends and prospects of camel and small ruminant production. Mehar *et al.* (2016) use a multivariate probity model to analyze decision-making on coping strategies. Bedeke *et al*. (2018) assess vulnerability to climate change among maize-dependent smallholders. (Gedefaw., 2018) Discuss diversifying crop types as an emerging adaptation strategy. Emiru *et al.* (2023) analyze proactive and reactive drought coping and adapting strategies.

As Betemariam *et al.* (2021) study drought, hunger, and coping Strategies among rural households, emphasizing integrated rural development strategies. Skinner Godey *et al.* (2019) uses multinomial logit models to identify the best drought coping strategies, highlighting proactive measures like collection and saving of pasture and soil and water conservation practices, and reactive strategies such as feeding roasted cactus for livestock and borrowing loans for small businesses. The studies collectively emphasize the importance of understanding diverse coping strategies to inform effective policies and interventions in the face of climate-induced challenges.

2.9. Applications of Indices of Drought, Impact and Coping Strategies

Indices of drought, impact, and coping strategies are used in various applications to understand and manage drought situations. Here are some common applications: We considered the number of studies about drought indices and drought impacts, respectively, and their geographicaldistribution as our metrics. We selected commonly used indices to depict operational types of droughts (Svoboda and Fuchs, 2016) and the indices commonly used by water managers (Bachmair *et al*.,2016).

2.9.1. Index of drought

Drought monitoring and early warning systems (DEWS) play a crucial role in predicting and addressing drought early on to minimize potential harm. These systems translate physical variables into drought indices like the palmer drought severity index, standardized precipitation index, and vegetation health index. While DEWS are essential, they often overlook the impacts of drought on water and food security, which are challenging to define and quantify due to diverse definitions and types of droughts (Mishra and Singh, 2010; (Wilhite *et al*., 1985) Wilhite, 2000; Santos Pereira *et al*., 2009). Assessing drought involves comparing index values with defined thresholds to determine severity, but the non-structural and prolonged nature of drought complicates this process Wilhite *et al*., 2007; Logar and Van den Bergh, 2011; Bachmair *et al*., 2016). Assessing drought involves the use of various indices. The Palmer Drought Severity Index (PDSI) (Palmer, 1965), Standardized Precipitation Index (SPI) (McKee *et al*., 1993), and the vegetation health index (VHI) (Kogan, 1995) are widely employed to quantify the severity and duration of drought events.

2.9.2. Index of socio-economic impacts of drought on pastoralism

Analyzing the socio-economic impact of drought on pastoral communities involves utilizing comprehensive indices. The Livestock Condition Index (LCI) (Morgan *et al*., 2001) and Forage Condition Index (FCI) Fernandez-Gimenez, 2002) assess livestock health and rangeland carrying capacity. The LCI considers factors like body condition and reproductive performance, while the FCI evaluates forage quality and quantity during drought stress. Recent research Walker *et al*. (2019) introduces modified indices like the Livelihood Vulnerability Index (LVI) and Smith and Jones (2015). The Pastoral Livelihood Resilience Index (PLRI), which incorporate variables such as income sources, food security, and access to basic services, acknowledging the interconnectedness of socio-economic factors. Study by Ahmed *et al*. (2020) The Household Livelihood Vulnerability Index (HLVI) further evaluates the impacts of recurrent droughts on pastoralist communities, considering asset vulnerability, social networks, and coping strategies. These evolving indices emphasize the importance of comprehensive metrics beyond traditional measures in assessing the socio-economic impacts on pastoralism during droughts.

2.9.3. Index of coping strategies of drought

Assessing coping Strategies during drought involves utilizing nuanced frameworks. The coping strategy index (CSI) (Ellis, 1998) and sustainable livelihoods framework offer insights into adaptive measures (Hassen and Assen, 2016). The household coping strategy assessment (HCSA) integrates water and food security, livestock management, and income-generating activities, while the community-based drought adaptation index (CDAI) Abdullahi *et al*. (2021) emphasizes communal strategies. Participatory approaches, such as the participatory rural appraisal (PRA), by Chambers (1994), involve local communities in identifying culturally relevant coping strategies. The pastoral risk management (PARIMA) model Fernandez Gimenez and Le Febre (2006), recognizes the cyclical nature of drought, incorporating proactive risk reduction and recovery measures. The Vulnerability and Adaptive Capacity Index (VACI) Mortimore and Adams (2001), offers a systematically evaluates pastoral households' vulnerability and adaptive capacity, considering socio-economic factors and livelihood flexibility. These frameworks collectively provide a comprehensive understanding of coping strategies, acknowledging the dynamic and multifaceted nature of drought impacts.

2.10. Conceptual Framework

Drawing on relevant theoretical frameworks, this section aims to establish a conceptual framework that guides the exploration of the impacts of drought on among Pastoral household and coping strategies. A conceptual framework shows a hypothesized representation that depicts the relationship between variables (Mugenda and Mugenda, 1999).

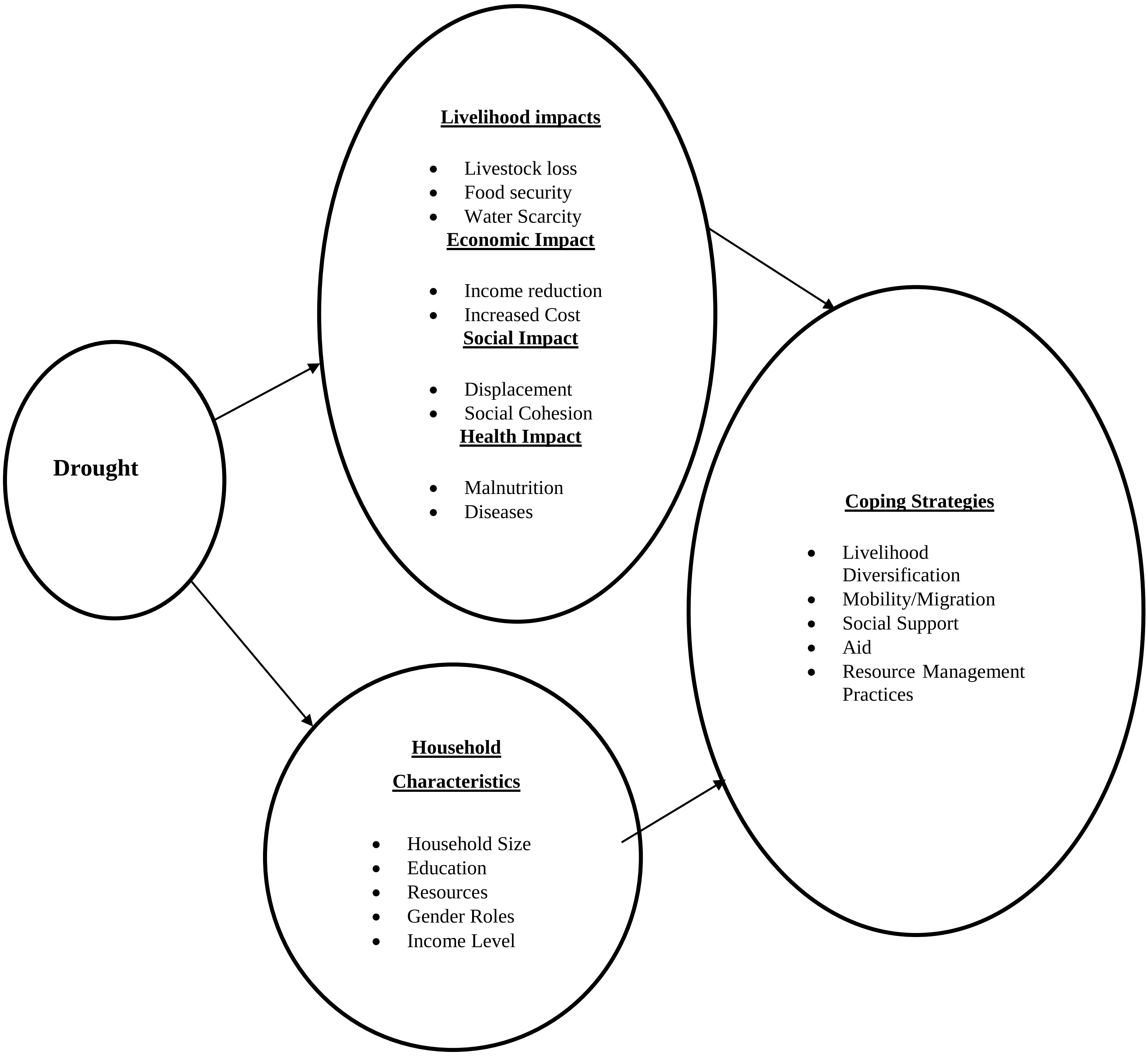

FIGURE 1.CONCEPTUAL FRAMEWORK FROM MUGENDA AND MUGENDA (1999)

3. RESEARCH METHODOLOGY

3.1. Description of the Study Area

3.1.1. Location and Size

Gumbi-Bordodde Woreda is located in the northern part of the Ethiopian Great Rift Valley, within the western Hararghe Zone of the Oromia Region. It lies 275 km northeast of Addis Ababa along the asphalt road to Djibouti. The main town of Bordodde is situated 73 km from Chiro, the administrative center of the western Hararghe Zone. Established in 2009 E.C. under the Oromia Regional State constitution, Gumbi-Bordodde Woreda is a predominantly pastoral and agro-pastoral area. It shares borders with Mieso Woreda to the east, Anchar Woreda to the west, Guba Koricha Woreda to the south, and Amibara Woreda in the Afar Region to the north. The woreda consists of 29 kebeles, including one urban and 28 rural kebeles, of which 17 are pastoral and 11 are agro-pastoral (Gumbi Bordodde Woreda Administration, 2022). Geographically, Bordodde is located at a latitude of 8°50'49" N and longitude of 40°10'00" E, with an elevation ranging from 800 meters above sea level at the Burii Araba plain to 2,580meters at Gumbi Mount (Gumbi Bordodde Woreda Administration2022).

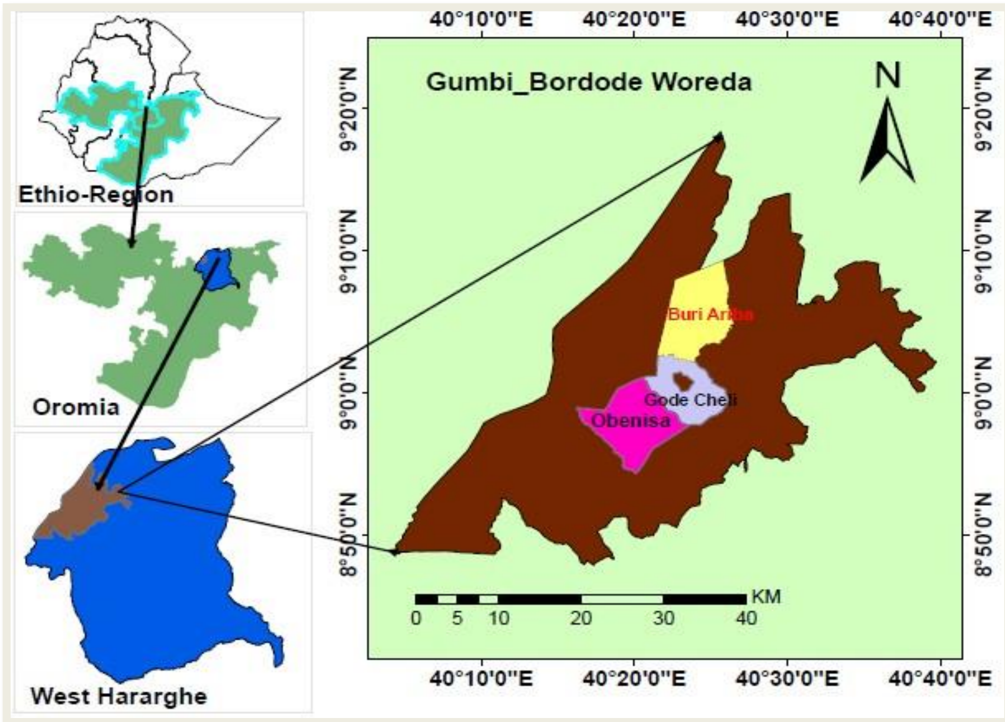

FIGURE 2. MAP OF THE STUDY AREA

3.1.2. Topography and Soils

The woreda encompasses an area of 1089.913 km^2 which comprise three distinctive agro-ecological landscapes: The steep slope is 2.76 %, gentle slope 6.33 %, and flat land area covers 26.20 % of the total size of the woreda as we have seen in fig.(3). The average landscape of the woreda is characterized by extensive grassland plains as well as savannahs, bush lands and woodlands with Acacia and thorn bush. Soil type of woreda is 75% silt soil, sandy soil 10% and others 15%. (Gumbi Bordode Woreda Administration, 2022).

3.1.3. Climate and Drainage

The Woreda is a semi-arid ecosystem with annual rain fall range between 410 and 700 mm. The rainfall pattern is bimodal with two distinct seasons. Short rains occur during March and April while long rains occur during July and August. The temperatures range from 15^0C to 40^0C. The months October to January are the coolest while the warmest temperature prevails during May and June.

3.1.4. Vegetation and Wildlife

Agriculture and livestock farming are the main source of livelihood for the people of the study area to get their daily food and income. Gumbi-Bordodde Woreda is mainly characterized with pastoralist farming system with some of them are agro-pastoralists. The woreda is mainly known by livestock raring since it is under one of pastoralist area in the west Hararghe zone. Even though, the community is characterized as pastoralist, some of them produce crop like sorghum, maize and Haricot bean for food. Rainfall during the main rain is unpredictable and erratic, and as a result, Crops fail in most years due to lack of even distribution of rainfall. In 17 of the 29 kebeles, the Predominant agricultural practice is pastoralism; some pastoralists are sedentary and other migrates with their herds in search of forage and water.

3.1.5. Population Characteristics

According to data obtained from Ethiopia Statistical Service (2024) report, the total population of the Gumbi-Bordodde Woreda 178,915 out of which 92,920 and 85,995 are male and female respectively. From the total population of the about 52,589 is urban dwellers whereas 126,326 is rural resident. The crude population density of the woreda is 104.5 Out of the total population of the woreda; about 51.93 percent is male while the female constitutes about 48.06 percent of the population in the woreda. The Oromo, Somali and other ethnic groups are inhabited in the woreda. Historically the woreda/cluster was comprised of both the current Oromia-Miesso, Somali region Gumbi-Bordodde as well as some part of the afar regional state. Nevertheless, the Miesso clusters are characterized by manifest differences and sub-group identifications that reflect intricate linguistic, religious, historic and settlement patterns and interactions (Ethiopia Statistical Service Chiro Branch office, 2024)

3.1.6. Socioeconomic Settings

Gumbi-Bordodde Woreda is one of the woreda in Oromia found in the rangelands of northeast and extensive grazing areas of the eastern Ethiopia, with 257,344 Hectares (ha) total land area, practicing pastoral and agro-pastoral system. Agriculture and livestock farming are the main source of livelihood for the people of the study area to get their daily food and income. Gumbi-Bordodde Woreda is mainly characterized with pastoralist farming system with some of them are agro-pastoralists. The woreda is mainly known by livestock raring since it is under one of pastoralist area in the west Hararghe zone. Even though, the community is characterized as pastoralist, some of them produce crop like sorghum, maize and Haricot bean for food.

Rainfall during the main rain is unpredictable and erratic, and as a result, Crops fail in most years due to lack of even distribution of rainfall. In 17 of the 29 kebeles, the Predominant agricultural practice is pastoralism; some pastoralists are sedentary and other migrates with their herds in search of forage and water. Cattle and goats are the most common livestock (Gumbi-Bordodde Woreda Agricultural office, 2023). The woreda has a total number of 29 Peasant Associations and 1 town dwellers associations

3.2. Research Design

The research design selected for this study was a cross-sectional design, which involves examining data from multiple cases at a single point in time. This approach facilitates identifying relationships between two variables at a specific moment without altering the conditions (Kothari, 2004). The study followed a two-phase process: first, qualitative data was gathered through survey questionnaires, followed by key informant interviews and focus group discussions to verify and enhance the information collected. Using a mixed-methods approach, this research was aimed to provide a thorough understanding of the socioeconomic impact of drought. The study evaluated the extent of drought’s effect on households and identified the coping strategies employed by households in the study area. By combining both quantitative and qualitative methods, the analysis was enriched, offering a more comprehensive view and deepening the insights drawn from each research objective.

3.3. SamplingTechnique,Target Population, and Sample Size Determination

3.3.1. Sampling Technique

This study was used simple random sampling techniques was apply to select both kebele and research participants. Gumbi-Bordodde Woreda has 17 pastoralists' kebeles with a total population of 106,944. The total household's size is 15,460. But the total household's size of the three kebeles are 1975. For this study, a simple Random sampling method was used to select respondents. Within the woreda farm households are stratified into pastoral (strata) depending on the predominant production system leading to stratification into pastoral system (livestock production) villages.

After identifying all kebeles in the pastoral system, the investigator represented three (3) kebeles from pastoral in such a way that those kebeles represents the pastoral communities in biophysical and socio-economic aspects. Accordingly, (Obenisa, Buri Ariba and Goda Calle) from pastoral kebeles were selected from the Woreda purposively. The number of households in each target kebeles are identified and sample size was determined using statically procedures.

3.3.2. Target Population Pastoral Area

It is from the entire population that the study comes up with the target population. The target population helps in generalization of the results of the study (Cooper & Schindler, 2015). In this study the target population is defined as Gumbi-Bordodde Woreda has 17 pastoralists kebeles with a total population of 106, 994(Gumbi-Bordodde Woreda Administration, 2023).

3.3.3. Sample Size Determination

To determine the sample size of the study Yamane's (1967), a simplified formula of calculating sample size was be used. Based on this formula the confidence level of this study is 93% and the margin of error is 0.07 due to nature of the study and population variability. When studying pastoral communities and drought impacts, researchers may encounter higher variability in responses due to diverse coping strategies and economic conditions.

The formula to calculate the sample size is:

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

Where: n=sample size,–N=population size,–e = Level of precision or sampling error =0.07.

Accordingly, $\mathbf{n} = \frac{1975}{1+1975(0.07)^2} = \mathbf{185}$

Hence, the representative sample size for this study was 185 Household Heads, from selected kebeles. Then the study used simple random sampling method to choose the members within the selected three *kebeles*. The study used Neyman Optimum Allocation formula (Wright, T., 2012) to distribute the respondents into selected pastoral Kebele. The purpose of the method is to maximize survey precision, given a fixed sample size. With Neyman allocation, the best sample size for Kebeles h (Obenisa, Buri Ariba and, Goda Calle) was:

$$nh = \left(\frac{Nh}{N}\right)n$$

Where: Nh =The sample size for Kebeles h, (Obenisa , Buri Ariba and Goda Calle)

n = Total sample size of the study,

Nh = The household heads for kebele h, (Obenisa, Buri Ariba and Goda Calle)

N - The total population of the study

Table 1: Total number of sample size from each kebeles

Selected Kebeles	Household heads of kebeles	Sample Size
Obenisa	621	58
Buri Ariba	814	76
Goda Calle	540	51
Total	1975	185

3.4. Data Types and Sources

The research used both primary and secondary data to conduct this research.

3.4.1. Primary Source of Data

The primary data collected from household by survey, key informants' interview, and focus group discussions (FGD) and observation.

3.4.2. Secondary Source of Data

The secondary climate data stations were taken from Ethiopian Meteorological Institute from 1991 to 2020. In addition, others are acquired and reviewed from the, published and unpublished documents of Gumbi-Bordodde Woreda Agriculture Office annual reports, and other related websites documents.

3.5. Methods of Data Collections

3.5.1. Household Survey Questionnaire

The questionnaire with both quantitative and qualitative responses was dominant tool used for data collection (Bryman, 2016). Semi structured questionnaire that includes both open and close ended were designed and employed to generate quantitative data from respondents. The main contents of the questionnaire were be personal information of the respondent Socioeconomic Characteristic, perception on variability and trends of drought incidences, impacts and coping strategies.

3.5.2. Focus Group Discussion

Data was also collected from focus group conversations and crucial snitch interviews for triangulation and standardization of questionnaire- grounded data. Focused group discussion was conducted to assess the information in regard to the trends of failure in the Woreda adaption/ managing strategies they use ahead and after the shocks and to know the institutional response strategy give for them ahead after the extremity. In this study three focus group discussions were conducted at the three kebeles with purposively selected knowledgeable community members consisted of elders, youth and women and service providers such kebele leaders, health assistances and veterinary workers. The three focus groups discussion consisting of 36 peoples were attended. The information obtained from focus group discussions was analyzed and checked with those obtained by other methods for triangulation.

Table 2: Total number of sample size from each kebeles

Selected Kebeles	Sex		Total
	Males	Females	
Obenisa	10	2	12
Buri Ariba	9	3	12
Goda Calle	10	2	12

3.6. Methods of Data Analysis

Before the analysis, some pre-analysis activities such as filling of the missing years from Archives of the station, adjustment of incomplete data and adjustment of outliers and Homogeneity test employed for quality data.

Accordingly, data of rainfall, minimum and maximum temperature captured into Microsoft Excel, 2016 following the days of a year (DOY) entry format. Data from the respondents was verified, compiled, coded and summarized and analyzed using the Statistical package for social science (SPSS) and excel computer programs. The results were summarized and presented using frequencies, tables and graphs.

Historical meteorological data (rainfall and temperature data) from 1991-2020 was used to characterize the climate of the study area. During data analysis descriptive statistics such as; minimum, maximum, mean, standard deviation, and coefficient of variation are used in the process to characterize and describe rainfall and temperature variability at different time scale; monthly, seasonal and annual. Trends of the climate variables was assessed using Mann-Kendall trend test and Sen´s slope estimator.

3.6.1. Standard Precipitation Index Computation

SPI was used to identify the meteorological drought or deficit of precipitation for multiple timescales in the studied stations (McKee, 1993). The SPI4 for three seasons;

belg (FMAM), kiremt (JJAS) and Bega (ONDJ) and SPI12 (annual) were determined using Drinc C software expressed mathematically as follows:

$$SPI_{ij} = \frac{X_{ij} - \mu_{ij}}{\delta_{ij}}$$

Where SPI_{ij} is the SPI of the ith month at the jth timescale, X_{ij} is rainfall total for the ith month at the jth time scale, μ_{ij} and aij are the long-term mean and standard deviation associated with the ith month at the jth time scale, respectively. McKee *et al*. (1993) first defined the index and the criteria for drought classifications by SPI values. In this research, the modified classification of Mondol *et al*., (2015) was followed Table 3.

Table 3: Total number of sample size from each kebeles

Drought classes	SPI precipitation regime
SPI ≥2.0	Extremely wet
1.5≤SPI<2.0	Very wet
1.0≤SPI≤1.5	Moderately wet
-1.0<SPI<1.0	Near normal
-1.5<SPI<-1.0	Moderate drought
-2.0<SPI≤-1.5	Severe drought
SPI≤-2.0	Extreme drought

6.6.2. Analysis of temperature and rainfall characteristics

To characterize temperature and rainfall variability daily temperature and rainfall data for a period of 30 years (1991-2020) were rearranged in a monthly and annual time step in Microsoft excel spreadsheet. The rearranged data were averaged over the thirty-year time span and analyzed in order to examine the monthly, seasonal and annual variability and trend.

In order to examine the observed and future temperature and rainfall variability of Gumbi-Bordodde woreda; statistical tools like mean, standard deviation (SD), coefficient of variation (CV) was used in Instat (v 3.37) statistical software. Coefficient of variability was used to classify the degree of temperature and rainfall characteristics variability as less, moderate and high. When CV < 20% it is less variable, CV from 20% to 30% is moderately variable, and CV > 30% is highly variable. Areas with CV > 30% are said to be vulnerable to drought (Hare, 1983; Gebremichael *et al.*, 2014). Scientifically, it is computed using the following formula:

$$\mathrm{CV} = \frac{SD}{\overline{X}} * 100 \qquad \text{equation (1)}$$

Where CV is Coefficient of variation, SD is the standard deviation and $\overline{X}$ is mean. According to Reddy (1990), the stability of rainfall is examined as follows: when standard deviation < 10 as very high stability, 10-20 as high stability, and 20-40 as moderate stability and > 40 as less stability. Where SD can be computed as:

$$SD = \sqrt{\left[\sum_{i=1}^{n} \frac{(xi-\overline{x})^2}{n}\right]} \qquad \text{equation (2)}$$

Standardized Anomaly Index (SAI): Moreover, SAI was used to detect the variability and nature of the trend. It is determined a

$$\mathrm{Z} = \frac{X - \overline{X}}{SD} \qquad \text{equation (3)}$$

Where, Z is number of standard deviations of the observation deviated from the normal, x is an observed rainfall value and $\overline{X}$ is mean rainfall and SD is the standard deviation. These statistics are enabled us to determine the dry (-ve values) and wet (+ve values) years in the observation.

3.6.3. Analysis of rainfall and temperature trend

For rainfall and temperature variables, trend test was carried out using the non-parametric Mann-Kendall's trend test which is less sensitive to outliers and test for a trend in a time series without specifying whether the trend is linear or non-linear (Partal and Kahya, 2006; Yenigun *et al.,* 2008; Hadgu *et al.,*2013). The Mann-Kendall's test statistic is given as:

$$S = \sum_{i=1}^{N-1} * \sum_{j=i+1}^{N} sgn\left(x_j - x_i\right) \quad \text{equation (5)}$$

Where S is the Mann-Kendal's test statistics; x_i and x_j are the sequential data values of the time series in the years *i* and *j* (*j* > *i*) and *N* is the length of the time series. A positive *S* value indicates an increasing trend and a negative value indicates a decreasing trend in the data series. The sign function is given as

$$sgn\left(x_{j-} x_x\right) = \begin{Bmatrix} +1\, if & \left(x_{j-} x_i\right) & > 0 \\ 0 \;\; if & \left(x_j - x_i\right) & = 0 \\ -1 \;\; if & \left(x_{j-} x_i\right) & < 1 \end{Bmatrix} \quad \text{equation (6)}$$

The variance of *S*, for the situation where there may be ties (i.e., equal values) in the *x* values: $\text{var(S)} = \frac{1}{18}[N(N-1)(2n+5) - \sum_{i=1}^{m} t_i(t_i-1)(2t_i+5)]$
equation (7)

Where, *m* is the number of tied groups in the data set and t_i is the number of data points in the i^{th} tied group. For n larger than 10, Z_{MK} approximates the standard normal distribution (Partal and Kahya, 2006; Yenigun *et al*., 2008) and computed as follows

$$Z_{MK} = \begin{Bmatrix} \frac{S-1}{\sqrt{var(S)}} & if & S > 0 \\ 0 & if & S = 0 \\ \frac{S+1}{\sqrt{var(S)}} & if & S < 0 \end{Bmatrix} \quad \text{equation (8)}$$

The presence of significant trend is evaluated using the Z_{MK} value. In a two-sided test for trend, the null hypothesis *Ho* should be accepted if $Z_{MK} < Z_{1-\alpha/2}$ at a given level of significance. $Z_{1\text{-}\alpha/2}$ is the critical value of Z_{MK} from the standard normal table.

3.6.4. Data quality control and Reliability of Data

Data of rainfall, minimum and maximum temperature were captured into Microsoft Excel, 2016 spreadsheet following the days of a year (DOY) entry format. Data quality control was done by careful inspection of the completeness and temporal consistency of the rainfall and temperature records in the study area. Missing values in the data series were filled by using Markov chain first order simulation models of INSTAT (Stern *et al.*, 2006). This is because of the fact that first order doesn`t exaggerate the result and it give an accurate model estimate (NMSA, 1996b and Stern *et al*, 2006). Data outlier detection and homogeneity test of rainfall and temperature data for studied station was carried out using XLStat software.

Reliability of measurement was established by examining the stability and consistency of the data. Reliability according to Mugenda (2003) implies the consistency and stability of measurement from one use of scale of the scale to the next. The questionnaire (both open ended and close ended questions) was translated into local language Afan Oromo and before conducting the final administration of the questionnaire, pilot test was be made on one randomly selected kebele.

3.6.5. Multiple regression model

The Model was developed using twelve explanatory variables or predictors, which had influences on pastoral coping strategies. In this study, the equation of multiple regression models was; $Y= \beta o + \beta 1X1+ \beta 2X2+$ and $\beta 3\ X3$, where; Y-is the value of the dependent variable (Pastoral Coping strategies). $\beta 0$ – show the average effect on Y if all variables are excluded from the model. The parameters $\beta 1$, $\beta 2$, and $\beta 3$ are the regression coefficients of parameters X1-X3-independent variables Where (X1- Socio-Economic, X2-Water and Pastureland, and X3- Environmental impact, ε - The total error of prediction (residual).

3.7. Ethical Considerations

The research was adhere to ethical standards, ensuring informed consent, confidentiality, and voluntary participation of the respondents. The investigator was acquired primary information through questionnaires, FGD and Interview to key informants was another method that the investigator employed for the study.

RESULTS AND DISCUSSIONS

4.1. Demographic and Socio-economic Characteristics of the Farmers (respondant) involved in the Study

4.1.1. Gender and Age distribution of the farmers

The gender aspect of climate variability impact analysis is crucial for developing countries like Ethiopia, where socio-economic activities were highly vulnerable. The survey revealed that 145 (78%) of respondents were male, while only 40 (22%) were female, indicating that most household heads in Gumbi-Bordodde were male. The data also showed that the majority of household heads in the study area were aged between 20 and 60, with 136 (74%) falling within this range. Those under the age of 20 represented 19% of the respondents. Given that most farmers fall within the 20-60 age range, this suggests a relatively young farming population with significant potential for sustainable agricultural development in Gumbi-Bordodde Woreda. According to the survey, 142 (77%) of respondents were married, 22 (12%) were single, 10 (5%) were widowed, and 11 (6%) were divorced. These findings suggest that the majority of household heads are married, indicating their role as responsible providers for their families.

4.1.2. Educational status of respondents

Literacy plays a crucial role in understanding facts, such as those related to drought, and in fostering changes to our lifestyles or strengthening our resilience, coping mechanisms, and mitigation strategies against various climate hazards. It contributes to enhancing work efficiency, competence, income, technology adoption, and the ability to create an environment that supports long-term education for dependents, ultimately leading to improved living conditions compared to those who are illiterate (Twongyirwe et al., 2019).

The results from the current study, shown in Table 4 below, reveal that approximately 52% of household heads in the study area have not received any formal education, while about 48% have attended different levels of formal schooling. This suggests that the high illiteracy rate in the Gumbi-Bordodde woreda has negatively affected the adoption and implementation of potential adaptation strategies to mitigate the impact of drought on agricultural production. Among the household heads, 36% have

Completed primary education, and 9% have attended secondary school, indicating a relatively good literacy level among the sample households in the study area. Other research supports this, showing that the education level of household heads influences the adoption of adaptation strategies, as those with higher education are more likely to implement climate change adaptation measures (Deressa et al., 2011). Furthermore, this study aligns with the findings of Twongyirwe et al. (2019), who reported that 61.4% of respondents were illiterate, while 38.6% were literate in the Raya Chercher and Raya Azebo woredas of southern Tigray, Ethiopia.

Regarding farm size, the majority (70%) of respondents managed farms ranging from 0.5 to 1.5 hectares, while 14% had land sizes smaller than 0.5 hectares. A smaller portion (17%) of farmers owned between 1.5 and 2 hectares of land (Table 4). This suggests that farmers in the study area face challenges in coping with the effects of climate variability and drought due to the limited size of their land. Consequently, land size emerges as a key factor contributing to the vulnerability of farmers to poverty in this region. Additionally, the study found that 61% of farmers had household sizes ranging from 6 to 10 members, indicating relatively large households. This is a significant factor in agricultural production in the area. Farmers with larger land holdings may find it easier to access new and improved agricultural technologies introduced in the region. Supporting this, previous studies by Taddesse (2011) and Tessema et al. (2013) also highlighted that farmers with larger land holdings are more likely to adopt various climate change adaptation strategies compared to those with smaller land area

Table. 4 Summary of gender, age group, marital status, educational status and farm size

		Kebeles							
		Obenisa		**Buri Ariba**		**Goda Calle**		**Total**	
	Variable	Freq	%	Freq	%	Freq	%	Freq	%
Gender	Male	48	83	56	74	41	59	145	78
	Female	10	17	20	26	10	14	40	22
	Total	58	100	76	100	51	100	185	100
Age group	< 20	8	14	11	14	16	31	35	19
	20 – 60	45	78	58	76	33	65	136	74
	>60	5	9	7	9	2	4	14	8
	Total	58	100	76	100	51	100	185	100
Marital status	Married	48	83	56	74	38	75	142	77
	Single	3	5	12	16	7	14	22	12
	Widowed	3	5	3	4	4	8	10	5
	Divorced	4	7	5	7	2	4	11	6
	Total	58	100	76	100	51	100	185	100
Educational level	Illiterate	30	52	39	51	28	55	97	52
	Primary school	22	38	26	34	19	37	67	36
	Secondary school	6	10	7	9	4	8	17	9
	Higher education	0	0	4	5	0	0	4	2
	Total	58	100	76	100	51	100	185	100
Size of farm size(Ha)	<0.5ha	14	24	8	11	3	6	25	14
	0.5-1ha	26	45	21	28	15	29	62	34
	1-1.5ha	14	24	32	42	21	41	67	36
	1.5-2ha	4	7	15	20	12	24	31	17
	Total	58	100	76	100	51	100	185	100
Household Size	< 6	20	34	28	37	13	25	61	33
	6 – 10	36	62	47	62	29	57	112	61
	> 10	2	3	1	1	9	18	12	6
	Total	58	100	76	100	51	100	185	100

4.2. Rainfall Amount Variability and Trend

As shown in Table 5 below, the average annual rainfall of Gumbi-Bordodde were 761mm with CV of 105% and SD of 48 mm. On average *belg* rainfall amounts of Gumbi-Bordodde weather stations was 269 mm with less stability (SD = 59) and high variability (CV 98%). Similarly, the average *Kiremt* rainfall amounts Gumbi-Bordodde were 410 mm with less stability and high variability. High CV was observed in *Belg* rainfall amount than *Kiremt* at station. Similarly, all month's rainfall amount had reviled high variation at the station.

At Gumbi-Bordodde woreda February, March, August, *Belg* and annual rainfall amount have been experienced non-significant decreasing trend while April, May, June, July, September, November, December, *Kiremt* and Bega rainfall amount have been experienced non- significant increasing trend in the woreda. *Belg* rainfall amount showed significant decreasing trend by -1.42 mm per year but *Kiremt* and *Bega* rainfall amount had showed no significant increasing trends by a factor of 0.66 and 0.17mm/year in the woreda.

The result is consistent with the findings by Belay et al., (2021) in Southern Ethiopia using time series analysis for the period 1983-2016 and noted that the seasonal trends of rainfall amount *for Belg, Kiremt,* and *Bega* seasons was -1.935 mm/year, 1.841 mm/year and 0.568 mm/year respectively. Whereas the declining trend of *belg* season was statistically significant. The observed decreasing trend of the *Belg* rainfall might be caused by the atmospheric– oceanic processes that influence rainfall in the region. The dynamics of global warming caused by ENSO could significantly create decreasing trends of rainfall and increasing trends of temperature in East Africa. A 1℃ increase of annual temperature in El Niño 3.4 SST region could decrease about 79 mm/year, particularly in East Africa (Matthews *et al.*, 2018). Following such dry conditions, possible adaptation and mitigation measures such as conservation agriculture and climate-smart options should be put in place (Seleshi, Y. and Zanke, U. 2004, Gashaw *et al*., 2014). Moreover, the current study is consistent with the findings of Fitsum *et al*. (2017) reported that, annual and *belg* rainfall showed a statistically no significant decreasing trend over most of the stations in Bale zone 1983-2013. Similarly, Wasihun *et al*. (2019) have reported high variability of seasonal and annual rainfall amount and non-significant decreasing trend of *Belg* and annual rainfall amount for the period 1988-2017 at Habro woreda, west Hararghe zone.

Table 5 Monthly, seasonal and annual rainfall amount variability and trend (1991- 2020)

Varables	Mean	Min.	Max.	SD	CV %	Sen's slope	p-value
January	20	0	150	33	163	0.00	0.70
February	33	0	239	47	44	-0.03	0.51
March	69	0	247	63	92	-1.04	0.05
April	103	0	371	72	70	0.25	0.72
May	64	0	230	55	86	0.31	0.53
June	47	5	110	27	57	0.38	0.09
July	137	0	267	65	48	0.98	0.22
August	138	19	296	64	46	-0.96	0.18
Sepember	88	0	168	41	47	0.61	0.08
October	34	0	361	62	185	-0.02	0.82
November	18	0	97	26	140	0.22	0.00
December	10	0	100	19	184	0.00	0.21
Belg	269	11	771	59	98	-1.42	0.18
Kiremt	410	75	645	49	50	0.66	0.50
Bega	82	0	439	35	168	0.17	0.73
Annual	761	282	1172	48	105	-1.28	0.43

4.3. Temporal Tempirature variability and tren

At Gumbi-Bordodde mean annual maximum temperature ranged 29.51–31.63°C and average of 30.72°C while mean annual minimum temperature ranged 14.05–16.88°C and average of 15.39°C and both maximum and minimum temperature had showed stable degree of hotness(SD < 2℃).

At Gumbi-Bordodde belg and *Bega* maximum temperature showed significant warming trend whereas *kiremt* and annual maximum temperature showed non-significant warming trend. Moreover, at except February March and November all months, season and annual minimum temperature showed significant warming trend (Table 6). As indicated in the table 6 below, CV and SD of *kiremt and belg* maximum temperature was 3.00% and 1.00°C and 4.5 % and 1.4℃ respectively, this indicates that *kiremt and belg* maximum temperature was less variable and stable in degree of hotness (Figure 7). The study is in agreement with the finding of Wasihun *et al*. (2019) who reported annual minimum temperature showed significant (p = 0.01) increasing trend by the factor of 0.06°C per year (0.6°C per decade) and significant increasing trend of annual maximum temperature by 0.02°C per year of at Habro woreda, west Hararghe zone. Likewise, Gebrehiwot and Veen (2013) reported that average annual minimum and maximum temperature in Tigray region has been increasing by about 0.72 ºC and 0.36 ºC, respectively every ten years over the period 1954-2008.4.3.1. Maximum temperature variability and trend

Table 6. Monthly, seasonal and annual maximum temperature variability and trend (mankkandlle) P- value

Variables	Mean	Min.	Max.	SD	CV %	Sen's slope	p-value
January	28.22	26.86	29.81	0.88	3.10	0.01	0.429
February	29.62	25.27	32.18	1.60	5.40	0.02	0.323
March	30.80	27.55	33.11	1.25	4.10	0.02	0.252
April	31.70	29.04	33.33	1.40	4.40	0.10	< 0.01
May	33.44	30.11	35.07	1.34	4.00	0.08	0001
June	33.57	31.11	35.06	0.81	2.40	0.03	0.192
July	31.74	29.70	33.72	1.07	3.40	0.09	< 0.01
August	30.40	28.69	31.82	0.86	2.80	0.04	0.010
September	30.86	28.60	33.4	1.08	3.50	0.08	0.001
October	30.92	27.59	32.40	1.18	3.80	0.07	0.011
November	29.17	27.68	31.68	1.08	3.70	0.05	0.022
December	28.15	26.73	29.15	0.66	2.40	0.02	0.003
Belg	31.39	28.86	32.57	1.4	4.5	0.05	< 0.01
Kiremt	31.64	30.15	32.88	1.0	3.0	0.06	0.363
Bega	29.12	28.15	30.12	0.9	3.3	0.01	0.01
Annual	30.72	29.51	31.63	1.1	3.6	0.04	323

4.3.2. Minimum temperature variability and trend

Table 7. Gumbi Bordodde monthly, seasonal and annual minimum temperature variability and trend

Variables	Mean	Min.	Max.	SD	CV%	Sen's slope	p-value
January	12.07	8.50	14.28	1.44	11.90	0.05	0.05
February	13.23	8.38	15.34	1.69	12.70	0.02	0.61
March	15.28	11.60	16.69	1.16	7.60	0.01	0.72
April	17.32	15.02	19.35	1.34	7.70	0.13	< 0.01
May	18.17	16.17	20.65	1.56	8.60	0.15	< 0.01
June	18.46	16.04	20.64	1.44	7.80	0.16	< 0.01
July	17.80	15.00	18.79	1.06	5.90	0.08	< 0.01
August	17.49	13.93	18.48	0.88	5.00	0.04	< 0.01
September	17.41	15.37	19.83	1.49	8.60	0.14	< 0.01
October	14.89	12.25	17.63	1.78	12.00	0.15	0.0002
November	11.25	7.30	13.92	1.17	10.40	0.01	0.24
December	11.35	8.07	15.08	2.19	19.30	0.12	0.03
Belg	16.00	14.33	17.50	1.43	9.15	0.08	0.0002
Kiremt	17.79	15.08	19.29	1.22	6.83	0.12	< 0.01
Bega	12.39	10.75	13.84	1.64	13.40	0.09	0.01
Annual	15.39	14.05	16.88	1.43	9.79	0.10	< 0.01

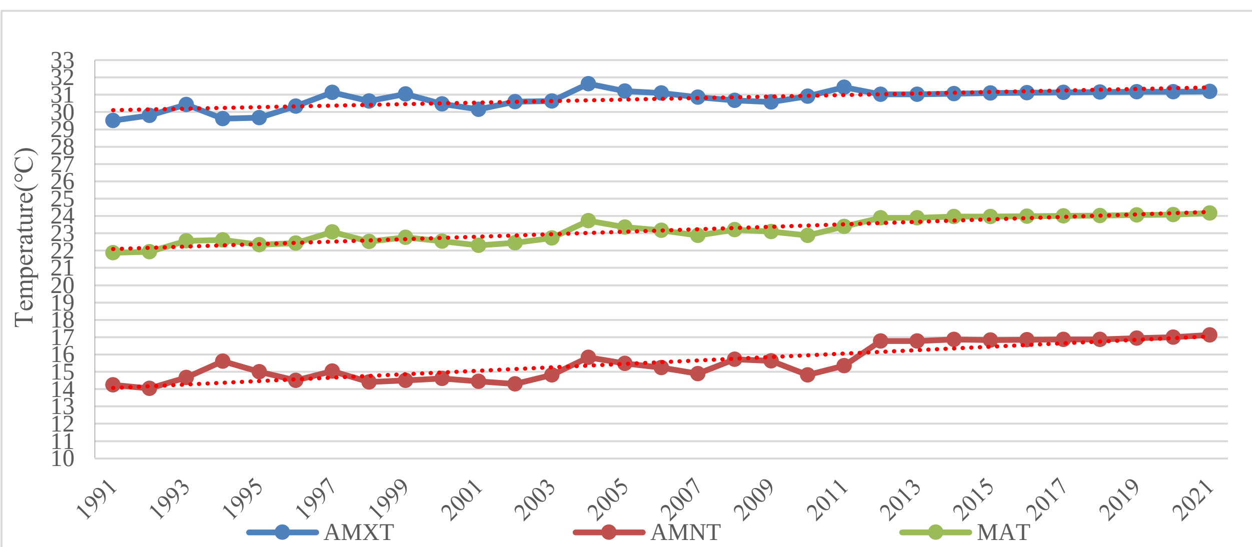

FIGURE 3. ANNUAL MAXIMUM TEMPERATURE VARIABILITY AND TREND

4.4. Drought Period & Trend Analysis Using Standard Precipitation Index Values

As shown in the Table 7, 8 and Figure 7, the result of belg SPI value showed precipitation regime as;, the extremely wet year was 1992, very wet was 1993, moderately wet 2013 and 2016, near normal year was; 2005,2011,2012,2001,1997,2002,2020, 1999, 2010, 1995, 1996, 2006, 2014, 2003, 2007, 2004, 2018, 1998, 2019, 2017, 2000, 2008, 1994 and 2009 year, moderate drought occurred in 2015 year, there is no severe drought occurred ,extreme drought occurred 1991 during the study period and in Gumbi-Bordodde Woreda as Shown in the Table 7, 8 and Figure 7.

Table 8. Drought Severity of Seasonal (SPI-4) and Annual (SPI-12)

Year	Belg SPI	Kiremt SPI	Annual SPI
1991	-2.56	1.80	-0.25
1992	2.70	-0.82	0.89
1993	1.69	0.93	1.50
1994	0.78	0.72	1.03
1995	-0.26	-2.03	-1.76
1996	-0.21	-1.40	-1.40
1997	-0.79	-1.25	-1.61
1998	0.27	-1.13	-0.97
1999	-0.51	-0.16	-0.40
2000	0.56	-0.95	0.50
2001	-0.79	0.10	-0.03
2002	-0.69	0.34	0.42
2003	-0.01	-0.64	0.70
2004	0.04	0.58	0.20
2005	-0.96	-1.54	-1.58
2006	-0.16	1.37	0.80
2007	0.01	0.05	0.29
2008	0.65	0.77	0.72
2009	0.88	1.49	1.84
2010	-0.42	0.98	0.23
2011	-0.84	-0.27	-0.42
2012	-0.82	-1.04	-1.48
2013	1.43	0.47	0.91
2014	-0.15	-0.34	-0.68
2015	-1.18	0.42	-0.87
2016	1.07	0.60	1.20
2017	0.50	0.63	0.54
2018	0.06	-1.18	-1.05
2019	0.42	0.88	0.82
2020	-0.68	0.62	-0.10

4.5. Seasonal and Annual SPI Precipitation Regime and Years of observation

4.5.1. Belg SPI precipitation regime and year of observation

Table 9. Belg SPI Precipitation Regime and year of observation

Range of SPI Values	Years of observation	Precipitation regime
SPI ≥2.0	1992	Extremely wet
1.5≤SPI<2.0	1993	Very wet
1.0≤SPI≤1.5	2013 2016	Moderately wet
-1.0<SPI<1.0	20052011 2012 2001 1997 2002 2020 19992010 1995 1996 2006 2014 2003 2007 20042018 1998 2019 2017 2000 2008 1994 2009	Near normal
-1.5<SPI<-1.0	2015	Moderate drought
-2.0<SPI≤-1.5	-	Severe drought
SPI≤-2.0	1991	Extreme drought

As shown in the Table 9, 10 and Figure 8, analysis the result of kiremt SPI value showed precipitation regime as; there is no year in which extremely wet year occurred, very wet was 1991, moderately wet 2006 and 2009, near normal year was; 2015,2011, 2001, 2002, 2020, 1999, 2010, 2014, 2003, 2007, 2004, 2019 2017, 2000, 2008, 1994, 2016, 2013, 1993 and 1992, moderate drought occurred in 2012, 1997, 1996 ,2018 and 1998 year, severe drought occurred during the 2005 and extreme drought occurred in the 1995 in Gumbi-Bordodde woreda.

4.5.2. Kiremt SPI precipitation regime and year of observation

Table 10. Kiremt SPI precipitation regime and year of observation

Range of SPI Values	Year	Precipitation regime
SPI ≥2.0	-	Extremely wet
1.5≤SPI<2.0	1991	Very wet
1.0≤SPI≤1.5	2006 2009	Moderately wet
-1.0<SPI<1.0	2015 2011 2001 2002 2020 1999 2010 20142003 2007 20042019 20172000 2008 19942016 2013 19931992	Near normal
-1.5<SPI<-1.0	2012 1997 1996 2018 1998	Moderate drought
-2.0<SPI≤-1.5	2005	Severe drought
SPI≤-2.0	19955	Extreme drought

As shown in the Table 9, 10 and Figure 9, analysis the result of annual SPI value showed precipitation regime as; there is no year in which extremely wet year occurred, very wet was 2009 and1993, moderately wet 1994 and 2016, near normal year was; 1991, 2015, 2011, 2001, 2002, 2020, 1999, 2010, 2006, 2014, 2003, 2007, 2004, 1998, 2019, 2017, 2000, 2008, 2013 and 1992 year, moderate drought occurred in the year of 2012, 1996 and 2018, severe drought occurred during the 2005, 1995 and 1997 and there is no extreme drought occurred in the study period at Gumbi-Bordodde woreda.

4.4.3. Annual SPI precipitation regime and year of observation

Table 11. Annual SPI precipitation regime and year of observation

Range of SPIPI Value	Years of observation	Precipitation regime
SPI ≥2.0	1992	extremely wet
1.5≤SPI<2.0	1993	very wet
1.0≤SPI≤1.5	2013 2016	moderately wet
-1.0<SPI<1.0	2005 2011 2012 2001 1997 2002 2020 1999 2010 1995 1996 2006 2014 2003 2007 2004 2018 1998 2019 2017 2000 2008 1994 2009	near normal
-1.5<SPI<1.0	2015	moderate drought
-2.0<SPI≤1.5	-	severe drought
SPI≤-2.0	1991	extreme drought

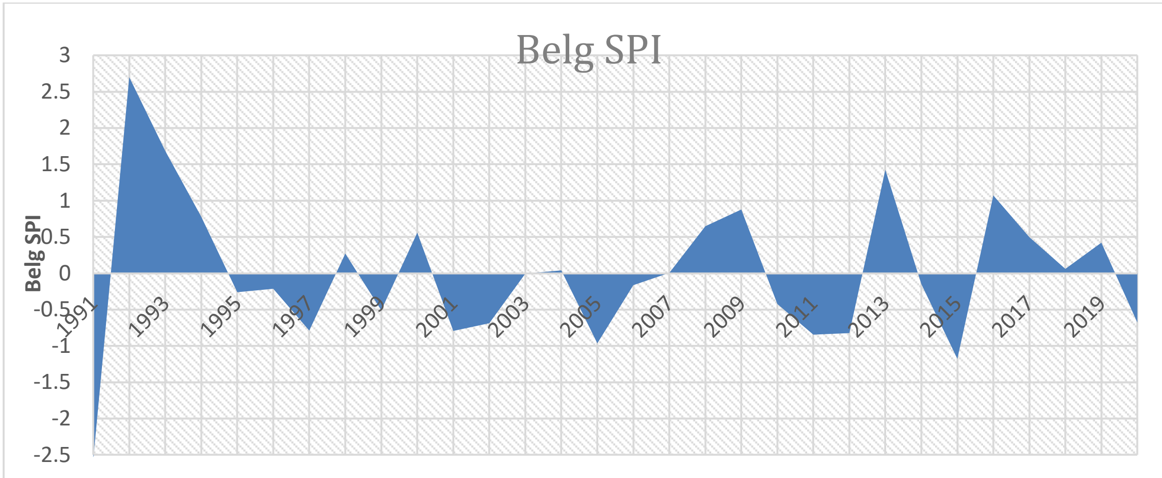

FIGURE 4. TREND AND VARIABILITY ANALYSIS OF BELG SEASON (SPI-4) AT GUMBI BORDODEWOREDA

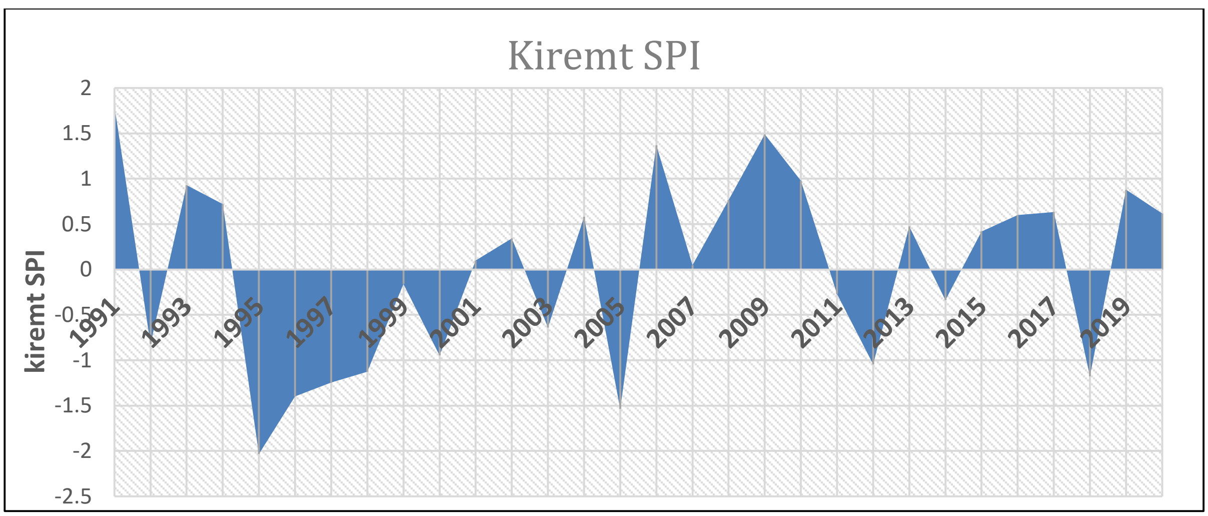

FIGURE 5. TREND AND VARIABILITY ANALYSIS OF KIREMT SEASON (SPI-4) AT GUMBI BORDODE WOREDA

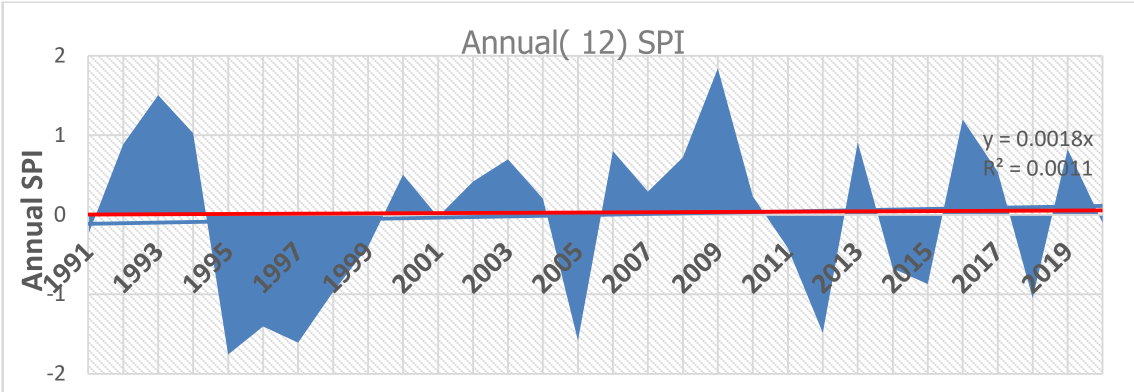

FIGURE 6. TREND AND VARIABILITY ANALYSIS OF ANNUAL (SPI-12) AT GUMBI BORDODDE

4.6.Temporal Drought Patterns

The results in Table 11 and Figure 7, 8, 9. Showed temporal (seasonal and annual) drought variability characterized in terms of drought frequency, magnitude, severity in Gumbi-Bordodde woreda over the course of 30 years (1991–2020). As illustrated in the Table 11. Below the SPI in the normal cluster has the largest frequency during the belg (24%), kiremt (20%) and annual (20%) at the study area while the wet and dry(drought) categories have the smallest frequency belg (7% wet and 13% dry), kiremt (23% wet and 10% dry), and annual (20%wet and 13% dry).

Furthermore, the frequency of SPI dry cluster (13%) in the Belg season is greater than the belg-wet cluster (7%). The frequency of SPI dry cluster in the Kiremt season (10%) is lower than the SPI wet cluster and vice versa. In addition, the frequency of the SPI dry cluster in the annual (13%) is lower than the SPI annual wet cluster (20%) at the study area. The study is in agreement with Morsy *et al*., 2022 who have reported that the SPI in the normal cluster has the largest frequency (60-80%) during the three seasons (*Belg*, *Kiremt*, and *Belg* to *kiremt*) over the period 1970-2005 at the selected 13 stations in Ethiopia.

Table 12. Seasonal and annual frequency of SPI precipitation categories at Gumbi-Bordodde

Cluster SPI	Belg		Kiremt		Annual	
	Frequency	%	Frequency	%	frequ ency	%
Drought	4	13	3	10	4	13
Near normal	24	80	20	67	20	67
Wet	2	7	7	23	6	20

4.7. Livestock Holding of the Pastoralists

Livestock production is the one of major livelihood of communities and it plays significant role in diversifying the income of farming communities in the Gumbi-Bordodde woreda. Farmers in the woreda have different livestock. The common animals used by respondent's farmers in the community of watershed area are for Oxen/Bulls, Cows, heifers, Calf (calves), goat, Mules Camel, sheep and Poultry. Accordingly, percentage owned in the range of 10 to 20 for Oxen/Bulls, Cows, heifers, Calf (calves), goat, Mules Camel, sheep and Poultry owned by were; 21, 22, 18, 26, 3, 49, 35 and 30% respectively per individual householders in the study area (Table 13). On other hands, majority of householder livestock's quantity were in the range of 10 to 20 except Mule that about 75% was in the range below 10

.

Table 13. Pastoralist Owns of Livestock

Livestock		Frequency	Percent (%)
Oxen/Bulls	less than 10	8	4
	10 to 20	38	21
	20 to 30	25	14
	greater than 30	8	4
Cows, heifers	less than 10	6	3
	10 to 20	40	22
	21 to 30	29	16
	greater than 30	6	3
Calf (calves)	less than 10	11	6
	10 to 20	33	18
	21 to 30	23	12
	greater than 30	7	4
goat	less than 10	25	14
	11 to 20	33	18
	21 to 30	45	24
	greater than 30	17	9
Mules	less than 10	75	41
	10 to 20	5	3
	21 to 30	0	0
	greater than 30	0	0
Camel	less than 10	56	30
	10 to 20	90	49
	21 to 30	60	32
	greater than 30	16	9
sheep	less than 10	46	25
	10 to 20	56	35
	21 to 30	32	17
	greater than 30	9	5
Poultry	less than 10	89	48
	10 to 20	55	30
	21 to 30	33	18
	greater than 30	12	6

4.8. Perception of Farmers on Impact of Climate Variability and Drought

Regarding to farmers perception of impacts of climate change and variability; majority (53-91%) of householders in the study have perceived negative impacts of climate change, variability and drought on different aspects of agricultural assets, environment and human. As presented in the Table 14 below; the percentage of householders agreed negative impact of climate change and drought on the aspects of; decrease livestock assets and productivity, decrease crop production and productivity, drying up of water points, decrease forage availability, increase human disease prevalence, increase livestock disease prevalence, increase food gap months, increase malnutrition, decrease household income source and level, households' terms of exchange/trade deteriorated was 78, 89, 62, 78, 66, 57, 89, 91, 84, 53% respectively. While percentage householders not agreed on the negative effect was 22, 11, 38, 22, 34, 43, 11, 9, 16 and 47% respectively.

Table 14. Perception of smallholder farmers on impact of climate variability and drought Conditions

Variable	Response option	Frequency	Percent (%)
Decrease livestock assets and productivity	Yes	145	78.4
	No	40	21.6
Decrease crop production and productivity	Yes	165	89.2
	No	20	10.8
Drying up of water points	Yes	115	62.2
	No	70	37.8
Decrease forage availability	Yes	144	77.8
	No	41	22.2
Increase human disease prevalence	Yes	123	66.5
	No	62	33.5
Increase livestock disease prevalence	Yes	105	56.8
	No	80	43.2
Increase food gap months	Yes	165	89.2
	No	20	10.8
Increase malnutrition	Yes	169	91.4
	No	16	8.6
Decrease household income source and level	Yes	156	84.3
	No	29	15.7
Households' Terms of Exchange/trade deteriorated	Yes	98	53.0
	No	87	47

4.9. Major Pastoralist Adaptation Strategies

Based on the household survey, farmers have been used different adaptation options to manage the impacts of drought and climate variability on their agricultural production in the study area. Sampled household heads have point out an adaptation options they used to drought and climate variability in the study area were; crop diversification, Construction of flood diversion channels for irrigation usage, selection of drought tolerant crop & livestock breed type, collection and saving of pastures and soil and water conservation practice with their respective percentage of; 72, 66, 48, 36 and 30% (Table 15).

Table 15. Pastoralist adaptation Strategy in the study area

Adaptation options	Frequency	Percent (%)
Crop diversification	130	72
Construction of flood diversion channels for irrigation usage	120	66
Selection of drought tolerant crop & livestock breed type	87	48
Collection and saving of pastures	66	36
Soil and Water Conservation practice	55	30

4.10. Results of Multiple regression model

The result of linear multiple regression shows the model was significant at a 5% probability level (Table 8). R^2 of 0.844 indicated the explanatory power of the model means 84.4% of the variation was due to the explanatory variables discussed below (Table 16).

Table 16. Results of Multiple regression model

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	22007.578	10615.655		2.073	.041
	Age	2524.042	3907.570	.083	.646	.520
	Marital status	-1797.900	2604.499	-.038	-.690	.492
	Gender	-429.922	4049.831	-.006	-.106	.916
	Farm size	-93.828	1726.441	-.003	-.054	.957
	Drought frequency	158.529	2191.803	.004	.072	.942
	Education level	3336.597	1786.234	.210	1.868	.065
	Pests and diseases (crop)	-13.652	193.409	-.004	-.071	.944
	Effects of drought on livestock (mortality)	.004	.008	.027	.486	.628
	Sources of income	.892	.061	.916	14.622	.000*
	Access to climate information	.731	.539	.075	1.358	.177
	Land holding size	.871	.150	.330	5.804	.000*
	Family size of the respondent	42.670	1370.295	.003	.031	.975

a. Dependent Variable: Pastoral Coping strategies

Note: ***, **, * = Significant at 1%, 5% and 10% probability level, respectively

Source: Model output

Land holding size: This variable had positively and significantly affected use of selection of drought tolerant crop & livestock breed type and crop diversification as drought adaptation strategies. Farmers with large land holding size may have an easier access to new improved crop technologies introduced in to the area. In line with this result, Taddesse (2011) and Tessema *et al.* (2013) also showed that farmers with large land holding size have adopted one or a combination of drought adaptation options as compared to the farmers with small land holdings. But the land holding of the households has a negative impact on the practice of soil and water conservation practice as drought adaptation strategies. The possible reason could be if the farmers have more land holding, they can benefit from the economic scale of it as compared with those who have small land holding. This result is consistent with the findings of Temesgen *et al*. (2008). Moreover, Mulatu (2013) noted that households' farm size is one of the most important factors that significantly affect farmers' preferences for the adaptation strategies to drought.

Sources of income: The income sources variable has a positive and significant impact on use of construction of flood diversion channels for irrigation usage and selection of drought tolerant crop & livestock breed type as an adaptation strategy. This could be apparent because use of construction of diversion channels and access to improved drought tolerant breeds requires financial resources to purchase improved seeds and hence increased income was encourage the investment capacity on this adaptation option. On the other hand, when the number of sources of income increases, farmers tend to invest on purchase of improved seed varieties, which increases productivity.

5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1. Summary

The study aimed to analyze the rainfall and temperature patterns, drought occurrence, its impact, and adaptation strategies used by pastoral households in Gumbi Bordodde Woreda, located in the West Hararghe Zone of Ethiopia. To achieve this objective, historical climate data from 1991 to 2020 was obtained from the National Meteorological Institute (NMI) of Ethiopia. A simple random sampling technique was applied to select both the kebele (village) and research participants. Gumbi-Bordodde Woreda is home to 17 pastoral kebeles with a total population of 106,944, and a total of 15,460 households. Of these, 1,975 households from three kebeles were selected for the study. Within the woreda, households were categorized into pastoral groups based on the dominant production system, particularly livestock farming.

The study collected data on adaptation strategies through household interviews, focus group discussions (FGDs), and observations. The primary data collected from key informants, interviews, and FGDs were verified, compiled, coded, and summarized for analysis. The Statistical Package for Social Science (SPSS) and Excel were used for data analysis, with results presented in the form of frequencies and tables. Rainfall and temperature data were analyzed using XLSTAT software, providing descriptive statistics such as mean, minimum, maximum, standard deviation, coefficient of variation, Sen's slope, and P-value. The Standardized Precipitation Index (SPI) was employed to assess drought conditions during the Belg and Kiremt seasons, as well as on an annual basis, using the Drinc C software.

The results showed that the average annual rainfall in Gumbi-Bordodde was 761 mm, with a coefficient of variation (CV) of 105% and a standard deviation (SD) of 48 mm. The *Belg* rainfall, on average, was 269 mm, with significant variability (SD = 59) and high CV (98%). Similarly, the average *Kiremt* rainfall was 410 mm, which also exhibited considerable instability and high variability. The *Belg* season rainfall showed a higher CV than the *Kiremt* season. All months of the year demonstrated significant variation in rainfall amounts. Furthermore, the study found that rainfall trends in February, March, and August, as well as the Belg and annual totals, showed a non-significant decreasing trend. In contrast, months such as April, May, June, July, September, November, December, *Kiremt*, and *Bega* rainfall showed a non-significant increasing trend. Specifically, *Belg* rainfall exhibited a significant decreasing trend of -1.42 mm per year, while *Kiremt* and *Bega* rainfall showed no significant increasing trends at rates of 0.66 mm/year and 0.17 mm/year, respectively.

Temperature data indicated that the mean annual maximum temperature in Gumbi-Bordodde ranged from 29.51°C to 31.63°C, with an average of 30.72°C. The mean annual minimum temperature ranged from 14.05°C to 16.88°C, with an average of 15.39°C. Both maximum and minimum temperatures showed stable levels of heat (SD < 2°C). The study also revealed significant warming trends in the maximum temperatures during the *Belg* and *Bega* seasons, while the *Kiremt* and annual maximum temperatures showed no significant warming. In terms of minimum temperatures, all months, seasons, and annual figures, except for February, March, and November, showed significant warming trends.

In addition, the study found that the frequency of dry SPI clusters during the Belg season (13%) was higher than the wet SPI clusters (7%). In the *Kiremt* season, the frequency of dry SPI clusters (10%) was lower than the wet clusters. For the annual analysis, the dry SPI cluster frequency (13%) was also lower than the wet SPI cluster frequency (20%).

5.2. Conclusions

The survey results show that out of the surveyed households, 142 (78%) of the respondents were male, while only 40 (22%) were female. This indicates that the majority of households in Gumbi-Bordodde are headed by men. Additionally, the survey revealed that 74% of the household heads were between the ages of 20-60, suggesting that the farming population is primarily young and has a higher potential for sustainable agricultural production in the area.

Regarding marital status, 142 (77%) of the respondents were married, 22 (12%) were single, 10 (5%) were widowed, and 11 (6%) were divorced, indicating that most household heads are married and have family responsibilities.

In terms of education, around 52% of the household heads had no formal education, while approximately 48% had attended varying levels of formal education. This highlights that a large portion of the population in Gumbi-Bordodde is illiterate, which negatively affects their ability to adopt and practice adaptation strategies for mitigating the impact of drought on agricultural production. Of those with education, 36% had completed primary school, and 9% had attended secondary school, suggesting a reasonable level of literacy in the area.

When it comes to farm size, the majority (70%) of the respondents had farms ranging from 0.5 to 1.5 hectares, while 14% had farms smaller than 0.5 hectares. Only 17% owned between 1.5 to 2 hectares. This indicates that many farmers in the area face challenges adapting to climate variability and drought due to the small size of their land. As a result, land size is a significant factor contributing to poverty in the region.

For livestock, most households owned between 10 and 20 animals, with the exception of mules, where approximately 75% of households owned fewer than 10.

Regarding adaptation strategies to climate variability and drought, respondents mentioned the following practices: crop diversification (72%), construction of flood diversion channels for irrigation (66%), selection of drought-tolerant crops and livestock breeds (48%), collection and saving of pastures (36%), and soil and water conservation practices (30%).

In terms of farmers' perceptions of climate change impacts, the majority (53-91%) of household heads observed negative effects of climate change, variability, and drought on various agricultural assets, the environment, and human wellbeing.

The study identified several key factors influencing adaptation strategies in the area. These include:

- **Income sources**, which positively influenced the construction of flood diversion channels for irrigation, while **age** had a negative impact.
- **Farm size, education level, and income sources** positively affected the selection of drought-tolerant crops and livestock breeds.
- **Access to climate information** positively influenced the collection and saving of pastures.
- **Family size** had a negative effect on soil and water conservation practices but a positive impact on crop diversification, while **livestock holding size** had a significant positive effect on adaptation to climate variability.

5.3. Recommendation

1. **Diversification of income sources**: To reduce the impacts of climate variability, it is recommended that households diversify their income sources. This could include ventures outside of farming and expanding livestock holdings.
2. **Enhance climate information systems**: Strengthening systems that provide pastoralists with reliable and timely climate information is crucial. This would help households make informed decisions regarding their farming and livestock operations and better prepare for adverse weather conditions.
3. **Expand agricultural education**: Increasing access to agricultural extension services and education is essential. By focusing on adult education programs, modern farming techniques could be more widely adopted.

4. **Provide support to pastoral households**: It is important to offer financial, technical, and material support to pastoral households through collaboration with NGOs and the government. This includes providing access to better agricultural inputs, climate-resilient infrastructure, and educational resources.

6. REFERENCES

Adan Guyo Shibia. 2024. Firms' use of formal and informal finance in coping with droughts and floods: experiences from Kenya. *Climate and Development,* 16:19-24.

Adesina AA and Baidu J. 1995. Farmers' perceptions and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa. *Agric. Econ.* 13:1-9.

Adugna Eneyew. 2019. Perception of Small Livestock Keepers on the Effect of Climate Related Risks and Household Food Security: The Case of Mana and Sekoru Woredas, Jimma Zone. Ethiopia. *Journal of Apply Science and Technology*, 10 (1): 49-70.

Adger, W.N. 2000. Social and ecological resilience: Are they related? Progress in Human Geography, 24(3):347-364.

Ahmadalipour A. 2017. Multi-Dimensional Drought Risk Assessment Based on Socio-Economic Vulnerabilities and Hydro-Climatological Factors. Portland State University

Aklilu Amsalu and Alebachew Adem. 2009. Assessment of climate change-induced hazards, impact and responses in the southern lowlands of Ethiopia, FSS Research Report No.4.Analysis and Applications (9th Ed.). New Jersey: Pearson Education, Inc., USA.

Alemneh Dejene, A. 1990. Environment, Famine and Politics in Ethiopia: A View from the Village. Lynne Rienner PublIcnisher.

Ayana Angassa and Gufu Oba. 2007. Herder perceptions on impacts of range enclosure, crop farming, fire ban and bush encroachment on the rangelands of Borana, South western Ethiopia. *Human Ecology*, 36: 201-215.

Argaw Ambelu, Zewdie Birhanu and Negalign Birhanu. 2015. Rapid Appraisal of Resilience to the Effects of Recurrent Rapid Appraisal of Resilience to the Effects of Recurrent. Jimma, Ethiopia: Horn of Africa Resilience Innovation Lab (HoA RILab).

Ashenafi Yimam Kassaye, Guangcheng Shao, Xiaojun Wang and Shiqing Wu. 2021. Quantification of drought severity change in Ethiopia during 1952-2017. *Environment, Development and Sustainability,* 23:5096-5121.

Barton, D., Morton, J. and Hendy, C. 2001. Drought contingency planning for pastoral livelihoods, Policy Series15, Chatham, UK: Natural Resources Institute. Basingstoke: MacMillan.

Berhanu Wassie and Beyene Fekadu. 2014. The impact of climate change on pastoral production systems: A study of climate variability and household adaptation strategies in southern Ethiopian rangelands, WIDER Working Paper, No. 2014/028, WIDER, Helsinki.

Berhanu Wassie, Colman D. and Fekadu Beyene. 2008. Diversification and Livelihood Sustainability in a Semi-arid Environment: A Case Study from Southern Ethiopia. *Journal of Development Studies,* 43(5):871-889.

Blench, R. 2001. You can‘t go home again: pastoralism in the new millennium. FAO report, London, 17 May 2001.

Belayneh Legesse, Yared Ayele, and Woldeamlak, B. 2013. Smallholder farmers' perceptions and adaptation to climate variability and climate change in Doba woreda, west Hararghe, Ethiopia. *Asian Journal of Empirical Research* 3(3):251-265.

Belay Tseganeh. 2014. Climate variability and change in Ethiopia: Exploring impacts and adaptation options for cereal production. Production Ecology and Resource Conservation, Wageningen University. Doctoral 16. Wageningen University.

Abraham Belay, Teferi Demissie, Recha, J.W.; Oludhe, C.; Osano, P.M.; Olaka, L.A. Dawit Solomon and Zerihun Berhane. 2021. Analysis of Climate Variability and Trends in Southern Ethiopia. *Climate*, 9(96): 1-17.

Bereket Tesfaye Haile, Desalegn Yayeh Ayal., Gudina Legese Feyisa and Fikiru Abiko Anose. 2022. Drought Analysis Using Standardized Evapotranspiration and Aridity Index at Bilate Watershed: Sub-Basins of Ethiopian Rift Valley. *Scientific World Journal,* 2022: 1 - 14.

Betemariam Gebre, Habtamu Yesigat Ayenew and Sibhatu Biadgilign. 2021. Drought, hunger and coping mechanisms among rural household in Southeast Ethiopia. *Heliyon*, 7(3): 1-7.

Boku Tache. 2008. Pastoralism under Stress: Resources, Institutions and Poverty among the Borana Oromo in Southern Ethiopia. Dissertation, Norwegian University of Life Sciences Department of International Environment and Development Studies

Coppock, L., Getachew Gebru, Solomon Desta, Sintayehu Mesele and Seyoum Tezera. 2008. Are cattle die-offs predictable on the Borena Plateau, ENVS Faculty Publications, Paper, 1-4.

Creswell, J. W. 2013. Research design: Qualitative, quantitative, and mixed methods approach. SAGE.

Croppenstedt, A. Mulat Demeke and Meschi MM. 2003. Technology adoption in the presence of constraints: the case of fertilizer demand in Ethiopia. *Dev. Econ*. 7(1):58-70.

Cullis, A. and Catley, A. 2012. Money to burn: Comparing the costs and benefits of drought responses in pastoralist areas of Ethiopia. *Journal of Humanitarian Assistance*, 1-9.

Dai, A. 2011. Drought under global warming: A review. Wiley Interdisciplinary Reviews: Climate Change, 2(1):45-65.

Dai, A. 2013. Increasing drought under global warming in observations and models. *Nature Climate Change*, 3(1): 52-58.

Dai, A., Zhao, T., Chen, L., and Chen, J. 2021. Assessing historical and future changes of droughts in China using the standardized precipitation evapotranspiration index. *Journal of Climate*, 34(1):225-242.

Davies, S. 1996. Adaptable livelihoods, coping with food insecurity in the Malian Sahel, Journal of science, technology and development in AGRIS; 1997

Defferew Kebede. 2011. The Impact of Drought on Livelihoods, Vulnerability and Coping Mechanisms: the Case of North Shoa Zone, Oromia. Addis Ababa University School of graduate studies, Addis Ababa University, Ethiopia.

Deressa Temesgen, Hassan RM, and Ringler C. 2011. Perception of and adaptation to climate change by farmers in the Nile basin of Ethiopia. *J. Agric. Sci.* 149(1):23-30.

Desalegn Yayeh Ayal., Maren Radeny., Solomon Desta. And Getachew Gebru. 2018. Climate variability, perceptions of pastoralists and their adaptation strategies:

Implications for livestock system and diseases in Borana zone, *International Journal of Climate Change Strategies and Management*, 10(4): 1-20.

Diawara, M.O., P. Hiernaux, E. Mougin, M. Grippa, C. Delon, and H.S. Diakité. 2018. Effets de la pâture sur la dynamique de la végétation herbacée au Sahel (Gourma, Mali): une approche par modélisation. *Cahiers Agricultures*, 27: 1-9.

Dilruba, K. and Roy. BC. 2012. Rural Livelihood Diversification in West Bengal: Determinants and Constraints for Upward Mobility? Evidence from a Panel Data Study in Ethiopia. *World Development*, 40(8):1634-1646.

Dirriba Mengistu. 2016. Impacts of Drought and Conventional Coping Strategies of Borana Community, Southern Ethiopia. *Research on Humanities and Social Science*s ISSN (Paper), 6(23): 2224-5766.

Dirriba Mengistu and Jemal Haji. 2015. Factors Affecting the Choices of Coping Strategies for Climate Extremes: The Case of Yabello Woreda, Borana Zone, Oromia National Regional State, Ethiopia. *International Journal of Engineering Innovation and Research*, 3 (4): 129-136.

Diress Tsegaye, Vedeld, P., and Moe, S.R. 2013. Pastoralists and livelihoods: A case study from northern Afar, Ethiopia. *Journal of Arid Environments*, 91: 138-146.

Doti, T. 2010. Climate variability, pastoralists' vulnerability and options. The case of the Borana of Northern Kenya. Climate change and natural resource conflicts in Africa. *Monograph*, 170: 189-204.

Doyo Kena., Eric, N. and Tesfaye Lemma. 2018. Livelihood diversification strategies among the Borana pastoral households of Yabello Woreda, Oromia Region, Ethiopia. *Journal of Agricultural Extension and Rural Development*, 10(10):211-221.

Dutra E, Magnusson L, Wetter Hall F, Cloke H, Balsamo, G and Pappenberger F. 2013. The 2010-2011 drought in the Horn of Africa in ECMWF reanalysis and seasonal forecast products. *Int J Climatol*, 33:1720-1729.

Eliza, M.J., C.Z. Leo, and E. Kalipeni. 2015. Oil discovery in Turkana County, Kenya: A source of conflict or development? *African Geographical Review*, 34(2): 142-164.

EM-DAT. 2018.http://www.emdat.be/disaster-list.2018

Emiru Birhane, Eskinder Gidey, Paidamwoyo Mhangara, Tirhas Gebregergs, Woldegebriel Zeweld, Haftamu Gebretsadik, Oagile Dikinya, Said Mussa, Amanuel Zenebe, Atkilt Girma, Girmatsion Fisseha, Alemu Addisu, Jemal Nasir and Tesfaye Zeleke. 2023. Analysis of drought coping strategies in northern Ethiopian highlands. *SN Applied Sciences*, 5(19): 1-14.

Eshetu Girma., Tino, J. and Wayessa Garedew. 2016. Rainfall trend and variability analysis in Setema-Gatira area of Jimma, Southwestern Ethiopia. *African journal of Agricultural reasearch*, 11(32):3037-3045.

Eskinder Gidey, Paidamwoyo Mhangara, Tirhas Gebregergs, Woldegebriel Zeweld, Haftamu Gebretsadik, Oagile Dikinya, Said Mussa, Amanuel Zenebe, Atkilt Girma, Girmatsion Fisseha, Alemu Addisu Jemal Nasir, Tesfaye Zeleke and Emiru Birhane. 2023. Analysis of drought coping strategies in northern Ethiopian highlands. *SN Applied Sciences*, 5(195): 1-14.

Eyasu Elias and Feyera Abdi. 2010. Putting Pastoralists on the Policy Agenda: Land Alienation in Southern Ethiopia. Gatekeeper No. 145. London: IIED.

Eze E, Atkilt Girma, Amanuel Zenebe and Gebreyohannes Zenebe. 2020. Feasible crop insurance indexes for drought risk management in Northern Ethiopia. *Int J Disaster Risk Reduc*t, 47:1-29.

FAO (Food Aid Organization). 2018. Pastoralism in Africa‘s drylands Reducing risks, addressing vulnerability and enhancing resilience, Pastoralism in Africa’s drylands. Rome.

Fasil Kebebew., DiressTsegaye and GrySynnevåg. 2001. Traditional Coping Strategies of the Afar and Borana Pastoralists in Response to Drought, Ethiopia Drylands Coordination Group Report No. 17 (11, 2001).

Faye, B., Chaibou, M. and Vias, G. 2012. Integrated impact of climate change and socioeconomic development on the evolution of camel farming systems. *British Journal of Environment and Climate British Journal of Environment and Climate Change*, 2: 227-244.

Feinstein International Center. 2007. Impact Assessments of Livelihoods-based Drought Interventions in Moyale and Dire Woredas. Tufts University.

Fitsum Bekele, Nega Mosisa and Dejen Terefe. 2017. Analysis of current rainfall variability and trends over Bale-Zone, South Eastern highland of Ethiopia. *Climate Change*, 3(12): 889-902.

Gelgelo Wako Duba; Solomon Tekalign and Tegegne Sishaw, 2021. Determinants Choices of Drought Coping Strategies among Borena Pastoral Communities: The Case of Yabello Woreda, Oromia Region, Southern Ethiopia. *American Journal of Life Sciences. 9(4):* 78-80.

Getachew Alem. 2018. Drought and its impacts in Ethiopia, Elsevier Publication, Weather and Climate Extremes, 22 (2018): 24-35.

Gujarati, D. 2003. Essentials of Econometrics, second edition, Mc Graw Hill, pp. 449-454. New York.

Guo, Y., Huang, S., Huang, Q., Wang, H., Fang, W., Yang, Y. and Wang, L. 2019. Assessing socioeconomic drought based on an improved multivariate standardized reliability and resilience index. *Journal of Hydrology*, 568: 904-918.

Habtamu Dagne Bogale, and Samuel Shibeshi Bikiko. 2017. The Role of Indigenous Knowledge in Climate Change Adaptation: The Case of Gibe Woreda, Hadiya Zone, Ethiopia. *International Journal of Environmental Protection and Policy*, 5(6):104-113.

Habtamu Teka, Casper, I., Madakadze, Joel. O. Botai., Abubeker Hassen., Ayana Angassa and Yared Mesfin. 2017. Evaluation of land use land cover changes using remote sensing Landsat images and pastoralists perceptions on range cover changes in Borana rangelands, Southern Ethiopia. *International Journal of Biodiversity Conservation*, 10: 1-8.

Gebre Hadgu, Kinde Tesfaye, Girma Mamo. And Belay Kassa. 2013. Trend and variability of rainfall in Tigray, Northern Ethiopia: Analysis of meteorological data and farmer's perception. Academia *Journal of Environmental Sciences*, 01(06): 1-13.

Gutu Tesso, Bezabih Emana and Mengistu Ketema. 2012. Econometric analysis of local level perception, adaptation and coping strategies to climate change induced shocks in North Shewa, Ethiopia. *Int. Res. J. Agric. Sci. Soil Sci.*, 2(8):347-363.

Helland, J. 2006. Land Tenure in the Pastoral Areas of Ethiopia. Addis Ababa: ILRI.

Herrero, M., C. Ringler, J., van de Steeg, P., Thornton, T., Zuo, E., Bryan, A., Omolo, J., Koo and Notenbaert, A. 2010. Kenya: Climate variability and climate change and their impacts on the agricultural sector. Report submitted to the World Bank, Washington, D.C.

HPG (Humanitarian Policy Group). 2006. Saving Lives through Livelihoods: Critical Gaps in the Response to Drought in the Greater Horn of Africa. The Humanitarian Policy Group HPG Briefing Note; Overseas Development Institute, May 2006.

Hogg, R. 1997. Changing land use and resource conflict among Somali pastoralists in the Haud of south-east Ethiopia. In Hogg (ed) Pastoralists, ethnicity and the state in Ethiopia. HaanPublishing. London.

Huho, J.M., Ngaira, J.K.W. and Ogindo, H.O. 2011. Living with drought: The case of Maasaipastoralists living in northern Kenya. *Educational International Research Journals*, 2(1): 779-789.

Huho, JM., and Mugalavai EM. 2010. The Effects of Droughts on Food Security in Kenya. The *International Journal of Climate Change: Impacts Resp*. 2(2):61-72.

Hurst, M., N. Jensen., S. Pedersen., A, Sharma. And J. Zambriski. 2012. Changing climate adaptation strategies of Borana pastoralists in southern Ethiopia. CGIAR Research Program on Climate Change, Agriculture and Food Security CCAFS. Working paper No. 15 Cali, Colombia.

Indris Siraje and Adam Bekele. 2013. Assessment of Food Insecurity and Coping Mechanisms among Pastoral Households of Afar National Regional State: The Case of Chifra Woreda, Ethiopia. *Ethiop. J. Agric. Sc*i., 23: 143-156.

Igoden, C., Ohoji, P. and Ekpare, J. 1990. Factors associated with the adoption of recommended practices for maize production in the Lake Basin of Nigeria. *Agricultural Administration and Extension,* 29 (2): 149-156.

IPCC. 2007. Climate Change mitigation. In: Metz B, Davidson OR, Bosch PR, Dave R, Meyer LA (Eds.), Cambridge University Press, USA.

IPCC. 2014. Summary for policy makers. (Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., Seyboth, K., Adler, A., Baum, I., Brunner, S., Eickemeier, P., Kriemann, B., Sovolainen, J., Schläümer, S., von Stechow, C., Zwickel, T., and Minx, J.C. In: Climate Change 2014: Mitigation of Climate Change. Contribution of

Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

Kairu, G. 2022. Drought and People's livelihood in the Horn of Africa. pg. 1 - 12.

Kashay Berhe. , Berhanu Gebremedhin, Simeon Ehui and Mohamed Saleem. 1998. Development needs of pastoral production systems in Ethiopia: Lessons learnt from ILRI‘s research in some pastoral areas of Ethiopia. Addis Ababa: ILRI

Kemal Adem Abdela, Aragaw Fantabil, Dereba Muleta, Tamirat Yohannes and Kazora Jonah. 2023. Bibliographic review on drought and water level articles. *Discover Water*, 3(17): 1-22.

Kogan F, Guo W and Yang W. 2019. Drought and food security prediction from NOAA new generation of operational satellites. *Geomat Nat Hazards Risk*, 10(1):651-666.

Krätli, S., el Dirani, O.H. and Young, H. 2013. Standing Wealth. Pastoralist Livestock Production and Local Livelihood in Sudan. Khartoum, United Nations Environment Programme (UNEP) and Feinstein International Centre, Tufts University.

Krätli, S. and Toulmin, C. 2020. Farmer-herder conflict in sub-Saharan Africa? IIED research report. London, International Institute for Environment and Development (IIED).

Li, J., Zhou, W., Guo, Y., GAO, Y. and Wu, J. 2020. Simulating the spatiotemporal dynamics of crop yield, water use, and income under future climate and policy scenarios. *Agricultural Water Management*, 231, 105993.

Lin, J. 1991. Education and innovation adoption in agriculture: evidence from hybrid rice in China. *American Journal of Agricultural Economics* 73 (3): 713-723.

MacDonald KC and MacDonald RH. 2000. The origins and development of domesticated animals in arid West Africa. In: Blench RM, MacDonald KC (eds) The origin and development of African livestock. University College Press, London, pp 127-16.

Maddison, D. 2006. The Perception of Adaptation to Climate Change in Africa. University of Pretoria: Johannesburg. PMCid: PMC 1698947. Washington, DC.

Mahyou H, Karrou M, Mimouni J, Mrabet R and Mourid M El. 2010. Drought risk assessment in pasture arid Morocco through remote sensing. *Afr J Environ Sci Technol*, 4(12):845-852.

Markakis, J. 2004. Pastoralism on the margin. Minority Rights Group International

Masih, S. Maskey F. E. F. Mussá. and P. Trambauer. 2014. A review of droughts on the African continent: a geospatial and long-term perspective

Matlou. 2021. Assessing the impact of agricultural drought resilience on smallholder livestock farming households.

Matthews, H.D.; Zickfeld, K.; Knutti, R. and Allen, M.R. 2018. Focus on cumulative emissions, global carbon budgets and the implications for climate mitigation targets. *Environ. Res. Lett.* 2018, *13*: 1-20.

McKee, T. B., Doesken, N. J., and Kleist, J. 1993. The relationship of drought frequency and duration to time scales. In Proceedings of the 8th Conference on Applied Climatology, (17(22), pp. 179-183).

Mesfin Woldemariam. 1984. Rural Vulnerability to Famine in Ethiopia: 1958-1977.

Mideksa Fufa. 2015. Factors Responsible for Income Diversification among Rural Farm Households in Agarfa Woreda, Bale Zone, Oromia National Regional State, Ethiopia. Master’s Thesis, Haramaya University, Ethiopia.

Mishra, A.K., and Singh. V. P. 2010. A review of drought concepts. *Journal of Hydrology*, 391(1): 202-216.

MoA (Ministry of Agriculture). 2013. Regional Pastoral Livelihoods Resilience Project (RPLRP) Ethiopia country project document. Addis Ababa.

Mohammed Gedefaw, Atkilt Girma, Denghua Y., Hao W., and Agitew G. 2018. Farmer's Perceptions and Adaptation Strategies to Climate Change, Its Determinants and Impacts in Ethiopia: Evidence from Qwara District. *Journal of Earth Science and Climatic Change*, 9(481): 1-8.

Morid, S., Smakhtinb, V. and Moghaddasi, M. 2006. Comparison of seven meteorological indices for drought monitoring in Iran. I*nternational Journal of Climatology*, 26(7): 971-985.

Morsy, M., Moursy, F.I. and Sayad, T. *et al*. 2022. Climatological Study of SPEI Drought Index Using Observed and CRU Gridded Dataset over Ethiopia. *Pure Appl. Geophysics.* 179: 3055-3073.

Morton, J. 2005. Pastoralist coping strategies and emergency livestock market intervention. In: McPeak, J G and Little, P D (eds.) Livestock marketing in Eastern Africa: Research and policy challenges, ITDG Publications, London.

Morton, J. and Barton, D. 2002. Destocking as a Drought Mitigation Measure: Clarifying rationales and answering critiques. Disasters, 26 (3) pp. 54.

Mpelasoka F, Awange J and Zerihun A. 2018. Influence of coupled ocean atmosphere phenomena on the Greater Horn of Africa droughts and their implications. *Science of* the *Total Environment,* 610-611:691-702.

Munang, R., Thiaw, k., Alverson, L., and Han. . 2013. The role of ecosystem services in climate change adaptation and disaster risk reduction. Current opinion in environmental sustainability, 5:, 1-6.

Muse, A. 2011. Diversification of Livelihood Activities as a Strategy to Promote Household Food Security: A Case Study of DaroLebu Woreda of West Hararghe, Oromia 88 Regional State, Ethiopia. Master‘s Thesis, Addis Ababa University, Addis Ababa, Ethiopia.

Ndambiri, K., Ritho, C., Mbogoh, G., Nganga, I., Muiruri, J., Nyangweso, M., Kipsat, J., Omboto, I., Ogada, O., Kefa, C., Kubowon, C. and Cherotwo, H. 2012. Analysis of farmers' perceptions of the effects of climate change in Kenya: The case of Kyuso woreda. *Journal of Environment and Earth Science,* 2:74-83.

NDMC (National Drought Mitigation Center) (2016). Drought Basics. Retrieved from drought.unl.edu.

Negash Mulatu Debalke. 2013. Determinants of farmers' preference for adaptation strategies to climate change: evidence from north Shoa zone of Amhara region Ethiopia. MPRA (Munich Personal RePEc Archive) Paper No. (48753)

NMA (National Meteorological Agency). 2007. Climate Change National Adaptation Programme of Action (NAPA) of Ethiopia. Addis Ababa: NMA.

NOAA,"U.S.SeasonalDroughtOutlook",www.cpc.ncep.noaa.gov/products/expert_assessm ent /sdo_summary.html.

Nolwandle, Z. M. 2019. Evaluating the impact of drought on rural communities: A case study of Umuziwabantu Local Municipality in KwaZulu Natal, South Africa. Swedish University of Agricultural Sciences.

Nori, M. and Davies, J. 2007. Change of Wind or Wind of Change Report on the conference on Climate Change, Adaptation and Pastoralism, organized by the World Initiative for Sustainable Pastoralism, IUCN, and Nairobi, Kenya.

Norris, E. and Batie, S. 1987. Virginia farmers ‘soil conservation decisions: an application of Tobit analysis. *Southern Journal of Agricultural Economics*, 19 (1): 89-97.

Odhiambo, M. 2006. Review of the literature on Pastoral Economics and Marketing: Kenya, Tanzania, Uganda and the Sudan. Report prepared for the World Initiative for Sustainable Pastoralism, IUCN EARO.

O’Neil D. 2011. Pastoralism. http://anthro.palomar.edu/subsistence/sub_3.htm

Olayemi, F.F., Adegbola, J.A., Bamishaiye, E.I. and Awagu, E.F. 2012. Assessment of post-harvest losses of some selected crops in eight Local Government Areas of River State, Nigeria. *Asian Journal of Rural Development,* 2(1): 13-23.

Olubunmi, L. O. 2010. Drought Coping Mechanisms: A Case Study of Small-Scale Household in Motheo Zone of the Free State Province. 1-143.

Ouma, E., A. Abdulai and A. Drucker. 2011. Measuring heterogeneous preferences for cattle traits among *cattle-keeping households in East Africa. American Journal of Agricultural Economics,* 89 (4): 1005-1019.

Oxfam. 2011. Briefing on the Horn of Africa Drought: Climate change and future impacts on food security, August 2011.

Pankhurst, R. 1986. The History of Famine and Epidemic in Ethiopia Prior to the Twentieth Century. Addis Ababa: Relief and Rehabilitation Commission. Published in the USA. Lynne Rienner Publishers Inc, 1800 30th street, Boulder Colorado.

Panu, U. S. and Sharma, T.C. 2002. Challenges in drought research: some perspectives and future directions. *Hydrology. Sci. J*, 47(S1):19-30.

Paulos Asrat and Belay Simane. 2018. Household’ perception of climate change and adaptation strategies in the Dabus watershed, North-West Ethiopia. *Ecological process*, 7(7): 1-13.

Paul, L. 2013. Socio economic Impact of Drought, their Coping Strategies and Government Intervention in marsabit county, Kenya. Master Thesis, Centre for Advanced Studies in Environmental Law and Policy (CASELAP), University of Nairobi, Kenya.

Paulo, A. A., Rosa, R. D. and Pereira, L. S. 2012. Climate trends and behavior of drought indices based on precipitation and evapotranspiration in Portugal. *Hazards Earth Syst.* Sci. 12: 1481-1491.

Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J. and Hanson, C.E. 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Rao, P.V.V. and Solomon Adisu. 2013. Trend Analysis and Adaptation Strategies of Climate Change in North Central Ethiopia. *International Journal of Agricultural Science and Research (IJASR)*, 3(1): 253-262.

Rasmussen, Kjeld, Martin Brandt, Xiaoye Tong, Pierre Hiernaux, Abdoul Aziz Diouf, Mohamed Habibou Assouma, Compton J. Tucker, and Rasmus Fensholt. 2018. Does grazing cause land degradation? Evidence from the sandy Ferlo in Northern Senegal. *Land Degradation and Development*, 29 (12):4337-4347.

Rathore, M.S. 2009. State Level Analysis of Drought Policies and Impacts in Rajasthan, India. Working Paper 93, Drought Series Paper No. 6. International Water Management Institute (IWMI).

Riche, B., Hachilek, E. and Cynthia, B.A. 2009. Climate-related vulnerability and adaptive capacity in Ethiopia‘s Borana and Somali communities, International Institute for Sustainable Development Final assessment report, Commissioned by SAVE the Children UK and CARE Ethiopia, Unpublished.

Riginos, C., Porensky, L.M., Veblen, K.E., Odadi, W.O., Sensenig, R.L., Kimuyu, D., Keesing, F., Wilkerson, M.L., and Young, T.P. 2012. Lessons on the relationship between livestock husbandry and biodiversity from the Kenya Long-term Exclosure Experiment (KLEE). USDA. Retrieved from USDA.

RoK. 2011. Food Security and Nutrition Policy, Government Printers, Nairobi. Sahel. Basingstoke: MacMillan.

Ruijs, A., M. de Bel, M. Kononen, V. Linderhof, and N. Polman. 2011. Adaptation to climate. Savanna environments in Southern Zimbabwe. *Human Ecology*, 20(3):293-314.

Scott Villiers, A. 2006. Peace, Trade and Unity: Reporting from the Horn of Africa Regional Pastoralist Gathering, Qarsa Dembii, and Yabello, Ethiopia. UNOCHA Pastoralist Communication Imitative.

Sena Amsalu. 2019. Review on the recurrence of drought and its multifaceted impact on agriculture, livelihoods, and vulnerability factors. *International journal of Horticulture, Agriculture and Food science (IJHAF*), 3(5):292-298.

Shapiro, B.I., Gebru, G., Desta, S., Negassa, A., Nigussie, K., Aboset, G. and Mechal, H. 2015. Ethiopia livestock master plan. ILRI Project Report. Nairobi, Kenya: International Livestock Research Institute (ILRI). Some pastoral areas of Ethiopia. Addis Ababa: ILRI.

Solomon Desta. 1999. Diversification of Livestock Asset for Pastoral Risk Management in the Borena Pastoral System of Southern Ethiopia. PhD Dissertation, Utah State University, Department of Range Land Resources. Logan, Utah, USA.

Sonneveld, B.G.J.S., Snelder, D.J., and Gebeyehu, A.K. 2017. Identifying Hotspots of Overgrazing in Pastoral Areas: Livestock Mobility and Fodder Supply Demand Balances in Nyangatom, Lower Omo Valley, Ethiopia. *Sustainability*, 13(6): 1-31.

Stern R, Rijks D, Dale. And I, Knock J. 2006. INSTAT (interactive statistics) climate guide. pp. 330.

Swain, S., P patel. And S, Nandi. 2017. Application of SPI, EDI and PNPI using MSWEP precipitation data over Marathwada, India. IEEE International Geoscience and Remote Sensing Symposium (IGARSS). 2017:55055507.

Taddesse T. 2011. Farmers' perception and adaptation mechanisms to climate change and variability: the case of La'ilay Maichew woreda, central Tigray, Ethiopia. An MSc Thesis Presented to the School of Graduate Studies of Haramaya University.

Tagel Gebrehiwot and Veen, A. 2013. Assessing the evidence of climate variability in the northern part of Ethiopia. *Journal of development and agricultural economics*, 5(3):104-119.

Temesgen, A. 2010. Climate change to conflict. Lessons from southern Ethiopia and northern Kenya. Fafo Report.

Temesgen D. R.M. Hassan, and C.Ringler. 2008. Measuring Ethiopian Farmers' Vulnerability to Climate Change across Regional States. IFPRI Discussion Paper

00806,

Temesgen, D., Hassan, R.M., Ringler, C. Tekie, A., and Mahmud, Y. 2009. Determinants of Farmers' Choice of Adaptation Methods to Climate Change in the Nile Basin of Ethiopia. *Global Environmental Change,* 19: 248-255.

Trenberth, K. E., Dai, A., van der Schrier, G., Jones, P. D., Barichivich, J., Briffa, K. R. & Sheffield, J. 2014. Global warming and changes in drought. *Nature Climate Change*, 4(1):17-22.

Trnka M, Hayes M, Jurečka F, Bartošová L, Anderson M, Brown J, Camarero JJ, Cudlín P, Dobrovolný P and Eitzinger J. 2018. Priority questions in multidisciplinary drought research. *Clim Res*., 75:241-260.

Twongyirwe, R., Mfitumukiza, D., Barasa, B., Naggayi, B. R., Odongo, H., Nyakato, V., and Mutoni, G. 2019. Perceived effects of drought on household food security in south western Uganda: Coping responses and determinants. *Weather and Climate Extremes, 24*: 1-11.

Udmale, P., Ichikawa, Y., Manandhar, S., Ishidaira, H., and Kiem, A. S. 2014. Household' perception of drought impacts, local adaptation and administrative mitigation measures in Maharashtra state, India. International Journal of Disaster Risk Reduction 10: pp. 250–69. Savelli, E., Rusca, M., Cloke, H., and Di Baldassarre, G.: Don't blame the rain: Social power and the 2015-2017 drought in Cape Town, South Africa.

UNICEF (United Nations Children's Fund). 2017. Horn of Africa call for action Pre-Humanitarian Requirements Document, November 2017, with sector analysis of likely needs.

UNOCHA (United Nations Office for Coordination of Humanitarian Affairs). 2016. Drought Humanitarian Report.

United States Geological Survey (USGS). (2016). Ethiopia Drought 2015: Impact and Response. Retrieved from USGS.

VSF (Veterinaries sans Frontiers). 2011. Rapid assessment in communities of Marsabit County on impacts of 2011 drought Nairobi, Kenya.

Virtanen, P., Palmujoki, E. and Dereje Terefe Gemechu. 2011. Global Climate Policies, Local Institutions and Food Security in a Pastoral Society in Ethiopia. Consilience: *The Journal of Sustainable Development*, 5(1), 96-118.

Wane, A. 2006. Review of the literature on pastoral economics and marketing: West Africa. Report prepared for the World Initiative for Sustainable Pastoralism, IUCN EARO

Wasihun Gizaw, Mengistu Mengesha and Lisanework Nigatu. 2019. Characterization of Past and Future Climate Variability of Habro Woreda, West Hararghe Zone, Oromia, Ethiopia.

Simachew Bantigegn Wasse. 2020. Natural resource degradation tendencies in Ethiopia: a review. *Environ Syst Re*s, 9(1):1-29.

WB (World Bank). 2010. World Development Indicators. The World Bank.

Wilhite, D. A. 2007. Drought. In J. Lidstone, L. M., Dechano. And J. P. Stoltman (Eds.), International Perspectives on Natural Disasters: Occurrence, Mitigation, and Consequences, 21, 147-162, Springer Netherlands.

Wilhite, D.A. 2000. Drought as a Natural Hazard: Concepts and Definitions (Chapter 1, pp. 3-18). In: Wilhite, D.A. (ed.) Drought: A Global Assessment (Volume 1), Rout ledge Publishers, London, U.K.

Wilhite, D. A., and Glantz, M. H. 1985. Understanding the drought phenomenon: The role of definitions. *Water International*, 10(3):111-120.

Wisner, B., Blaikie, P., Cannon, T., and Davis, I. 2004. At Risk: Natural Hazards, People's Vulnerability and Disasters (2nd Ed.). Rout ledge.

Woinishet Asnake. 2010. Participation into Off-Farm Activities in Rural Ethiopia: Who Earns More? Masters of Arts in Development Studies; International Institute of Social Studies. Erasmus University, Netherland.

Yibekal Tessema, Chanyalew Aweke and Getachew Endris. 2013. Understanding the process of adaptation to climate change by small-holder farmers: the case of east Hararghe Zone, Ethiopia. *Agric. Food Econ.*, 1(13): 1-117.

Yohannes Gebremichael., Magagi, S., Bayer, W. and Waters-Bayer, A. 2010. More than climate change: pressures leading to innovation by pastoralists in Ethiopia and Niger. Future Agricultures

Yuan Z, Xu J, Chen J, Huo J, Yu Y, Locher P and Xu B. 2017. Drought Assessment and Projection under Climate Change: A Case Study in the Middle and Lower Jinsha River Basin. *Advanced Meteorology*, 2017: 1-16.

7. APPENDICES

Haramaya University

College of Social Science and Humanities

School of Geography and Environmental Studies

Appendix I: General Background of the Sample Respondent

1. How long years is the head of household? It is ________________Years.
2. What is the sex of head of household? 1=Female 0=Male
3. What is the marital status of head of household?

S/N	Marital status	Yes=1	No=0
1	Married		
2	Divorced		
3	Widowed		
4	Single		

4. Does anyone in your household member can read or write? 1=Yes 0=No
5. If yes for above Q4, what is the maximum educational level for any of HH members?

   1= Primary 2= High school 3= Higher education

6. Do you have any cultivated farming land through rainfed/ irrigation?

   1=Yes 0=No

7. If your answer is yes for Q6, what is the size of your farmland? It is ____________Ha.
8. What is your household size? It is__________________ in numerals.
9. Write the exact numbers of HH members within appropriate age range to know dependency ratio and productive age members.

Choice	Age range in years	# of HH members
1	# of family members > 60 years	
2	# of family members <15 years	
3	# of family members between 15 years and 60 years	
4	Total # of household members	

10. What is your drought adaptation experience in years? It is ___________years.

11. Do you receive training in drought management and or climate change related issues by any organization? 1=Yes 0=No

12. Impact of drought on pastoral households in the study area?

S/N	**Types of Impact of drought**	Write "1 " if they have access and "0" otherwise.
1.	Decrease livestock assets and productivity	
2.	Decrease crop production and productivity	
3.	Drying up of water points	
4.	Decrease forage availability	
5.	Increase human disease prevalence	
6.	Increase livestock disease prevalence	
7.	Increase food gap months	
8.	Increase malnutrition	
9.	Decrease household income source and level	
10.	Households' Terms of Exchange/trade deteriorated	

13. Farmers' perception towards severity of drought on the different parameters

S/N	Description of items	✓ Tick for the appropriate Likert scale				
		Very high	High	Moderate	low	Very low
1.	Decrease livestock assets and productivity					
2.	Decrease crop production and productivity					
3.	Drying up of water points					
4.	Decrease forage availability					
5.	Increase human disease prevalence					
6.	Increase livestock disease prevalence					
7.	Increase food gap months					
8.	Increase malnutrition					
9.	Decrease household income source and level					
10.	Affect households' Terms of Exchange					

14. What is the length of cycle of drought year and frequency of occurrence in in the past 30 years?

1. Drought frequency is increasing and happens every 5 years.
2. Drought frequency is increasing and happens every 10 years.
3. Drought frequency is increasing and happens less than 5 years.
4. Drought frequency is increasing and happens every one year.

15. What is the patterns of drought at present in terms of length of cycle of drought year when compared to before 20 years? Tick (√) where it is appropriate

Patterns of Drought	**Now**	**Before 20 years**
1.short		
2. Medium		
3.Long		

16. What is the duration of drought months in a year when compared to before 20 years? Tick (√) where it is appropriate

Patterns of Drought	**Now**	**Before 20 years**
1.short		
2. Medium		
3.Long		

17. What is the severity of drought or hotness of the sun and wind speed when compared to 20 years before? Tick (√) where it is appropriate

Patterns of Drought	**Now (At present time)**	**Before 20 years**
1.Low		
2.Moderate		
3.High		

18. What are the trends of rainfall and temperature at present when compared to 20 years before? Tick (√) where it is appropriate

Climate induced shocks	**Now (At present time)**		**Before 20 years**		
	Increa se	**Decrease**	**Increase**	**Dec reas e**	**No change**
Trends of rainfall					
Mehere/sum mer rain					
Belg/spring rain					
Temperature trends					
Wind speed					

19. What is the drought coping strategies employed by pastoral households in the study area?

S/N	**Climate Change adaptation strategies**	**Write (1) if they have access and (0) otherwise.**
1.	Integrating livestock with crop production	
2.	Livestock diversification and herd composition change	
3.	Livestock mobility/Migration	
4.	Income source diversification	
5.	Decreasing food consumption	
6.	Livestock selling	
7.	Use of forage /feed storage	
8.	Remittance	
9.	Food Aid	
10.	Improved crop varieties	
11.	Access to irrigation	
12.	Use of water harvesting (well/pond)	

20. What is the public services access status of households from different institutions?

S/N	Institutional service indicators	Write (1) if access and (0)	Quantity if applicable
1.	Credit access from MFI (RuSACCO/ OSACSCo in a year		
2.	Frequency of extension service contacts by DA/CF		
3.	Access to market information		
4.	Access to EW/climate information		
5.	Access to improved agricultural inputs/ agricultural technologies		
6.	Have you received training on water harvesting/drought management?		

21. What is the access condition for economic indicators of households?

S/N	Economic capacity Variables	Write (1) if they have access and (0) otherwise.	Quantify if applicable
1.	Annual income in ETB		
2.	Access to farm extension services		
3.	Food security gap months		
4.	Water shortage months in a year		

22. How was your **livestock asset** holding looks like now? Choose that all appropriate responses and fill the quantity and unit price in the space provided.

Type of livestock	Did you have livestock		If yes, write the # of livestock	Unit price (ETB)
	Yes (1)	No (0)		
Oxen/Bulls				
Cows, heifers				
Calf (calves)				
Donkeys				
Mules and horses				
Camel				
Shoat				
Poultry				
Total livestock in (TLU)				
Total value in (ETB)				

23. **What is looks like for local Household's Perception on Climate Change and Variability?**

S/N	Physical settings/natural variables	Write (1) if they faced problem and (0) otherwise.	Quantify if applicable in the past 30 years
1.	Climate change is perceived by HHs		
2.	Rainfall amount decreased within 30 years		
3.	Temperature is increased within 30 years		
4.	Drought is happened within 30 years		

24. **What is your annual income level in ETB from different combined sources stated below?**

S/N	**Livelihood strategies/pathways**	If access (1), otherwise "0"	Income in ETB
1.	**On-farm** include agricultural crop production such as sale of grain, fruit and vegetable and Chat sales; livestock sales include such as ox fattening, shoat fattening, poultry and bee keeping		
2.	**Off-farm** include trading of livestock, shoat, ox, poultry, egg and camels, vegetable trade of food grain and chat trade and rental of farmland		
3.	**Non-farm** includes petty trade like oil, sugar, shopping, local beer, soft drinks, hair braiding, hand crafting, mining activities,		
4.	Remittances, retirements, and gifts/inheritance related incomes		
5 .	**Daily labor** activities like charcoal collection, lumbering work, construction work, water transportation, mud work, stone cutting,)		

25. **How did the** trend of annual crop production look like from harvest in past 20 years?

1=Increase 0=Decreases 2 =No change

26. What is household food security condition looks like in the past 5 years?

1=Improved food security 0=No change in food security

27. How many months did HH face food gaps in the last year? It is__________ months.
28. How do you evaluate diversity of food from all sources?

1=improved 0=not improved

29. What was the usual number of meals taken per day for your household?

1= 3 times a day 0= 2 times and < a day

30. Does the variability in rainfall and temperature affect your agriculture land productivity of nutritious food in the past 12 months? 1=Yes 0=No

31. Does the variability in rainfall and temperature affects your access to big and small livestock (Ox, hen, goat) 1=Yes 0=No

32. How do you see the incidence of malnutrition for CU5 in the past 30 years?

1= Increasing 2= Decreasing

33. Do you know about preparing balanced and diversified food? 1=Yes 0=No

34. Do you or your husband know additional dietary requirements during pregnancy, and lactating periods? 1=Yes 0=No

35. Have you malnourished children who are under five years (CU5) **?**

1=Yes 0=No

36. Who **eats food first in your household?**		**37. Who managed the income of the household?**	
1.	Men	1.	Husband
2.	women	2.	Wife
3.	Children	3.	Mother-in-law
4.	All	4.	Children
5.		5.	Husband

38. Who will decide for your home on nutrition outcomes during a disaster?		**39. Do you have children greater than 6 months?**	
1.	Men	1.	Yes
2.	women	2.	No
3.	Children	**40. If the answer is yes for question number 39, do you give the children complimentary food in the past 24 hours?**	
4.	All		Yes
			No

Appendix II: Checklists for KII and Focus Group Discussion

1. Farmers' perception towards severity of drought on the different parameters

S/N	Description of items	✓ Tick for the appropriate Likert scale				
		Very high	High	Moderate	low	Very low
1.	Decrease livestock assets and productivity					
2.	Decrease crop production and productivity					
3.	Drying up of water points					
4.	Decrease forage availability					
5.	Increase human disease prevalence					
6.	Increase livestock disease prevalence					
7.	Increase food gap months					
8.	Increase malnutrition					
9.	Decrease household income source and level					
10.	Affect households' Terms of Exchange					

2. What is the drought coping strategies employed by pastoral households in the study area?

S/N	**Climate Change adaptation strategies**	Write (1) if they have access and (0) otherwise.
1.	Integrating livestock with crop production	
2.	Livestock diversification and herd composition change	
3.	Livestock mobility/Migration	
	Income source diversification	
4.	Decreasing food consumption	
	Livestock selling	
5.	Use of forage /feed storage	
	Remittance	
6.	Food Aid	
	Improved crop varieties	
7.	Access to irrigation	
8.	Use of water harvesting (well/pond)	

3. What is the frequency of drought occurrence at present year when compared to before 20 years?

Tick (√) where it is appropriate

Patterns of Drought	**Now (At present time)**	**Before 20 years**
1.short		
2. Medium		
3.Long		

4. What is the duration of drought months in a year when compared to before 20 years? Tick (√) where it is appropriate

Patterns of Drought	**Now**	**Before 20 years**
1.short		
2. Medium		
3.Long		