PASTORALISTS' PERCEPTIONS, VULNERABILITY AND THEIR ADAPTATION STRATEGIES TO CLIMATE CHANGE AND VARIABILITY: CHALLENGES TO PASTORAL MOBILITY IN BORANA ZONE OF SOUTHERN ETHIOPIA

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Pastoralists' Perceptions, Vulnerability and their Adaptation Strategies to Climate Change and Variability: Challenges to Pastoral Mobility in Borana Zone of Southern Ethiopia

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I hereby certify that I have read and evaluated this Thesis entitled "Pastoralists' Perceptions, Vulnerability and their Adaptation Strategies to Climate Change and Variability: "challenges to pastoral mobility in borana zone of southern ethiopia" prepared under my guidance by Kadija Kadiro Geche. I recommend that it be submitted as fulfilling the thesis requirement.

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BIOGRAPHICAL SKETCH

The author was born on February 26, 1992 in Mega town, Dirre District of Borana Zone, Oromia Regional State. She attended her Primary education at Valley Bridge Primary School in Nairobi, Kenya and her secondary educations at Yabelo Senior Secondary and Preparatory School. After successful completion of her preparatory school, she joined Haramaya University in 2012 and graduated with Bachelor of Sciences Degree in Rural Development and Agricultural Extension in July 2015. Since her graduation, she has served in Haramaya University as Graduate ~~A~~assistant for two years. Then, she rejoined Africa Center of Excellence for Climate Smart Agriculture and Biodiversity Conservation at Haramaya University in December 2018 to pursue her MSc Degree in Climate Smart Agriculture in regular program.

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ACRONYMS AND ABBREVIATIONS

ASAL	Arid and Semi-Arid Land
BZAO	Borana Zone Administration Office
CSA	Central Statistical Agency
FAO	Food and Agricultural Organization
FDRE	Federal Democratic Republic of Ethiopia
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GPS	Global Positioning System
IFPRI	International Food Policy Research Institute
IGAD	Intergovernmental Authority on Development
IHDP	International Human Dimensions Programme
ILRI	International Livestock Research Institute
IPCC	Intergovernmental Panel on Climate Change
KII	Key Informant Interview
LVI	Livelihood Vulnerability Index
NGO	Non-Governmental Organization
PA	Peasant Association
PCA	Principal Component Analysis
PFE	Pastoralist Forum Ethiopia
SNNP	Southern Nations, Nationalities and People's
TLU	Tropical Livestock Unit
UNDP	United Nation Development Programme
UNEP	United Nation Environmental Programme
USAID	United State Aid for International Development
VAM	Vulnerability and Mapping
WFP	World Food Programme

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ABSTRACT

Climate change and variability is increasingly being recognized as a critical challenge to pastoral production systems in the arid and semi-arid rangelands of Ethiopia. Pastoral communities in the Borana zone of Ethiopia have been changing and adapting their livelihoods to changing environmental conditions for centuries. The objective of this study was to assess the vulnerability of pastoralists and their adaptation strategies to climate change and variability in the rangeland of Borana Zone. The study used cross-sectional data collected from a sample of 160 pastoralists using multistage sampling procedures. Both qualitative and quantitative data obtained from primary and secondary sources were used. The primary data were collected from 160 randomly selected respondents, focus group discussants and key informant interviewees whereas secondary data were collected from different institutions (both governmental and non-governmental organizations (NGOs). Data was analyzed by descriptive statistical methods and applied vulnerability indices: Livelihood Vulnerability Index (LVI) and LVI-IPCC, as well as qualitative data analysis techniques such as narration and quotation. The survey results showed that 71% of the respondent perceived a very high impact on herd mobility. Respondents' perceptions results show climate change is real and is negatively affecting forage availability (in quality and quantity); livestock production and reproduction performances; herders' practices and their livelihoods. The results from the vulnerability indices showed that Gobso with LVI-IPCC of 0.0970 indicated highly vulnerable PA with very high exposure to natural hazards and only a least adaptive capacity. Most of the households fall within the moderately vulnerable category. Borana pastoralists are already taking adaptation measures such as mobility, Kalo (enclosures), destocking, herd diversification, using borehole and prayers and other rites. However, increase in drought occurrence in the last few years is reducing their resilience. The study concludes that, various social, economic and biophysical determinants influence households' vulnerability to climate-induced stresses. Hence, adoption of Climate Smart Agriculture policies and strategies with emphasis on improving adaptation strategies of pastoralists' are necessary for better planning and targeting of interventions.

Key words: Pastoralists, Perception, Climate Change, Vulnerability, Adaptation, Mobility

1. INTRODUCTION

1.1. Background of the Study

Climate change is defined as a significant and measurable change in the statistical distribution of weather patterns over periods ranging from decades to millions of years (IPCC, 2014). It may be a change in average weather conditions, or in the distribution of weather around the average conditions. The change in global climate has been reported to have severe effect on environmentally based livelihoods in many areas of the world (Omolo, 2010). The adverse effects of climate change include increased frequency and intensity of storm, thunder, flood, drought and hurricanes. All these are having severe effect on human livelihood, causing poverty, malnutrition and reduced agricultural productivity (Ayanda *et al.*, 2013).

Climate change exacerbates the existing social problem in the society and will further undermine current efforts to reduce poverty and vulnerability, particularly in pastoral areas. Injustice and vulnerability in turn undermines the resilience of vulnerable populations decreasing their ability to cope and adapt to the consequences of climate change and their ability to grow economically. At a time when pastoralists face an increasingly precarious future, vulnerability is increased because many social services are inadequate, inappropriate or inaccessible (Boko *et al.,* 2007). Many developing countries, which have their economies largely depend on climate-sensitive agricultural production systems, are particularly at risk and vulnerable to the impact of climate change (Gezie, 2019). However, the extent of such vulnerability will depend on how efficiently communities adapt to the changing climatic conditions. Studies show that majority of households in the arid and semi-arid regions have limited assets and scarce resources to use in adaptation or coping with climate - induced shock or stresses (Ifejika, 2010; Silvestri *et al.,* 2012). Undoubtedly, extreme climate scenarios are likely to exacerbate vulnerability with much impact on human and natural systems in the arid and semi - arid regions unless effective adaptation and mitigation mechanisms are put in place.

The impact of drought appears to have become more severe in recent years in East Africa (DEC, 2017). Although East African pastoralists have historically coped with seasonal and annual climatic variability, their rainfall-dependent livelihoods are especially vulnerable to the long-term climatic changes projected for the region (Kirkbride and Grahn, 2008). What is obvious is that climate change is impacting on the physical and biological systems (Malhi *et al*., 2020). However, little information exists on household vulnerability to climate change and variability.

The Borana lowland of Ethiopia, that is known to have supported veritable pastoral economy in the past (ESAP, 2000), exhibits deteriorating conditions of rangeland with a marked decrease in grass species and increase in shrubs (Terefe *et al.,* 2012). The grazing systems over the Borana plateau have become increasingly unsustainable (Coppock *et al.,* 2008; Wassie *et al.,* 2007; Getachew *et al.,* 2006). This is because the area has been affected by cyclical and prolonged drought with a heavy toll on livestock that deepens the level of poverty (Coppock *et al.,* 2008) and food insecurity (Ayal *et al.* 2018). The livelihood of pastoralists in Borana is adversely affected by climate change and extremes (Hurst *et al.,* 2012). The efficacy of their coping and adaptation strategies are compromised by climate extremes and associated risks (Hurst *et al.,* 2012; Aklilu *et al.,* 2009). There is a need for a new and deeper understanding of vulnerability and adaptation strategies of Borana pastoralists for an accurate appreciation of their environmental and socio-economic trajectories.

Pastoral mobility is one possible form of adaptation within a broader set of potential adaptive responses that pastoral communities make when systems are exposed to stresses or changing environmental conditions. Being mobile is an important strategy adopted by millions of pastoralists worldwide to ensure adequate forage intake for livestock while maintaining rangeland ecosystem sustainability (Sanou *et al.,* 2018). Pastoralists in the Borana Plateau of Southern Ethiopia employ mobility in order to adapt to and survive the impacts of climate variability, which is characterized by erratic and unpredictable climatic conditions. These pastoralists traverse large areas in search of pasture and water for their livestock (Marin, 2010;

Turner *et al.,* 2014), which they depend upon for their livelihoods. The proportion of household vulnerability to extreme weather events is increasing in Borana Zone. Therefore, analyzing household vulnerability to climate change and understanding their adaptation strategies is necessary for adaptation planning and resource allocation in the rural areas where climate change impact is most felt (Bobadoye, 2016).This study will explore recent changes in pastoral mobility due to climate change and examines vulnerability of Borana pastoralists, their perceptions on mobile herding and adaptation strategies of Borana Pastoralist of southern Ethiopia.

1.2. Statement of the Problem

Climate change impacts weakens and even reverse the progress made in improving the socioeconomic welfare of most African countries. The negative influences of climate change can be exacerbated by the existing mounting poverty, human diseases and the increasing population (IPCC, 2014). According to Yanda and Mubaya (2011), the incidence of climate shocks such as droughts and floods are the features of the climate in African countries. The current and predicted climate influences indicate that a severe impact will be observed more in Africa than in other continents, as the livelihoods of African people are mainly based on rain-fed agriculture and due to low incomes and its geographic exposure (Fenta and Muluken, 2017).

Ethiopia has a diversified climate, which has different size and diversity of major agro-ecological zones render it suitable for the support of large numbers and classes of livestock (Funk *et al.*, 2012). However, the country has suffered from climatic variability and extremes (Alebachew and Woldeamlak, 2011). Consequence of the long-term climate related to changes in precipitation patterns, rainfall variability, and temperature has increased the frequency of droughts and floods (World Bank, 2010). Frequent droughts and floods are the main hazard risks to rural livelihoods in the country. The incidences of droughts have been increasing mostly in the pastoral communities of the country (Berhanu and Fekadu, 2015).

According to Funk *et al.,* (2015), precipitation in Ethiopia is anticipated to decrease and become more uneven in the future. Climate extremes such as more intense and prolonged droughts and floods could happen in Ethiopia due to climate change and variability (UNDP, 2008). However, it is well recognized that some of adaptation and coping strategies used by pastoralist may effectively address several challenges besides climate variability and change.

Mobility, the traditional nomadic form of pastoralism based on strategic seasonal migration in response to fluctuations in resource availability including water and pasture, has long been employed by pastoralists to adapt to and survive the impacts of climate change and variability. Although mobility has long been serving as a pastoral adaptation mechanism to efficiently utilize rangeland resources spatially and temporally, in the past few years it has been constrained by different forms of land fragmentation. As different forms of land fragmentation subdivide more areas, pastoralists' ability to track environmental conditions and mobilize herds to seek pockets of good forage is limited and the total area of the remaining rangelands has declined. Consequently, pastoralists are forced to stay around encampments or move long distances to cross protected (private enclosure) and occupied (bush encroachment and cropping) rangelands (Mellisse, and Wassie, 2014).

In agro-pastoral systems of Ethiopia, the distance of regular mobility decreased by 7 percent between 2010 and 2013 due to climate change and variability, which consequently compromises herd access to resources like pasture and water. This has a profound implication on pastoral livelihood assets, such as livestock holdings, communal rangeland, watering points and income, which, in turn, make pastoralists increasingly vulnerable to food self-insufficiency and famine. In contrast in purely pastoral system of Ethiopia regular mobility has increased (Mellisse and Wassie, 2014). Climate-induced shocks and stresses such as droughts, rising temperature and irregular rainfall-reduced pasture and water availability (Conway, 2000). Consequently, leading to extensive movement beyond settlement areas in pure pastoral system which in turn increases susceptibility of livestock to disease and emaciation (Demeke *et al.,* 2011). Although changes in climate and climate extremes will be the greatest challenge

for pastoral communities in Ethiopia, few studies have been undertaken in the country concerning how and whether pastoral mobility helps in reducing pastoralists livelihood vulnerability and enhance their resilience to climate change. Most of the growing literature has investigated seasonality, poverty and food insecurity (Dercon and Krishnan, 2000). Nevertheless, the issue of climate change and variability and its impact on livestock system and livestock disease among pastoralists has been the subject of recent investigation in the study area (Ayal et al., 2018). Wario *et al*., (2016) provide analysis of contemporary Borana pastoralists' livestock mobility practices and how they have adapted grazing management strategies. However, there is a need for more systematic investigation into impact of climate change on mobile herding and pastoralist's livelihood vulnerability to climate shocks and their adaptation strategies.

Mobility consists in a flexible solution enabling a sound exploitation of variable resources by mobile herds (Scoones, 1994). Accordingly, over the centuries, this mobility has been perceived as increasing the resilience of rural households in semi-arid Africa to climate change and variability (Turner *et al.*, 1994). However, how long will this mobility contribute to reinforce the resilience of pastoralists in Borana of southern Ethiopia? This interrogation is raised because of the increased challenges to which mobile herding is gradually confronted in East Africa. Among challenges there are the reduction of grazing land size (Gonin, 2015), the obstruction of livestock routes [Kimiti, *et al.,* 2016), the reduction of watering points, qualitative and quantitative decline in forage biomass (Kiema, 2013), and the recrudescence of conflicts between land users. These challenges affect livestock production and reproduction performance and finally the livelihoods of pastoral communities. Muller-Mahn *et al.,* (2010) indicated that the traditional coping strategies of pastoralists in Ethiopia have become increasingly insufficient to sustain local livelihoods during times of drought. A critical and systematic appraisal of current individual adaptive behavior and public measures in pastoral areas is essentially justifiable in view of the need to design policies and selectively promote innovative practices that can enhance pastoralist adaptive capacities (Berhanu and Fekadu, 2015).

It is assumed that for households to decide whether to adapt or not to climate change and variability, they must first perceive the change (Deressa et al., 2009; Silvestri et al., 2012). Studies by Muller-Mahn *et al.,* (2010) and Wario *et al*., (2016) shows that ASAL communities in Ethiopia are mainly dominated by pastoralist who are vulnerable to climate change and variability due to their dependence on climate sensitive livelihood activities. It is therefore important to understand the perception of ASAL communities for planning adaptation options local at level. Studies on perception, awareness and local knowledge at the household and community levels can provide the basis for concepts and methods for assessing climate change vulnerability and adaptation strategies for pastoral livelihoods.

Therefore, this study will focus on the perception of Borana pastoralists on climate change impacts on mobile herding and their livelihood, vulnerability of pastoralist community and adaptation mechanism to climate change and variability in the rangeland of Borana zone.

1.3. Objectives of the Study

The general objective of this study is to assess the Perception and vulnerability of Borana pastoralists and their adaptation strategies to climate change and variability in the rangeland of Borana Zone, Ethiopia.

The specific objectives of this study were:

- To examine the perception of pastoralists on Climate Change impacts on mobile herding
- To assess vulnerability of Borana pastoralists to the effect of climate change and variability and
- To assess Borana pastoralists adaptation and coping strategies

1.4. Research Questions

- What is the perception of Borana pastoralist to climate change impacts on mobile herding?
- What are the socio-economic conditions that create vulnerability to climate change and variability, and how does the community cope with or adapt to it and how is this changing?

1.5. Scope and Limitation of the Study

It would have been the ambition of the study to cover wider area (regional and national level) to better understand vulnerability of pastoral community and their adaptation strategies to climate change and variability which will necessarily require much time, finance and large up-to-date and accurate data. Thus, the study only focused on Borana zone of southern Ethiopia. Though the present study analyzed the vulnerability of pastoralists and their adaptation strategies, the study did not analyze climatic data to determine the climate trends in Borana. Furthermore, this study examines the perception of pastoralists on Climate Change impacts on mobile herding.

1.6. Significance of the Study

In Ethiopia, where more than 60 percent of its territory is arid and semi-arid lowland occupied by pastoralists. In the arid and semi-arid pastoral systems of Borana, livestock mobility has been a means of utilizing pasture and water available across heterogeneous landscapes. It is indicated that pastoralists have come under increasing pressure and their traditional coping and adaptation strategies have become insufficient to sustain their livelihoods. This research is important in showing whether there is a future for mobile pastoralists in rapidly changing climate, by analyzing their vulnerability level and different factors that aggravate their vulnerability and coping strategies of these vulnerable populations including recommendations

to stay climate smart and have climate resilient community and institutions. It will also consider some of the implications of the findings, including the cultural consequences.

The study will also help to understand the indigenous adaptation/coping mechanisms deployed by pastoral households to adapt/cope with climate change and variability which may be useful to integrate their indigenous knowledge in the development policy of the country for sustainable development of pastoralists. Furthermore, the information that will be obtained through the study is believed to help researchers who may have interest to be engaged in similar study while serving as a source of data. Above all, the study results and recommendations will have a paramount significance for policy makers, policy advocates, development planners and practitioners who may be in need of such information.

2. LITERATURE REVIEW

2.1. Basic Concept and Definition

Climate change and variability is emerging as one of the most serious global challenge. It is considered to be one of the most severe threats to sustainable development with severe impacts on the environment, human health, food security, economic activities, natural resource management and physical infrastructure (Hulme et al., 2001; Nicholson, 2014). IPCC (2014) defined climate change as any change in climate over time, whether due to natural variability or human activity. According to \UNFCCC (1992), climate change is "the change in climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods".

The concept of vulnerability provides a basis for understanding the spatial and temporal patterns of climate-related migration, as well as its consequences for societal well-being (McLeman, and Hunter 2010). IPCC (2014) defines vulnerability to climate change as "the degree to which a system is susceptible to and unable to cope with adverse effect of climate change including climate variability and its extremes". Vulnerability is a function of character, magnitude and rate of climate change and variability to which a system is exposed to, its sensitivity and its adaptive capacity. Adaptive capacity is the ability of people to cope with changing context and is explained by socio–economic indicators. Sensitivity is the ability of a system to be affected and exposure is the incidence of extreme climatic event (Kasperson *et al*., 1995; Paavola, 2008). Vulnerability to climate change can be analyzed at global, regional, national and local level (Brooks 2004; Deressa *et al*., 2008; IPCC 2014).

Adaptation to climate change is defined by IPCC (2014) as the "adjustment in ecological, social or economic system in response to actual or expected climatic stimuli, and their effects to moderate or offset potential damage or take advantage of opportunities associated with change in climate". The adaptation process includes three essential stages (1) vulnerability

assessment (2) capacity building and (3) implementation of adaptation options. Pastoral households and their communities in ASALs have indigenous ways of adapting to varying degree of extreme weather events. Recent increase in the frequency of occurrence of these extreme weather events such as drought is widening the resilience of the pastoral community and having severe effect on the pastoralist livelihood in the arid and semi-arid areas of Ethiopia.

2.2. Climate Change and Pastoralists

Climate variability and change has significant impacts on human and natural systems due to increasing occurrence of uncharacteristic extreme weather events and the intensification of both frequency and severity of climate stressors, such as drought (Hulme *et al.,* 2001). The manifestations of climate variability and change have the potential to directly and severely impact communities that rely on climate-sensitive production systems like pastoralism (Bryan *et al.,* 2013; Nicholson, 2014). The increasing frequency of drought events as observed between 2008 and 2009, and thereafter in 2010 to 2011 underscored the need to examine adaptation strategies for long-term resilience to drought. Studies in the region show that vulnerability to drought, is arguably increasing on the back of climate variability and change, and violent conflicts providing compelling justification for effective adaptation strategies in the Horn of Africa (Smit and Pilifosova 2001; Paavola 2008; Headey and Ecker, 2013).

There are predictions that due to accelerated anthropogenic and man-made activities, climate variability may increase in the future and that extremes might become more frequent in sub-Saharan Africa (Intergovernmental Panel on Climate Change IPCC, 2014). The increased climate variability under projected scenarios is expected to augment vulnerability in the tropics, unless key investments are made to improve adaptive capacity of communities. Concern has been raised about viability of pastoralism which is practiced in sensitive environment characterized by high spatial and temporal variability in rainfall, and thus thought to be highly vulnerable to both present and future climate variability (Conway *et al.,* 2005;

Little, 2012). However, contrasting past and present adaptation responses of pastoralist communities with those that are likely to be required in the future could give some indication of where the greatest stresses and transformation processes will lie for long-term climate resilience building.

Pastoralist populations have always been highly adaptive, a necessary trait given the weather variability that is characteristic of the arid and semi-arid ecosystems in which they inhabit in East Africa (Galvin, 2009). Nonetheless, climate variability and change are forcing new levels of transformative adaptations among pastoral communities, and many are significantly affected by the consequences of their coping and adaptations strategies (Tsegaye *et al.,* 2013). This raises the question to what extent past and present responses of pastoral communities and their system to climate variability and extremes facilitate their long-term adaptation to projected climate scenarios. Other studies have showed that adaptation to climate variability is necessary both to reduce current vulnerability to climatic extremes as well as to prepare for future climate variability and change (Adger *et al.,* 2005; Notenbaert *et al.,* 2013). While some adaptations may be developed specifically to cope with climate variability and projected change such as climate-proof infrastructures, adaptations often also involve policy, legal, institutional and financial responses to reduce sensitivity and increase adaptive capacity for resilience (Ford *et al.,* 2013).

Climatic fluctuations are a defining characteristic of dry land areas in Africa, as rainfall tends to vary substantially between and within years. Pastoralism is a livelihood system that enables dry land people to cope with this difficult environment. Although pastoral systems are very diverse, most display some common characteristics: (1) Livestock depend on natural pastures for their diets, and rainfall is the most important factor determining the quantity and quality of pastures and water (2) Herds are composed mainly of indigenous livestock breeds (3) Livestock represent more than just economic assets - they are also social, cultural and spiritual assets, and define social identity (4) Natural resources are managed through common property regimes where access to pastures and water is negotiated and dependent on flexible and

reciprocal arrangements (Hesse and Cotula, 2006). While pastoral systems are resilient because they enable people to cope with unpredictable environments, they are also dependent on maintaining a delicate and constantly changing balance between pastures, livestock and people. If there are too many animals, the family herd will not find sufficient pasture, and there is a danger of over-grazing if livestock mobility is constrained. If there are too few animals or the family is too large, subsistence requirements will not be met. If the family is too small, livestock may not be properly managed and, crucially, if quality and quantity of pastures decrease dramatically (e.g. as a result of drought), pastoralists may lose their livestock and face destitution. Pastoralists use a range of strategies to maintain that balance. Central among these is livestock mobility - moving herds to areas with better grazing conditions, and securing access to critical resources during the dry season and in times of crisis (Hesse and Cotula, 2006).

For a long time, lack of understanding and negative perceptions of pastoral systems resulted in unfavorable policies - particularly policies constraining herd mobility. In many parts of the Sahel, mobility is also hindered by agricultural encroachment on livestock tracks. As a result, many pastoralists have become more "sedentary", and some have lost their traditional contacts in dry-season and refuge areas. Recent research has challenged negative perceptions of pastoralism, however. Herd mobility is now recognized as a rational strategy in unstable environments, and some countries have taken steps to facilitate movement of herds (Hesse and Cotula, 2006).

2.3. Climate Change and Pastoralists in Ethiopia

Ethiopia is repetitively exemplified as the potential country in livestock resource (Shapiro *et al*., 2015). This resource forms an integral part in the agricultural system and basis of livelihood for larger rural and semi-urban population. In pastoral areas, beyond the economic advantage it matters a cultural prestige and social status of the society (Coppock, 1994). Livestock, especially cattle, plays a leading role in determining the social position of the

pastoral households in the society besides its crucial role in cultural heritages and economic welfares. The recent livestock population of Ethiopia estimates that the country has about 57.83 million cattle, 28.89 million sheep, 29.70 million goats, 2.08 million horses,7.88 million donkeys, 60.51 million poultry, 5.92 million beehive, 0.41 million mules and about 1.23 million camels (CSA, 2016). From the total cattle population 98.95% are local breeds and the remaining are hybrid and exotic breeds. 99.8% of the sheep and nearly all goat population of the country are local breeds (CSA, 2013). They are an important component of nearly all farming systems in Ethiopia and provide draught power, milk, meat, manure, hides, skins and other products (Funk et al., 2012).

The livestock subsector has an enormous contribution to Ethiopia's national economy and livelihoods of many Ethiopians, and still promising to rally round the economic development of the country. Livestock plays vital roles in generating income to farmers, creating job opportunities, ensuring food security, providing services, contributing to asset, social, cultural and environmental values, and sustain livelihoods. The subsector contributes about 16.5% of the national Gross Domestic Product (GDP) and 35.6% of the agricultural GDP (Metaferia *et al*., 2011). It also contributes 15% of export earnings and 30% of agricultural employment (Behnke, 2010). The livestock subsector supports and sustain livelihoods for 80% of all rural population. The GDP of livestock related activities valued at birr 59 billion (Metaferia *et al*., 2011).

Among factors which influence livestock production climate and location are undoubtedly the most significant. In fact, climatology characteristics such as ambient temperature and rainfall patterns have great influence on pasture and food resources availability cycle throughout the year among animal populations. This means during rainy season pastures are available in higher quantities and show good nutritional quality whereas dry season's pastures have poor nutritional quality with high fiber and low protein contents, which often results in declining the animal production (Abebe, 2017). The rain pattern during the year also strongly influences disease and parasites outbreaks influencing animal production systems productivity.

In arid and semi-arid areas where rainfall is highly variable and unpredictable, the influence of climate change on the livelihood system is very significant. Pastoralism, the major livelihood system, in most of arid and semi-arid areas of the Horn Africa in general, and specifically, in the lowland arid and semi-arid areas of Ethiopia have been developed in response to such change as an adaptation strategy to prevent and manage the risk of climate related disaster (e.g. drought). However, in the last 2-3 decades the vulnerability of pastoralists to drought has been increasing in sub-Saharan Africa particularly in the Horn (Duguma, 2013).

East Africa is home to thousands of pastoralists who herd their livestock in the semiarid to arid areas of the region. Rainfall seasonality affects forage availability, livestock production and ultimately the livelihoods of these people. East African rainfall is bimodal but is characterized by uncertainty both spatially and temporally (Galvin *et al.*, 2004). With regard to this, Ruijs *et al.*, (2011) reveals that the north- and south-eastern parts of Ethiopia are facing lower rainfall and higher temperature levels than the rest of the country. Generally, due to the varying rainfall and temperature patterns, the arid, semi-arid and sub-humid lowlands are more vulnerable than the highland areas (Ruijs *et al.*, 2011). As a result, pastoral people inhabiting this part of the country (the Borana, the Afar, the Karrayu and the Somali pastoralists of Ethiopia) have suffered frequently from climate related hazards, particularly drought. Hence, the more erratic and the lower rainfall levels, the higher the vulnerability of these pastoralists to climate variability and change.

2.4. Perception of pastoralists to Climate Change and Variability

Perceptions of climate change particularly within dryland communities are very important in addressing adaptation to extreme climate events in sub-Saharan Africa (Fraser *et al.* 2011; Silvestri *et al.* 2012). Studies show that dryland communities‟ normally bear the brunt of extreme climate change and likely to be more vulnerability unless appropriate adaptation measures are put in place (Hassan and Nhemachena 2008; Rao *et al.* 2011). Future climate scenarios predict increased frequency and intensity of dry spells throughout the drylands of

East Africa (Below *et al.* 2010; IPCC, 2014), with impacts projected to worsen and, threaten food security and erode climate resilience of communities. It is however, assumed that for households to decide whether to adapt or not to climate changes they must first perceive the change (Deressa *et al*. 2009). Thus, perception is seen as a prerequisite for adaptation (Silvestri *et al.* 2012).

Study by Fraser *et al*. (2011) indicate that dryland communities, especially pastoralist are vulnerable to climate induced stresses due to their low adaptive capacity and over dependence on climate sensitive livelihood activities. Their vulnerability to increasing climate change is further compounded by other socio-economic, political and ecological factors including but not limited to inadequate sources of income, limited livestock marketing opportunities, political marginalization, changing land tenure, unclear property right regimes, and breakdown of traditional social and resource governance institutions (Bryan *et al.* 2013). Therefore, to identify sustainable mechanisms to minimize impacts of climate change and vulnerability of the households, it is essential to have full comprehension of factors that influence perceptions of climate change and adaptation choices. Adaptation in this context refers to initiatives and measures to reduce vulnerability of human systems against actual or expected climate change effects (IPCC, 2012). While, vulnerability denotes the capacity to be wounded, i.e., the degree to which a system is likely to experience harm due to exposure to a hazards (Turner *et al.* 2003)

2.5. Pastoralism, Vulnerability and Adaptation to Climate Change

2.5.1. What is pastoralism

Pastoralism is the finely-honed symbiotic relationship between local ecology, domesticated livestock and people in resource-scarce, climatically marginal and highly variable conditions. It represents a complex form of natural resource management, involving a continuous ecological balance between pastures, livestock and people (World Initiative for Sustainable Pastoralism, 2007). Pastoralist people are those whose way of life largely depends on mobile

livestock-herding (Swift, 1988) they live in a range of environments in many countries across every continent in the world.

In sub-Saharan Africa mobile pastoralism is predominantly practiced in arid and semi-arid lands (ASALs). These areas are hot and dry, with low and erratic rainfall. There are no many livelihoods that are suited to this arid environment, but mobile livestock-keeping is particularly well adapted. In fact, pastoralism in Africa evolved in response to climate variability over 6000 years ago when the Sahara entered a period of prolonged desiccation. With no reliable supplies of permanent water, pastoralism enabled people to adapt to an increasingly arid and unpredictable environment by moving livestock according to the shifting availability of water and pasture (Brooks, 2006). This opportunistic management system continues to this day, making pastoralism an effective and efficient land use and production system for the dry lands of the world.

To be practiced effectively, pastoralism depends on freedom of movement for all herds between pastures and water sources; this is usually facilitated through some form of common-property regime. According to a UNDP report, where mobile livestock-production continues unhampered, it has helped in the conservation of biodiversity, improved livelihoods, and resulted in sustainable land management. Where it is constrained by land use or land tenure changes, decentralization, and policy disincentives, it has led to serious overgrazing, land degradation, and poverty (Niamir *et al.*, 2004).

2.5.2. Pastoralist and vulnerability

The 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 (Kloos 1982, Hogg 1997, Helland, 2006, Feinstien International Center 2007, and 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). But while aid may have helped to keep pastoralists alive, they remain highly vulnerable. Climate variation remains a perennial problem to pastoralists; hence their vulnerability has to be explained with reference to a much broader set of issues. Government policies and socioeconomic factors are also contributing their part.

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).

2.5.3. Approach to vulnerability assessment

There are three major conceptual approaches to analyzing vulnerability to climate change: the biophysical (impact assessment); the socio-economic; and the integrated approaches.

2.5.3.1. Biophysical approach

The biophysical approach to analyzing vulnerability which is also called impact assessment attempts to assess the level of damage caused by a given climatic extreme on both social and biological systems. For instance, the monetary impact of climate change on agriculture can be measured by modeling the relationships between climatic variables and farm income (Polsky and Esterling, 2001). Also, the impact of climatic variables on pastoralism can be measured by relating climate extremes to livestock production (Ombogo, 2013). Other related impact assessment studies include the impact of climate change: on human mortality and health terms (Martens *et al.* 1999); on food and water availability (Xiao *et al.* 2002); and on ecosystem damage (Forner 2006). The damage is most often estimated by taking forecasts or estimates from climate prediction models (Kurukulasuriya and Mendelsohn 2008a) or by creating indicators of sensitivity by identifying potential or actual hazards and their frequency (Cutter *et al.* 2000). Füssel, (2007) identified this approach as a risk-hazard approach; he described it as an end-point analysis that responds to research questions such as 'to what extent is climate change and its extreme affecting human and social system'.

Although very informative, the biophysical approach has its limitations. Assessment of biophysical factor does not provide a sufficient understanding of the complex dynamics of vulnerability to climate change and variability. It focuses on impact of climate extremes on a system not giving consideration to other factors. Assessment of biophysical factor does not provide a sufficient understanding of the complex dynamics of vulnerability to climate change and variability. It focuses on impact of climate extremes on a system not giving consideration to other factors. This approach is difficult to apply to people whose exposure to hazards largely depends on their behaviour, as determined by socioeconomic factors. It neglects both structural factors and human agency in understanding vulnerability and adapting to it. The approach overemphasizes extreme events while ignoring the root causes and everyday social processes that influence vulnerability (Liverman 1990; Hewitt 1997). For example, the biophysical approach can only measure the effect of drought on crop yield, but it will not

reflect how various household or communities are influenced or affected by the change in crop yield.

2.5.3.2. Socio-economic approach

The socio-economic vulnerability assessment approach focuses vulnerability analyses on people. It concentrates on socio-economic and political status of individuals or social groups (Fussel, 2007; Deressa, 2010; Opiyo, 2014). Individuals in a community vary in terms of level of education, wealth, health status, access to credit, access to information and technology, formal and informal (social) capital and political power, which are responsible for variations in vulnerability levels (Füssel, 2007; Deressa *et al.*,2008). Consequently, vulnerability is considered to be a state that exists inside a system before it encounters a hazard event (Kelly and Adger 2000). In this contest, vulnerability is measured as a function of institutional and economic changes in the society. The socio-economic approach focuses on the state of individuals, groups or communities in terms of their ability to cope or adapt to external stress placed on their livelihoods. It considers the availability of resources by individuals or communities and their ability to call on these resources when needed. The term 'response capacity' and 'coping capacity' are used to denote the concept.

The main limitation of the socio-economic approach is that it focuses only on variations within society (i.e. differences among individuals or social groups). In reality, societies vary not only due to socio-political factors but also because of environmental or biophysical factors. This method overlooks the intensities, frequency and probabilities of environmental hazards such as drought and floods. The socio-economic approach does not account for the impact of natural events which can have significant impact on vulnerability of individuals or communities. For example, increase in frequency of forest fire can increase the vulnerability of a community when compared to another community with similar socio-economic characteristics.

2.5.3.3. The integrated approach

The integrated assessment approach combines both socio-economic and biophysical approaches to determine vulnerability. Researchers realizing the limitations in the bio-physical and socio-economic approach to vulnerability assessment developed the integrated approach to combine both internal factors of a vulnerable system and its exposure to external hazard to determine vulnerability (Cutter, 1993; Fussel, 2007; Deressa 2010; Opiyo, 2014). The hazard-of-place model (Cutter *et al*., 2000) and the coupled vulnerability framework (Tunner II *et al*., 2003) are examples of the integrated vulnerability approach. This approach agrees with Cutter (1996) definition of vulnerability as ‘‘the likelihood that an individual or group will be exposed to and adversely affected by a hazard. It is the combination of the hazards of place with the social-economic profile of communities.’’ Integrated definitions of vulnerability are also commonly used in environmental change and climate change vulnerability assessment with reference to regions, communities, or other social units (Deressa 2010; Opiyo, 2014).

IPCC (2014) definition of vulnerability as a function of adaptive capacity, sensitivity and exposure accommodates the integrated approach to vulnerability studies. (Fussel and Klein, 2006; Deressa, 2010). Sensitivity and exposure in the IPCC terms relates to biophysical approach while adaptive capacity talks about the socio-economic properties of a household or a community. Even though the integrated assessment approach corrects the weaknesses of the other approaches, it also has its limitations. The main limitation is that there is no standard method for combining the biophysical and socio-economic indicators. Allocating weights to different parameters with different units ranging from socio-economic parameters such as income levels, educational qualifications, to bio-physical parameters such as drought frequency and flood occurrence is also a challenge in the integrated approach.

2.5.4. Adaptation and coping strategies of pastoralist communities to climate change and variability

Adaptation to climate change is a broad concept that covers actions taken by individuals, communities, private companies and public bodies such as governments to enhance resilience to climate change and variability (Mitchell and Tanner, 2006). IPCC (2014) defined adaptation to climate change as "adjustment in ecological, social or economic system in response to actual or expected climatic stimuli and their effects to moderate or offset potential damage or take advantage of opportunities associated with change in climate". Successful adaptation strategies should reduce vulnerability. It builds on and strengthens existing coping mechanisms, targeting climate change vulnerability with specific measures and integrating vulnerability reduction into wider policies (Mitchell and Tanner, 2006). The aim of an adaptation strategy should be to increase the capacity of a system to survive external weather shocks or changes. For many decades, pastoral communities in ASALs have developed indigenous ways of adapting to varying degree of extreme weather events; however, recent increase in the frequency of occurrence of these weather events are stretching the resilience of pastoral communities (Bobadoye, 2016).

Pastoral communities employ a number of strategies to adapt to the impact of climate change and its extremes (Keya, 2001). Some of the adaptation and coping strategies used by pastoralist in ASALs of Kenya include mobility, large and diverse herds, herd separation and splitting, informal social security systems, and engaging in other livelihood activities like crop farming, charcoal burning, and wage labor. Unfortunately, some of these strategies that have served the pastoralist communities very well in the past and are presently constrained due to increase in the frequent occurrence of droughts and rapid social and economic changes.

Pastoral adaptations in the lowlands of Ethiopia depend entirely on access to wide tracts of land to make full use of a resource base that is generally poor and unevenly distributed (Helland, 2006). Mobility of pastoral and semi-pastoral communities is the basis of the traditional coping strategy, based on opportunistic movements within and across

geographically distributed grazing units, which are composed of those households that depend on common permanent water sources (Angassa and Oba, 2008).

Livestock mobility is an inherent strategy of pastoralists to optimize production of a heterogeneous landscape under unstable climate (Ndikumama *et al*., 2000). Pastoralist mobility has two dimensions. The first is resource utilization mobility, where pastoralists continue to move in response to unpredictable forage and water availability. The strategy allows pastoral herds to maximize dispersed forage resources when they are available and most nutritious. Pastoralists also move their herds to escape drought occurrence in a particular location. The distances moved depend on availability of limited resources and the social and political "environment" shared with neighbors (Kagunyu, 2014). Mobility is an intrinsic part of the pastoralist existence and needs to be understood as the strategic mobility of people and livestock. The social networks amongst pastoralist offer security and insurance that allows for flexibility in mobility of livestock and people (Opiyo, 2014). Mobility is therefore a fundamental adaptation strategy to changing climatic condition and trends in the ASALs of Kenya. Studies have also shown that ASALs ecosystems are healthier where mobile pastoralism continues to be practiced effectively (Niamir-Fuller, 2000; Nassef *et al.,* 2009; Agrawal 2010; Opiyo, 2014). Grazing opens up pastures, stimulates effective vegetation growth, fertilizes the soil with animal dung and enhances its water infiltration capacity as hoof action breaks up the soil crust. It also aids in seed dispersal to maintain pasture diversity, prevents bush encroachment and enhances the cycling of nutrients through the ecosystem (Goldman and Fernando, 2013).

In the culture of Ethiopian pastoralists, the grazing units consist of semi-sedentary camps where the elderly, women, and children stay with dairy cows or lactating animals. The surplus herd, composed of dry cows, heifers, and male animals, join the mobile herd management unit herded by young men on more remote grazing lands. Rangeland rotation during the wet and dry seasons traditionally prevented overgrazing, while controlled access to water provided the key mechanism for guaranteeing sustainable use of the grazing lands (Desta and Coppok,

2004, Angassa and Oba, 2008). Similarly, Agrawal (2010) argues that mobility is a way of life for large groups of people in semiarid regions, and a long-standing mechanism to deal with spatiotemporal variations in rainfall and range productivity; and hence the status of the social group in question matters whether mobility is the desirable adaptation or not.

Herd diversification is another adaptation strategy used by pastoral communities in ASALs of Kenya. This involves keeping several species/types of livestock. The rearing of different livestock species has ecological and economic advantage for the pastoralist (Kinyamario and Ekaya, 2001). Diversification optimizes the use of heterogeneous ecosystem and meets different socio-economic obligations. Livestock species have different uses, feeding preferences, levels of physiological and behavioral adaptation to extreme climatic events. Therefore, livestock diversification is necessary for exploitation of the different ecological niches and the animal's complementary adaptabilities, as well as for meeting social and economic needs during drought conditions. Livelihood diversification is also a common adaptation strategy to climate change and variability in ASALs. Diversification of sources of income is a core livelihood strategy of rural livelihoods systems in most developing countries (Little *et al.,* 2001; McCabe *et al.,* 2010). Pastoralists diversify their sources of income during extreme climatic condition such as drought (Opiyo, 2014). Alternative sources of livelihood engaged by pastoralist include livestock trading, selling of hide and skins, and cultivating crops. Pastoralist are also involved in a variety of wage-earning occupations ranging from professional to manual labor; and entrepreneurial activities including shop keeping, craft production and sales, and transportation.

The ability of pastoral and agro-pastoral households to adapt is constrained by many factors including land degradation, limited education, poor access to financial resources and markets to diversify their livelihoods, gender inequalities and marginalization (Njuki and Sanginga, 2013). Many householders in ASALs are unable to test new adaptation practices such as new crop varieties, drought-tolerant livestock and reducing soil degradation due to their low capacity to invest, lack of inputs and access to information (Bryan *et al.,* 2013). Based on

available literature, we developed theoretical model showing the relationship between mobility and socio-economic, policy and biophysical factors;

Q= F (K, L, M) Where, Q: Mobility; L: Policy factors; K: Socio-economic factors; M: Biophysical factors

We conclude that there is positive relation between mobility and socio-economic factors such as herd diversification, sales of livestock, cultivating crops etc. Different socio-economic factors optimize the use of heterogeneous ecosystem and meet different socio-economic obligations. On the other hand, policy factors is negatively related to mobility especially from the point view of rangeland fragmentation which has caused mobility constraints and in turn increases the distance of mobility. Among the factors which influences pastoral mobility is biophysical factors, for instance temperature and rainfall pattern have great influence on food resources availability which is directly related to movement of pastoralist in search of water and pasture.

2.6. Empirical Studies on Climate Change Impact on Pastoralists

The climate studies by Intergovernmental Panel on Climate Change IPCC (2014) show that Climate Change events have always been a regular and expected occurrence in the arid and semi-arid regions, and adaptation responses and strategies are the critical means of mitigating the effects of Climate Change. Yet even with the complementary responses and adaptation mechanism, Climate Change remains the overwhelming challenge to livestock herds and pastoral livelihoods. While the combination of large herd mortality and clear exposure to Climate Change is certainly indicative of rising vulnerability to climate, livestock experts also emphasize that this increasing vulnerability is substantially the result of weakened coping mechanisms (Lind 2003; Little 2012). The following evidence of adverse climate change also suggest that Climate Change is the overwhelming challenge to mobile livestock herds and pastoral livelihoods.

The study conducted on Assessment of the vulnerability of Ethiopian agriculture to climate change and farmers' adaptation strategies by (Deressa., 2010) shows that The vulnerability of Oromia Regional State in general is attributed to higher frequencies of droughts and floods and lower access to technology, institutions and infrastructure. Similarly the study conducted by Riche *et al.* (2009) shows that communities in Borana zones are highly impacted by climate hazards.

Likewise studies in Kenya by Opiyo and Francis (2014) on household level vulnerability shows that the majority of households fall within the moderately vulnerable category who have less than 5 years experience, either divorced or widowed household heads, household heads with no social linkages, household heads with no access to extension services, households who own less than two TLUs, own private lands, households which do not received any cash remittances, household heads with more than two coping strategies, households who practice mobility and are able to move freely with their livestock herd, and perceive climatic changes in the area.

Another study conducted by Debela *et al.*, (2019) on adaptation to Climate Change in the Pastoral and Agropastoral Systems of Borana, South Ethiopia shows that smallholders in the pastoral systems adopted a wide range of adaptation measures and tried to remain flexible to overcome what they perceived as changing climatic conditions. Supplementary feeding, off-farm employment and herd mobility to remote areas are the three most commonly used adaptive strategies smallholders and their communities pursued as responses to climate change.

Empirical studies have witnessed the significant impact of Climate Change on pastoralists and pastoral practices and their livelihood. This has been very much so in the sub-Sahara Africa which have their economies largely depend on climate-sensitive agricultural production systems, are particularly at risk and vulnerable to the impact of climate change (Kempe 2009). However the extent of such vulnerability will depend on how efficiently communities adapt to the changing climatic conditions.

2.7. Conceptual Framework

This study aims at examining the vulnerability of Borana pastoralists and identifying the coping/adaptation strategies. This study also aims at exploring changes in pastoral mobility due to climate related stocks, such as droughts and floods, and climate stresses such as climate change and variability. Therefore, an attempt has been made to employ the conceptual framework developed by Frankenberger *et al.* (2012).

The conceptual framework in Figure. 1 shows a comprehensive and holistic approach to understand the vulnerability of the Borana pastoralist community to climate change and variability; and identifying viable adaptation options for the community through stakeholder involvement. The framework considered vulnerability as a function of exposure to climate sensitivity and adaptive capacity of the households; it involves the community and stakeholders in understanding the vulnerability to climate change by the pastoralist households and also understanding adaptation strategies adopted by pastoralist against climate change and variability. The resilience pathway is viewed as a process rather than a static state of a system. Households and communities that are able to use their adaptive capacity to manage stresses they are exposed to, and incrementally reduce their vulnerability are on a resilience pathway. Using this conceptual framework, this study identifies which elements of the framework made the household resilient to climate change and variability, and which drivers increases the vulnerability of the households in the Borana region. The study also analyzed the specific adaptation and coping strategies that Borana pastoralist are using in coping with climate-induced disturbances for more effective targeting of policies and adaptation programmes.

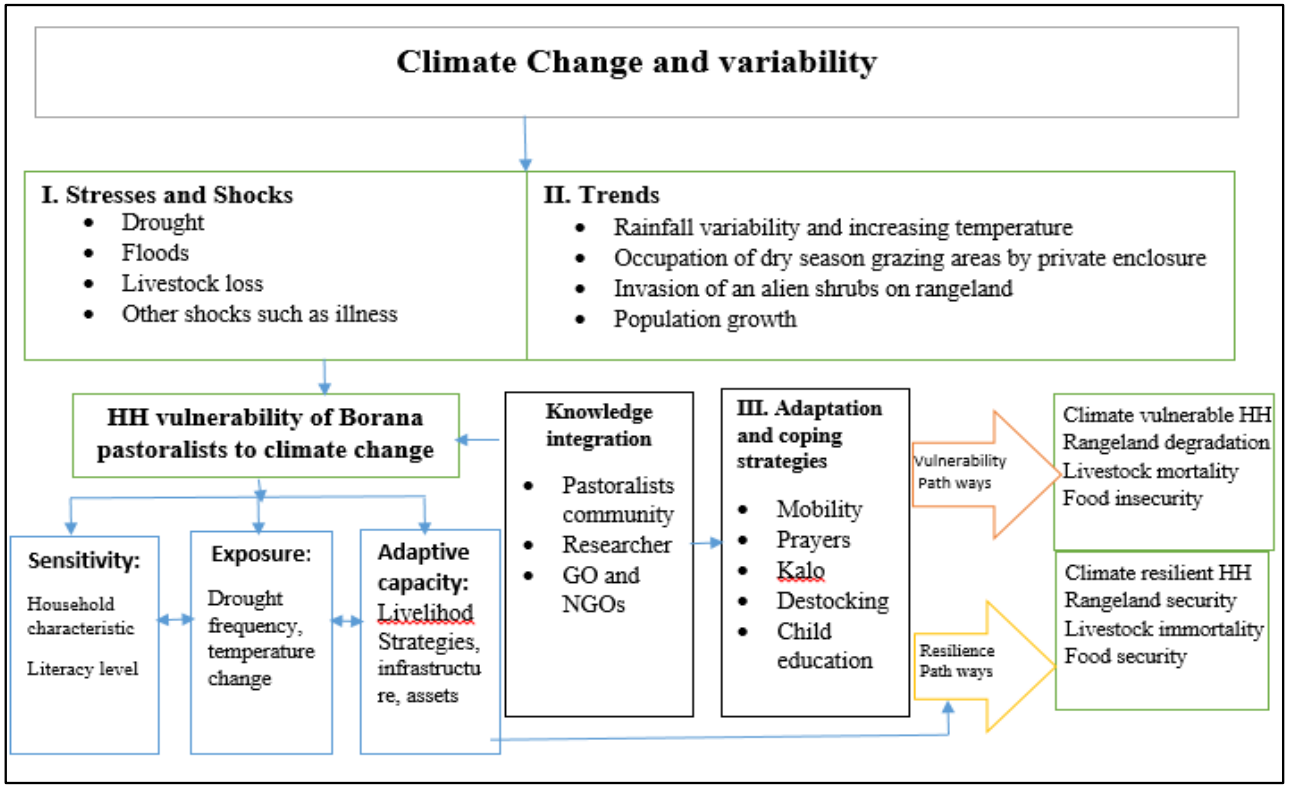

Figure 1. Conceptual Framework
(Source: Frankenberger *et al.*, 2012)

3. RESEARCH METHODOLOGY

3.1. Description of the Study Area

The study was conducted among the Borana pastoralists of southern Ethiopia. An arid and semi-arid region where pastoralism is the primary livelihood strategy. Borana is home to over 350000 people with a livestock population around one million (Coppock, 2016). The Borana rangelands of southern Ethiopia cover an area of about 95,000 km^2 with altitude ranging from 500 to 1500 m above sea level (Homann, 2005). Mean annual rainfall ranges from 300 mm in the lowlands to 1000 mm in the highlands. Annual precipitation distribution is bimodal, with 60% in the primary rain season (April to May) and 30% in the secondary rain season (October to November) each year (Coppock, 1994; Kamara, 2001). The longest dry period from December to February is in "*Bona"* season and the cold dry months from June to August is "*Adolessa"* season (BZAO, 2010). The Borana predominantly rear cattle but the numbers of small ruminants and camels are on the rise (Megersa *et al*. 2014). The Borana range is a tropical savannah vegetation, originally open grasslands but taken over by acacia bushes (Dalle *et al.*, 2006). Rainfall variability, differences in soil types, and variation in latitude within the rangelands creates dissimilar landscape types (Cossins and Upton 1988; Oba, 1998).

The Borana pastoralists divide their rangelands into two broad regions: the Dirre and Liban rangeland based on the characteristics of the natural resources (indigenous landscape categories). The regions are further reclassified into zones called dheeda, differentiated by altitude and rainfall variation. Liban region has two dheeda (zones), Golba and Dida, while Dirre has five dheeda, which include Wayaama, Golbo, Dirre (with tula deep wells), Gomoole, and Malbe (Oba 1998; Oba and Kotile 2001). Wayaama is located to the East and is characterized by red soil, warm conditions and is regarded an important wet season grazing area. Golbo is the lowlands situated to the southwest towards the border with Kenya and is

associated with gray soils and black boulders of volcanic origin, suitable also for wet season grazing. The Dirre dheeda is where clusters of ancient tula wells are located. This zone is characterized by open savannah grass lands with a variety of perennial grasses, permanent water sources, and is preferred for dry season grazing. Gomoole lies towards the north and is characterized by sub-humid conditions, and the Malbe is situated towards northwest, characterized by undulating hills and adjacent lowlands (Angassa and Oba 2007; Oba 1998). Within the dheeda (zones) are units called madda (PA) comprising permanent water sources and associated grazing ranges, which further encompass smaller sub-units of resource users called arda that are a collection of villages (olla) (Homann 2004; Helland 1980; Kamara et al. 2004; Oba and Kotile 2001; Coppock 1994).

Livestock herding, as the major livelihood strategy of Boran pastoralists, is generally practiced in two forms of home-based herding and satellite-based herding. Home-based herding (*worra*) involves the herding of lactating cows, calves, and ruminants close to settlements. In this form of herding, livestock are herded to nearby grazing sites during the day and taken back to settlement villages in the evening on a daily basis. Satellite-based herding (*forra*) involves multiple temporary camps to graze livestock at substantial distances beyond one-day reach and have access to better forage available near the settlements, thus the system is partially transhumant. One household can practice both forms of herding simultaneously through herd splitting (Liao *et al*., 2017).

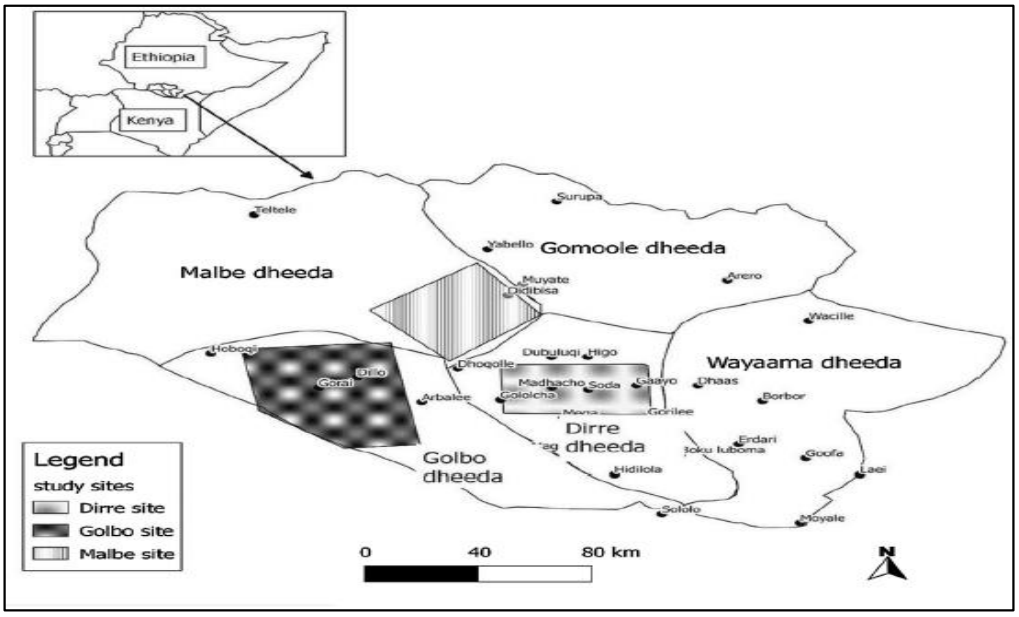

Figure 2. Map of the study area

3.2. Sampling Procedures and Sample Size Determination

Multistage purposive and random sampling method was employed to draw representative sample respondents in the first stage, Borana zone was purposively selected based on geographical location, pastoral dominant livelihood strategies and proneness to drought events. In the second stage, the division within the zone by pastoralists was listed and categorized on the basis of two major rangelands (Dirre and Liban) which is further classified into deedha (zones). This was then followed by systematic selection of three dheeda (zones) of Dirre (dheeda), Malbe, and Golbo from the Dirre rangeland. In the Dirre (dheeda), Malbe and the Golbo production systems, the *foora*-herd management uses opportunistic mobility in response to erratic rainfall distributions, the dry season grazing lands are limited. Drought is stressful resulting in greater livestock deaths than in the Liban *Chaari* production systems

(Oba, 1998, Wario *et al.,* 2016). The selection considered ecological gradient and pastoralists' perceived bio-physical differences and most importantly the severities of the effect of climate change and variability. In this respect, the three selected dheeda (zones) are regarded representative of the Borana rangelands (Wario *et al.,* 2016). The dheeda (zones) of Gomoole and Wayaama was not selected due to the dominant practice of agro-pastoralism in Gomoole and intermittent ethnic conflicts in Wayaama. Afterwards, from each of the three selected dheeda (zones), two adjacent madda (PA) was selected based on accessibility and road access and size of the cattle herds. From Dirre (dheeda), Madhacho and Soda madda (PA) was selected, from Malbe, Haraweyu and Gobso was selected while Dillo and Gorai madda was considered from Golbo dheeda (PA). Madda was chosen as a unit of study because it is the Borana pastoralists' basis for resource management, with identifiable resource borders and associated users (Coppock, 1994).

Finally, a proportional to size method (2.4%) of the total population was used to determine 160 household. Selection of participant households in each study site was based on herd size. We obtained household lists from the PA offices and sort them into different cattle herding units with the support of PA representatives and community elders. Then Systematic random sampling was employed to select respondents for interview.

Table 1. List of selected madda (PA) and number of sampled households

Madda (PA)	Total population number	Total number of Household	Number of sampled Household
Soda	3817	1025	25
Madacho	5394	1192	29
Haraweyu	3254	985	24
Gobso	2821	816	20
Dillo	6296	1591	38
Gorai	3426	1024	24
Total	25,008	6,621	160

Source: Borana zone office of agriculture and own computation, 2020.

3.3. Data Type, Sources and Methods of Data Collection

Both quantitative and qualitative data were collected from primary and secondary sources for this study. Primary data were collected using interview schedule, key informant interviews (KII) and focus group discussion (FGD) with experienced people and local community elders (Abba olla, Abba qae, Abba eela, Chora eela, Abba herega), and government and non-governmental organization officials during the fieldwork and field observation. Secondary data was collected from different institutions (both governmental and non-governmental organizations (NGOs) to supplement the primary data. Secondary data sources include published and unpublished documents of theoretical and empirical nature, and various activity reports of governmental and non-governmental institution. Further, related federal and regional government policies, strategy documents, newspapers, textbooks, and proclamations were reviewed and used to provide necessary information to achieve the objectives of the study. This triangulation will enable the researcher to obtain the variety of information on perception of pastoralist on climate change impact on mobile herding, vulnerability of pastoralists and adaptation strategies to climate-induced shocks and stresses.

3.3.1. Interviews schedules

A semi-structured questionnaire with open-ended and multiple-response questions was used for survey. Information on different aspect of the study was obtained through the administration of questionnaire on individual pastoralist households and community leaders. The information collected using the questionnaire include (1) demographic information of the households; (2) socio-economic characteristics of individual households including resource endowments, sources of income and infrastructural status; (3) information on perception of Borana pastoralist to climate change and variability, climate-related extreme events and their impacts on the mobile herders; (4) adaptation and coping strategies of households to climate change and climate variability. To avoid misinterpretation, the household interviews were

conducted in the local language (afaan boorana) by the local field assistants (DAs). Before data collection enumerators were recruited and then training was provided to enumerators on questionnaire administration, translation and recording of the responses. Immediately after training, the questionnaire was pretested and modified before the execution of the survey.

3.3.2. Key informant interviews (KII)

A total of twelve key informant interviewees, were interviewed. Individuals from local organizations, peace committee, water and pasture committee, experienced herders, village headmen (abba olla), well father (aba eela) and drought monitors, community-based agricultural workers, and opinion leaders were interviewed to implore more information and knowledge on livestock production system, years of extreme climatic occurrence, weather forecasting system, pastoral mobility strategies, vulnerability and aspects on households adaptation and coping strategies.

During the key-informant interviews the movement patterns inferred were validated. The process mainly constitutes camp locations, travel distances, and extent of movement that were typical for these herds and the *madda* they represented. In addition, the factors affecting pastoralist decision-making in each *madda* including environmental conditions, conflicts within and among communities, settlement patterns, and development interventions by government agencies and non-government organizations were identified.

3.3.3. Focus group discussions (FGD)

The participants in FGD were selected based on gender with the help of the local leaders and development agents. A total of four focus group (**purposively**) discussions were conducted separately with a gender parity (of eight men and eight women) from the sampled madda (PA). Participants in the focus group discussions were household heads selected based on the number of years they have spent in the location and their main source of livelihood which is

pastoralism. The discussions that was held with community different groups aimed at capturing the perception of pastoralist on climate change impact on mobile herding, vulnerability indicators and adaptation and coping strategies to extreme climate events which were collected using check list prepared for this purpose.

3.4. Methods of Data Analysis

3.4.1. Statistical Analysis

The data collected were analyzed using both qualitative and quantitative approaches Data collected on perception of the pastoralists about impacts of climate change on mobile herding, household characteristics and adaptation strategies to climate change and variability were analyzed using likert scale descriptive statistics.

Frequency analyses and Pearson's chi-square (χ 2) test was used to analyze respondents' statements related to climate change impacts on mobile herding. Statistical test significance was set at 5% ($p < 0.05$).

Qualitative data collected in this study from focus group discussions and key informant interviews on perception of Borana pastoralist on climate change impact on Mobile herding and adaptation strategies to climate change and its extremes were coded and analyzed using Statistical Package for Social Science (SPSS version 22) software.

3.4.2. Vulnerability analysis

The integrated vulnerability assessment method was used to analyze vulnerability of Borana pastoralist to climate change. The method is in line with the intergovernmental panel on climate change IPCC (2012) definition of vulnerability as the degree to which a system is susceptible or unable to cope with adverse effect of climate change, including climate variability and extremes, and vulnerability is a function of the character, magnitude and rate of

climate variation to which a system is exposed, its sensitivity and its adaptive capacity. When adaptive capacity of the pastoralist household is less than the sensitivity and exposure, the household becomes more vulnerable to climate change impacts and the reverse is also true, the higher the adaptive capacity, the less vulnerable the household to climate change impact. This method uses a combination of indicators to measure vulnerability by computing indices and weighted average for the selected indicators. The indicators used in this study were selected based on researchers' observation, literature review of published research done in pastoralists' communities and the opinion of the Borana pastoralist's communities of southern Ethiopia. Community involvement is important in selecting indicators for vulnerability analysis. This is because vulnerability to climate change is location specific.

The livelihood vulnerability index constitutes six major components. These are natural disasters and climate variability; infrastructure and assets; livelihood strategies; information and knowledge networks; food and water; and socio-demographic profile. Each component has indicators or sub-components (Table 13). These were developed based on a review of the literature on each major component as well as the practicality of collecting the needed data through household surveys. The livelihood vulnerability index uses a balanced weighted average approach (Sullivan et al., 2002, Azam *et al*., 2019) where each sub-component contributes equally to the overall index even though each major component is comprised of a different number of sub-components. The LVI formula used here utilizes the simple approach of applying equal weights to all major components. Because each of the sub-components is measured on a different scale, it was first necessary to standardize each as an index. The equation (1) used for this conversion was adapted from the Human Development Index to calculate the life expectancy index (UNDP, 2007):

$$Index_{Pai} = \frac{Q_{Pai} - Q_{Min}}{Q_{Max} - Q_{Min}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where Q_{Pai} is the original sub-component for peasant association i, and Q_{Min} and Q_{Max} are the minimum and maximum values, respectively, for each sub-component determined using data from all the six peasant associations. For example, the "Average education level of the household head" sub-component" ranged from 1 to 6 in all the peasant associations. These minimum and maximum values were used to transform this indicator into a standardized index so it could be integrated into the Socio-demographic component of the LVI. For variables that measure frequencies such as the 'percent of households reporting having had floods,' the minimum value was set at 0 and the maximum at 100.

After each was standardized, the sub-components were averaged using equation (2) to calculate the value of each major component:

$$M_{Pa_i} = \frac{\sum_{i=1}^{n} Index_{Pa_i}}{n} \quad \text{.....(2)}$$ Where; -

- M_{pai} is one of the six major components for peasant association i [Natural Disasters & Climate Variability (NC); Infrastructure & Assets (IA); Livelihood Strategies (LS); Information & Knowledge Networks (IK); Food & Water (FW); and Socio-Demographic Profile (SP)],
- $index_{Pa_i}$ Represents the sub-components, indexed by i, that make up each major component, and n is the number of sub-components in each major component.

The six major components were then combined according to the categorization scheme in Table 15 using the following equation:

$$CF_{Pa_i} = \frac{\sum_{i=1}^{n} w_{M_i} M_{Pa_i}}{\sum_{i=1}^{n} w_{M_i}} \quad \text{..... (3)}$$ Where; -

- CF_{Pa_i} is an IPCC-defined contributing factor (exposure, sensitivity, or adaptive capacity) for peasant association i,
- M_{Pa_i} are the major components for peasant association i, indexed by i,
- $*\, w_{M_i}$ is the weight of each major component (as indicated in appendice Table 2 and 3), and
- n is the number of major components in each contributing factor.

*The weights of each major component are determined by the number of sub-components that make up each major component and are included to ensure that all sub-components contribute equally to the overall LVI (Sullivan et al., 2002). Once exposure, sensitivity, and adaptive capacity for a peasant association were calculated, the three contributing factors were combined using the following equation:

$$LVI(IPCC) = \left(EX_{Pa_i} - AC_{Pa_i}\right) * SE_{Pa_i} \quad \ldots\ldots\ldots\ldots\ldots (4)$$

Where; -

- $LVI(IPCC)$ is the Livelihood Vulnerability Index for peasant association i expressed using the IPCC vulnerability framework;
- EX_{pai} is the calculated exposure score for peasant association i, equivalent to the Natural Disaster and Climate Variability major component);
- AC_{pai} is the calculated adaptive capacity score for peasant association (weighted average of the - Infrastructure and Assets; Livelihood Strategies, Information and Knowledge Networks, and Food and Water major components); and
- SE_{pai} is the calculated sensitivity score for peasant association i (weighted average of the Socio-demographic Profile major component variables)?

4. RESULTS AND DISCUSSION

This chapter contains four main sections in which the main result and finding of the study is presented and discussed. The first section deals with the result of descriptive statistics about the demographic and socio-economic characteristics of pastoralists in the study area. The results of perception of pastoralists on impact of climate change and variability on mobile herding is presented in the second section. Vulnerability assessment of pastoralists to the effect of climate change and variability and their adaptation strategies are presented in the third and fourth sections respectively.

4.1. Descriptive Results

4.1.1. Demographic characteristics of the sampled household

To study the perceptions of household about the existence of climate change and variability and associated consequences, it is necessary to grasp their level of education, family size, sex and age etc. This enables us to differentiate how socio-economic and demographic differences lead to varying perceptions on climate change and variability. The empirical data help to evaluate the validity of previous studies about the difference between the literate and the illiterate, male-headed households and female-headed households, old and young, etc., in perceiving the manifestations climate change variability and its impact on the pastoralists.

The demographic characteristics of sampled respondents indicate that most of them (86.2%) were male-headed and the remaining (13.8%) are female-headed households. The marital status shows that 87.5% of the respondents were married. The mean age of sampled respondents was 47 years with average family size of seven persons (Table 2). The result of the level of education of Borana household heads in each madda showed that on average almost 82% of the sampled pastoralists do not read and write even with limited (4.4%) access to informal education. Researchers have shown that differences in literacy, age, marital status,

gender, and family size creates a big divide in accessing basic infrastructures, which in turn means different levels of vulnerability to climate related risks (Alebachew, 2011).

Table 2. Demographic characteristics of sample households

Items	**Frequency**	**Average**
Gender		
M	138	86.2
F	22	13.8
Marital status		
Married	140	87.5
Divorced	10	6.3
widowed	10	6.3
Education level		
Unable to read and write	130	81.9
Informal Education	7	4.4
Primary Level	11	6.8
Secondary Level	3	1.3
Diploma	5	3.1
University Level	4	2.5
		Mean
Age		47
Family size		7

Source: Own survey, 2019

4.1.2. Socio-economic characteristics of the sampled households

Average number of livestock owned: Livestock, especially cattle, plays a leading role in determining the social position of the pastoral households in the society besides its crucial role in cultural heritages and economic welfares (Mengistu, 2016). However, the intellectual evidence indicated that the livestock per capita of pastoralists are diminishing from 4.1 to 2.3 TLU and more recently found 1.9 TLU (Bekele, 2013). Also, the standard livestock per capita for self-sufficiency by agro-pastoral households is accepted to be 3-4.1 TLU per person and 7 TLU per person for a pure pastoral community (Sandford, 1983; Lybbert *et al.*, 2004). The

same holds true in the study area with a mean of 2.48 TLU per capital which show that the Borana households on average are losing self-sufficiency in terms of livestock production

Table 3. Average number of livestock owned by household head

Animal category	mean	TLU
Cattle	16.51	11.55
Goat	22.29	2.23
Sheep	19.44	1.94
Horse	0.13	0.14
Camel	1.05	1.05
Donkey	1.15	0.46
Chicken	2.63	0.034
Total	9.03	2.48

Source: Own survey, 2019

Access of household head to basic infrastructure: Except electricity with access of 33.8% and clean water (69.4%), all the sampled pastoralists have access to toilet, health center, school and road. The small percentage of household head with access to electricity shows that there is need for government to expand electricity to rural areas. This will create alternative sources of livelihood in the rural areas and also improve their access to information. Inaccessibility to various infrastructure can affects the level of vulnerability of the pastoralists either directly or indirectly. Thus, improving access to infrastructure and services will moderate the dramatic change in pastoral society. The findings of this study concur with (Desta *et al.,* 2008) which reported that Over 90% of the respondents indicated that there was an increased access and a positive trend in the asset ownership of Borana community of southern Ethiopia (Table 4).

Table 4.Basic infrastructure household head can assess

infrastructures	Yes (%)	No (%)
Electricity	33.8%	66.2
Toilet (Borehole)	100.0%	0
Health post	100.0%	0
School(Primary)	100.0%	0
Clean Water(Drinking)	69.4%	30.6
Road (Earthen road)	100.0%	0

Source: Own survey, 2019

Sources of livelihood for the household head: The sources of livelihood of respondents are presented in (Table 5). The results show that 98.1% of respondents were involved in livestock keeping (pastoralism). This study also shows that 65.6% of respondents were involved in Livestock Trading, the study also shows that 48% involved in business, 18% were involved in crop production and 10% of households were government employees. Studies (Bryan *et al*., 2009; Rao *et al*., 2011; Silvestri *et al*., 2012; Musa, 2014) had reported that pastoralism is the main source of livelihood in Arid and Semi-Arid Lands (ASALs) and that pastoralist has developed mechanisms to cope with climate variability over the years. However, increase in extreme climatic events such as drought in recent decades has triggered adoption of alternative sources of livelihood among pastoral communities.

Table 5. Sources of livelihood of household head (%)

Sources of livelihood of household head	Yes	No
Livestock Keeping	98.1	1.9
Livestock Trading	65.6	34.4
Crop Farming	18.8	81.3
Business	48.8	51.2
Government Employment	10.0	90

Source and year

4.2. Perception on Impact of Climate Change and Variability on Mobile Herding

Perceptions on rainfall trend in Dire rangeland

Local knowledge of rainfall variability is based on long term experience and familiarity with seasonal rainfall pattern in an area (Bobadoye, 2016). The perception of the Borana pastoralists on rainfall trends in the last 10 years presented in Figure 3 shows that 88.8% of the respondents perceived that rainfall is reducing in the study area, 6.3% perceived that rainfall varies continuously and 5% reported that there is no change of rainfall in the study area in the last 10 years. Pastoralists living in arid and semi-arid lands of Ethiopia are particularly vulnerable to climate induced stress due to over dependence on climate sensitive livelihood activities. Understanding their perception to rainfall pattern is therefore very important in addressing adaptation to extreme climatic events especially drought. KII participant also agreed that rainfall is reducing and there is an increase in drought occurrence in the area. They agreed with one of them who said that:

"Although we Borana community are known worldwide as pastoralists, however, the rate at which drought is increasing will most likely lead to the end of pastoralism in Borana within the next 20-30 years."

However, changes perceived by respondents were not always in agreement with the observed climate data as indicated by (Alle, 2013; Ayal *et al.* 2018). Changing climatic conditions such as reduced annual precipitation and rainfall variability are often recognized to be important factors of rangeland productivity declines. Therefore, higher aridity may imply increase pastoral mobility for household livelihood sustenance (Martin *et al*., 2014). Previous study by (Bati, 2013) conducted in Borana of southern Ethiopia reported that rural household generally perceived a reduction in rainfall amount over the years. Result of this study also agrees with (Ayal *et al.* 2018) who reported that the majority of respondents perceived that seasonal and

annual rainfall amount and number of rainy days has been decreasing, while drought frequency and severity increased from time to time in their localities.

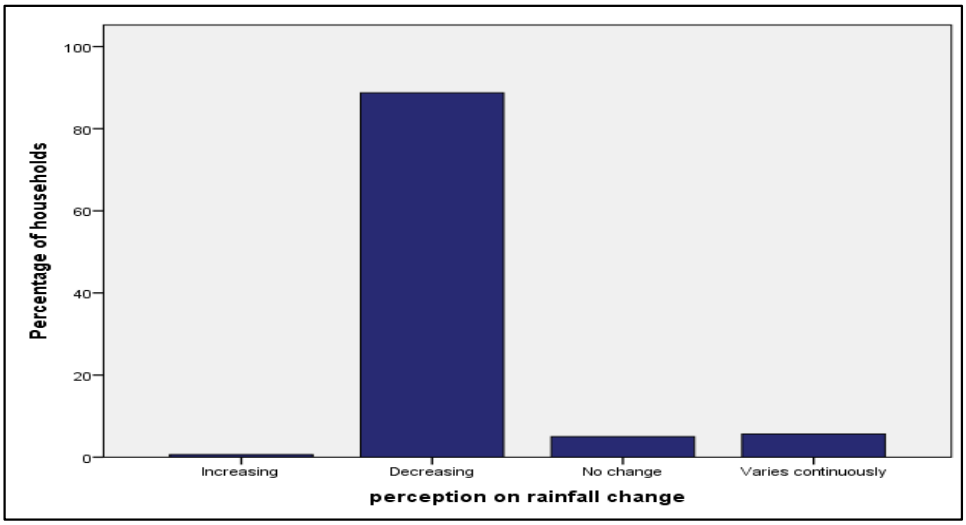

Figure 3. Pastoralist's Perceptions on rainfall trend in Dire rangeland in the last 10 years

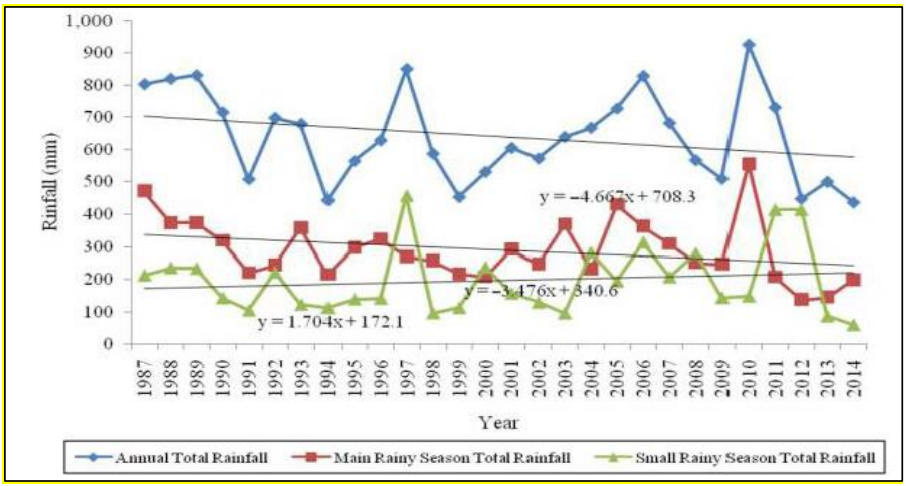

Figure 4. Trends of annual and seasonal rainfall, 1987-2014
Source: (Ayal *et al*., 2018)

Perceptions on temperature changes in Dire rangeland

The result on the perception of Borana pastoralist on temperature change in the study area, showed that 95% of the respondent perceived that average temperature is increasing, and only 5% perceived that temperature Varies continuously (Figure 4). This shows that the Borana pastoralists are already experiencing the effect of increasing temperature on their livelihoods. Global climate model for East Africa indicate that climate change may increase temperature by 4^0C by the year 2100 (IPCC, 2007). Increased temperature has been known to have significant impact on water availability and pasture resources, thus *pastoralists are forced to traverse large areas in search of pasture and water for their livestock, which they depend upon for their livelihoods.* Consequently, the Borena pastoralists are more vulnerable to climate variability. This study agrees with the findings of (Ayal *et al.* 2018) who reported that

78% of household interviewed in Borana perceived the increasing in temperature from time to time in their localities. Result of this study also agrees with (Debela *et al.*, 2019) who reported that farmers in arid and semi-arid lands of Ethiopia already perceive the effect of change in temperature and rainfall, and that they are developing coping strategies to the adverse effect of climate change.

Meterological data by (Ayal *et al.* 2018) also show The increase in maximum temperature (0.41°C) per decade was much higher compared to the minimum temperature (0.33°C) per decade. Mean temperatures are predicted by the IPCC to continue to rise in the range of 0.9-1.1C by 2030, 1.6-2.0C by 2050, and 2.5-3.5C by 2080. Average national rainfall has not been decreasing on an annual basis, but the *belg* rains, which fall from March through May, and constitute the main rains for the southern regions of Ethiopia, have seen increasing variability and extremes. As indicated in FEWS NET data, this includes alarming declines in rainfall in recent years. Southern Ethiopia has experienced severe droughts in 2006, 2008, and 2010-2011 (Stark *et al.* 2011).

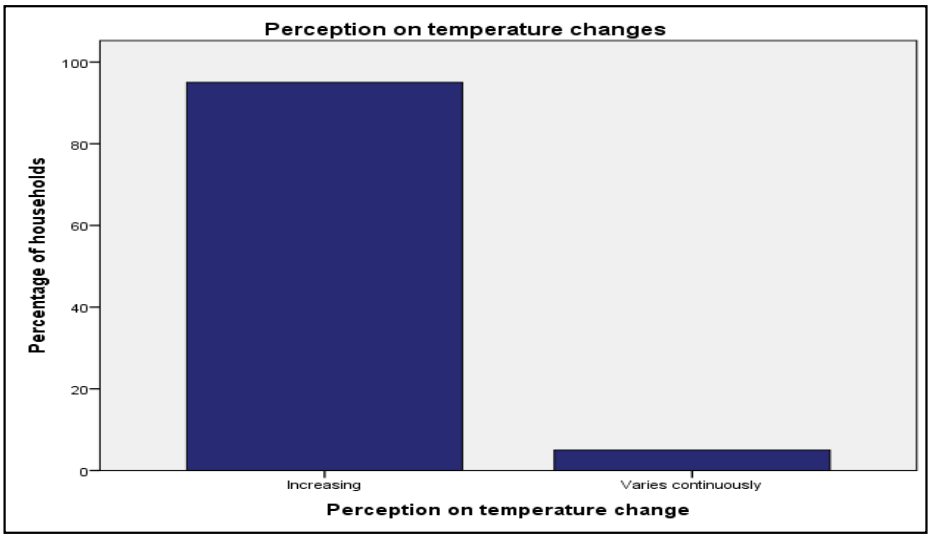

Figure 5. Pastoralist's Perceptions on temperature trend in Dire rangeland in the last 10 years

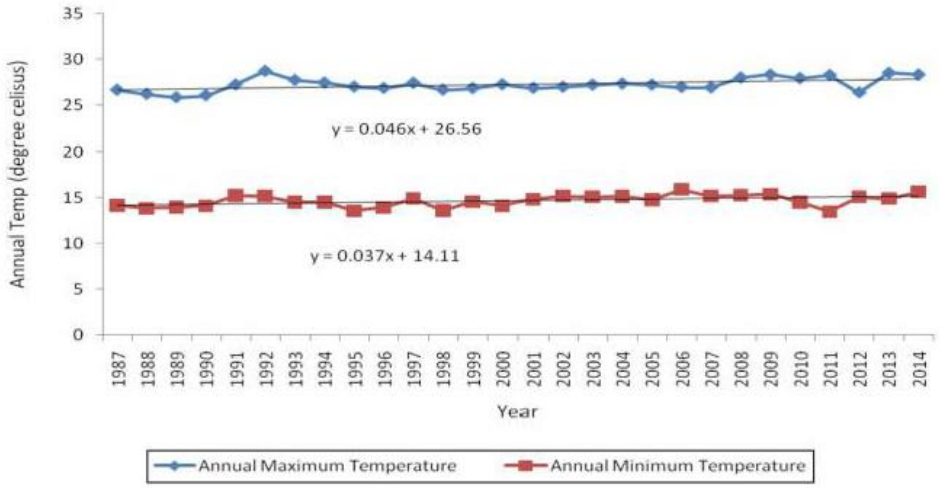

Figure 6. Trends of annual and seasonal temprature, 1987-2014
Source: (Ayal *et al*., 2018)

Perceptions on extreme climate occurrence in dire rangeland

The perception of Borana pastoralist on actual experience with extreme climatic occurrence shows that drought and famine are the major climatic challenge faced by pastoralist in dire rangeland. The results in Table 6 revealed that the Borana observed extreme drought from 1973 to 2016/17. The result showed that drought occurrence is increasing in Borana in recent years leading to worse impact on the people and the animals. This concurs with the findings of Riché *et al*., (2009) and Iticha and Husen., (2019) who reported that drought occurrence has changed from every 8 years to every 1-2 years in Borana, evidence that the area is vulnerable to stresses related to climate changes. It shows that the Borana communities keep adequate mental records of extreme climatic events and they have names for years of extreme drought for easy remembrance. It can be deduced that rural dwellers especially pastoralists who depends on rainfall for their livelihood sustenance have useful information on climatic trends and they should be actively involved in decision making of adoption of climate smart agricultural practices in their communities.

Table 6. Perceptions of Borana pastoralists on extreme climate occurrence in dire rangeland

Year	Events	Local name of drought	Impact on people
1973/74	Drought	Oola gada Gobba	There were conflict among clans, people moved their animals, death of livestocks and few cases of loss of lives.
1983/84	Famine	Oola Diima Suga	People moved their animals but mobility was affected by conflicts between Gari Somali and Borana which lead to loss of lives by conflict rather than drought.
1991/92	Famine	Chiina titte guracha	Black flies invaded the area and caused loss of lives both on people and animals.
1999/2000	Drought		80% of livestock died, major Borana Somali conflict over land.
2005/2006	Severe drought		Death of 25-60 % of all livestock in the area.
2008/2011	Severe drought		Death of livestock, Starvation and facing food insecurity caused by drought.
2015/2016	Worst drought		

in 50 yrs	

Source: FGD and KII

4.2.1. Perceptions on climate change impacts on mobile herds

Climatic related extreme events have over the years been a major concern in the arid and semi-arid lands of Ethiopia. These events especially drought has led to loss of livestock and human lives with severe social, economic and environmental consequences. A six point rating scale was used to determine the impact of climate change and variability on livestock and pastoralist communities in Borana. The 5 point ordinal scale were graded either as 6= very high impact, 5= high impact, 4= moderate impact, 3= low impact 2= Very low 1= no impact.

Table 7. Perceptions on climate change impacts on mobile herds (%)

CC impact	No effect	Very low	Low	Average	High	Very high
Animal travel long distance	0	2.5	6.3	1.9	18.1	71.3
Decrease in the number of births per year	0	13.1	16.3	24.4	23.1	23.1
Drop in Milk production	9.4	6.3	20	23.8	13.8	30
Death of livestock	0.6	9.4	9.4	23.1	18.1	39.4
Excessive loss of weight	10.6	5.6	5.6	11.3	46.3	20.6
Increase of infectious and parasitic diseases	6.9	8.8	23.8	23.1	16.9	20.6
Appearance of new animal diseases	10	11.3	38.8	10	6.9	23.1
Abortion of livestock	23.8	29.4	13.1	3.1	16.3	14.4

Source: survey, 2019

About 71% of respondents stated that climate change had a very high impact on herd mobility, while 18.1% reported a high impact of climate change on herd mobility. This shows that herd mobility which is a key survival and resource management strategy commonly practiced by herder societies for efficient use of meagre and scattered rangeland resources for sustainable livelihoods in Borana is severely affected by climate change. Indeed, 24.4%, 23.1% and 23.1% of the respondent reported that climate change has average, high and very high impact on decline in yearly parturition of calves per cow, 30% and 39.4% of respondents respectively reported very high impact of climate change on drop-in milk production and death of livestock

also 46.3% of the respondent reported an excessive loss of weight of mobile herds to be high. On the other hand, 24% and 39% of the respondent respectively reported that climate change has low impact on increase of infectious and parasitic diseases and emergence of new animal diseases and 29.4% stated very low impact on abortion of livestock.

According to Iticha and Husen. (2019) the highest proportion of the respondents (92.5%) identified that drought was the most devastating climatic hazard prevailing in Borana. This could be due to the negative consequences of drought such as decreased water and pastures availability, decreased livestock productivity, crop failure in agro-pastoral areas, increased food insecurity and malnutrition, increased human and livestock diseases and death, abnormal community mobility, and increased school drop-out due to community migration in search of pasture and water. According to the respondents, they lost a large number of livestock due to severe droughts; pointing the drought events in 2008, 2011 and 2015 seasons as example. During the drought period of 2000, 80% of livestock died (Angassa and Oba, 2007). The author indicated that recurrent drought is responsible for seasonal outbreak of livestock diseases, causing heavy livestock mortalities, particularly of cattle. The respondents mentioned that the frequency of droughts is increasing from time to time; estimating that now it occurs every 1–2 years compared to only once in 8 years or once in a Gada cycle in the past. They identified conflict as one of the major concealed consequences of climate change. Deadly conflict occasionally occurred due to drought-related abnormal mobility across new boundaries in search of pastures and water resources. Yanda and Mubaya (2011) indicated that non-climatic hazards such as increased prevalence of livestock diseases and increased threat of conflicts arising from the scramble for water resources and scarce fertile land were the major impacts of climate change and variability. Focus group discussant agreed that the pastoralist mobile herds is threatened in Borana. KII also agreed with one of them who said that:

“Although Borana are known worldwide as pastoralist, however, increasingly frequent as well as intense drought conditions continue resulting in scarcity of pasture and water

resources challenging the sustainability of traditional pastoralism and forcing pastoralists to traverse large areas and also the continuous sales and fencing of land will most likely lead to the end of pastoralism in the near future."

Several studies (Yilma *et al* 2009, Berhanu and Fekadu, 2015, Elias, 2015) have reported the severe effect of climate change on the pastoralist mobile herds in ASALs in Ethiopia. Elias (2015) reported that restriction of mobility has increased vulnerability of Borana pastoralists vulnerable to frequent drought that decimated most if not all of their cattle.

4.2.2. Perceptions on climate change impacts on pastoral herder's livelihoods

Table 8. Perceptions on climate change impacts on pastoral herder's livelihoods (%)

CC impact	No effect	very low	Low	Average	High	Very high
Long distance to fetch water for domestic use	0	1.3	2.5	15	24.4	56.9
Increase in physical effort in herding	0	5	2.5	26.3	43.1	22.5
Food insecurity	5	8.8	21.3	13.1	32.5	19.4
Regression of animal heritage	3.8	20.6	20.6	20	21.3	13.8
Decrease in income	3.1	1.3	14.4	18.8	24.4	38.1
Loss of prestige	16.3	16.9	13.1	19.4	18.8	15.6

Source: survey, 2019

Perceptions on impact of climate change on long distance to fetch water

Respondents identified water shortage as the biggest problem facing Borana pastoralists. Table 8 shows that 57% of respondent believed that climate change had a very high impact on water for domestic use, 24.4% reported high impact, 15% reported average impact, 2.5% reported low impact and 0% reported no impact.

KII agreed that they face a critical water shortage saying.

"Lack of water is one of the biggest challenges facing Borana pastoralists. We need the government and NGOs to assist in building boreholes, dams and water pans for us and our livestock. This will stop the water borne diseases affecting people and also save our women and children the danger of traveling long distance in search of water."

This study agrees with the findings of (Yilma *et al.,* 2009) who reported that majority of household interviewed in Borana perceived that there is critical water shortage in their localities. Result of this study also agrees with (Riché *et al*., 2009) who reported that drought also affected the water availability leading to water shortages and travel over long distances by women in search of water. Consequently, Climate change have severe effect on water availability for domestic use in Borana.

Perception on impact of climate change on increased physical effort on herding

Table 8 shows that 22.5% of respondent believed that climate change has very severe impact on physical effort in herding, 43.1% believed it has high impact, 26.3% believed it has average impact. Accordingly, this could be due to ethnic conflict over resources which has become serious problem facing mobile herders and sometimes resulting in violent clashes. Also according to respondents some remote pastures in *Dirre rangelands* are still used for wet-season grazing. However, they have been subject to overgrazing and degradation due to concentration of livestock from all over *Borena* land.

On western (Dirre) rangelands, new distant grazing frontiers were also explored which means travelling hundreds of km (taking 2-3 weeks on one-way trip); this is far beyond the normal range of movement looking for pasture and water which results in increased physical effort on mobile herding. This study agrees with the findings of Sanou *et al.* (2018) who reported that

100% of respondent perceived an increase in effort on herding as an impact of climate change and variability.

Perception on impact of climate change on food security

Table 8 shows that climate change is affecting food security and eating habit among Borana pastoralist. About 19.4% of respondents reported that climate change has a very high impact on food security and eating habit, 32.5% reported high impact, 13.1% reported average impact, 21.3% reported low impacts and 5% reported no impact. Borana pastoralists were known for eating meat, drinking milk and blood. However, recurrence drought has led to severe loss of livestock and reduction on milk availability. Borana pastoralists depend on food aid from government, NGOs and Community based organizations during severe drought. Although relief food was not a desired option, respondents reported that helplessness during and after droughts left them mainly dependent on it for survival. The effect of drought is felt more by women and young children who cannot easily migrate in search of alternative sources of income and who need good nutrition for survival. Several studies (Kebebew *et al* 2001, Yilma *et al.,* 2009, Elias, 2015) reported the effect of drought on food security in ASALs of Borana. (Bati, 2013) also stated that climate variability and change is a major threat to food security in Borana rangeland.

The KII agreed with one of them who said:

"To maintain food security Borana people have increasingly come to rely on favorable market exchange between pastoral products and grain. But In drought situations the exchange rate normally becomes unfavorable to pastoralists this is simply because during drought periods the prices of animals decrease whereas the prices of grains increase leading poor people more vulnerable to food shortage and have to sell proportionally more of their animals"

Perception on impact of climate change on decrease in income

The direct and indirect impacts of climate change on income of the pastoralists have been reported by many studies (Riché *et al*., 2009, Berhanu and Fekadu, 2015, Sanou *et al.* 2018). About 38.1% of respondents perceived that climate change had very severe and 24.4% perceived severe impact of climate change on decline of household income. This study agrees with the findings of Ayal *et al. (*2018) who reported that, the resultant livestock disease and loss of body weight affects the market price of livestock and entails added cost in terms of money, time and energy for treatment and management. Hence, it reduces the household income and worsens food insecurity among the Borena pastoralists.

According to information gathered from FGD, drought leads to decreased pasture and water availability, which in turn leads to livestock emaciation and death, reduced livestock productivity (in terms of milk and meat), more livestock being sold on the market, and lower livestock prices, thereby leading to weaker terms of trade and decreased household incomes.

One of the KII stated that:

"*Droughts has led to decreased in pasture availability; water shortages; loss of weight and death of livestock; decreased livestock disease resistance and productivity; decreased livestock prices and household incomes, therefore income generated through livestock sales is no longer sufficient, compounding poverty, food insecurity, and pastoralist drop-outs*".

4.2.3. Pastoralists Perception on climate change impacts on pastoral practices

Climate change and variability is negatively affecting herds' transhumance over the last decade (Figure 5). About 87.5% of respondents reported changes in destination zone over the last 10 years while 12.5% reported no changes in destination zone over the last 10 years. Also 86.3% reported a change in paths followed by transhumant herds over the last 10 years while 13.8% reported no changes. For the departure period in transhumance, most respondents

reported that it has been earlier over the last decade. Indeed, 58.8%, 38.8 and 2.5% of the respondents indicated earlier, late and same departure period respectively over the last 10 years. However, more than half of the respondents reported an increased duration within and to reach destination zones. Thus, over the last 10 years durations to reach destination zones have increased, decrease and remain the same for 60%, 38.8% and 1.3% of respondents respectively, while 71.9%, reported an increased duration within these zones, 25.6% and 2.5% reported a decrease and no change in duration within destination zone respectively. In such conditions the effectiveness of livestock mobility (which have been for long time an adaptation strategy to climate change and variability) and the related practices appears to be gradually challenged in Borana.

Wario *et al* 2016 similarly found changes in mobility patterns in Borana. Early departure in transhumance and the increased duration of livestock within destination zones could have reinforced transhumant resilience as new alternatives to adapt to climate change. Unfortunately, these alternatives are gradually compromised. Indeed, recently, the communities disallowed the use of foora to reduce competition as grazing areas dwindled. *Foora* is currently only allowed in cases of drought; and even then, the herders cannot set up *foora* camps wherever they intend to, but must move into existing settlements. While the previous Borana resource use system allowed open rights of access to any pastures by the residents of the Borana territory (Cossins and Upton, 1988; Helland, 1982, wario *et al*., 2016). In most of respondents' (69.4%) perspectives, the periods of stay (allowed by community) at each stock post (1 to 3 months) are far shorter than the current necessary duration (about 6 months).

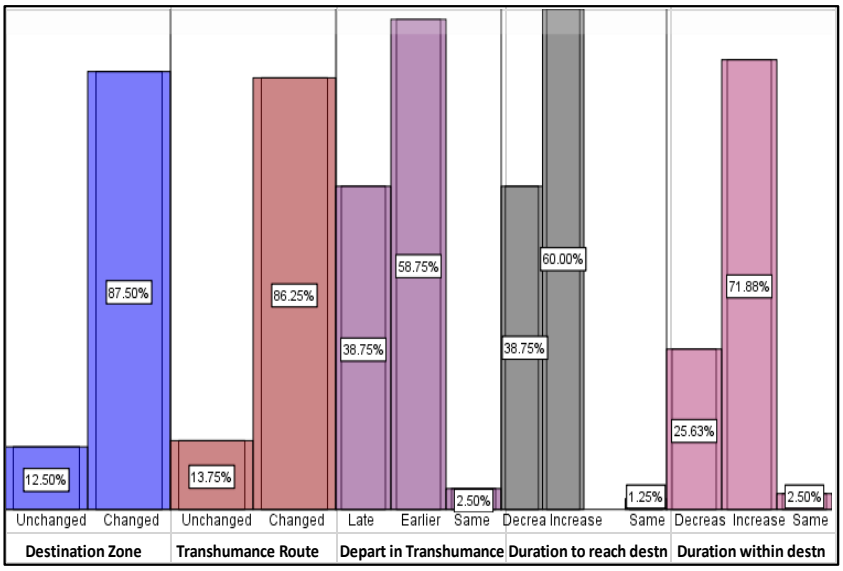

Figure 7. Pastoralist's Perceptions on climate change impacts on pastoral practices

4.3. Vulnerability of Communities to Climate Change and Variability

4.3.1. Vulnerability indicators and it's expected direction

The vulnerability indicators used for this study is presented in Table 9. These vulnerability indicators were categorized according to the definition of vulnerability as a function of adaptive capacity, exposure and sensitivity. The Borana communities and the researcher also analyzed the expected impact the selected indicators will have on vulnerability in the study area, identifying indicators that should enhance vulnerability and those that should reduce vulnerability.

Table 9. Vulnerability indicators and expected direction with respect to vulnerability

Determinants of Vulnerability	Vulnerability indicators	Description of indicator used for analysis	Relationship between indicator and vulnerability
Adaptive capacity	Wealth	Herd size, livestock diversity, land size, non-farm income, income from crop farming	The more the size of herd own and income generated by households the less the vulnerability to climate change
	Access to information	Visit by extension agents, access to climate information	The more access the household has to climate information the less their vulnerability
	Infrastructures and asset	Access to electricity, toilet and hospitals. Own radio and TV	The more the households that have access to electricity, hospitals and other asset the less their vulnerability
Sensitivity	Household characteristics	Household size, number of dependent, marital status, gender of household head, age of household head	The higher household size and number of dependents, the higher the vulnerability. Female headed households are more vulnerable
	Literacy level	Level of education	The higher the literacy rate, the less the vulnerability
Exposure	Extreme climates	Frequency of drought and floods	The higher the frequency of extreme events the more the vulnerability
	Change in climate	Temperature change Precipitation change	Reduced rainfall and increase temperature increase vulnerability

Source: Own survey, 2019

The influence of variables on the vulnerability of Borana pastoralists (Table 10) was determined together with the Borana communities. The researcher with the agreement of the communities assigned a positive sign when the variable is agreed to increase vulnerability in the study area and negative sign when it reduces vulnerability. The Borana community generally agreed that to a large proportion, the result of this study gives a reflection of their experience on climate change and extreme climatic events and the vulnerability indicators used actually influence their vulnerability to climate change.

Table 10. Social-economic factors and their influence on vulnerability

Hypothesized variables	Influence on vulnerability
Social variables	
Gender of HH head: female headed households	+
Age of HH head: 50+ years	+
Experience in the area: 45+ years	-
HH size: 5+ persons	+
Education level: no primary education	+
Dependents: 5+ persons	-
Marital status: single (including divorced and widowed)	+
Visit by extension officers: no access to extension services	+
Receive climate information	-
Economic variables	
Non-farm income: with income from non-farm activities	-
Herd size: 100+ total herd size	-
Livestock diversity: own 2+ domestic animal types	-
HH members employed: 3+ members employed	-
Credit access: have no access to credit	+
Livestock mobility: able to move livestock freely	-
Own radio	-
Own TV	-
Access to electricity	-
Access to hospital	-
Access to toilet	-
Environmental variables	
Temperature: noticed increase	+
Rainfall: noticed decrease	+
Drought: experience drought within the last 10 years	+
Floods: experience floods within last the 10 years	+
Drought frequency: every year	+

Floods frequency: every year	+

Positive sign means variables increase vulnerability while negative sign means they reduce vulnerability. Source: Own survey, 2019

4.3.2. Vulnerability level of the community

Calculating the livelihood vulnerability index using the IPCC framework approach

The LVI includes six major components; - Natural Disasters & Climate Variability; Infrastructure & Assets; Livelihood Strategies; Information & Knowledge Networks; Food & Water; and Socio-Demographic Profile. Each is comprised of several indicators or sub-components (Table 11). These were developed based on a review of the literature on each major component as well as the practicality of collecting the needed data through household surveys. Appendices Table 2 and 3. Includes an explanation of how each sub-component was coded and the units of measurement.

Table 11. Categorization of major components into contributing factors for calculation of the LVI–IPCC

IPCC Contributing factors to vulnerability	Major components & subcomponents
Exposure (EX)	Natural Disasters & Climate Variability (NC)
	- Percentage of households that have experienced floods over the last 10 years (EX-NCFL)
	- Percentage of households that have experienced prolonged droughts over the last 10 years (EX-NCDR)
	- Percentage of households that have experienced increase in precipitation over the last 10 yrs (EX-NCPR)
	- Percentage of households that have experienced increase in temperatures over the last 10 yrs (EX-NCTE)
Adaptive Capacity (AC)	Infrastructure & Assets (IA)
	- Percentage of households with access to electricity lines (AC-IAEL)
	- Percentage of households with access to health centers (AC-IAHC)
	- Percentage of households with physical latrines in their homesteads (AC-IAPL)
	- Average heard size (AC-IAHS)
	- Percentage of households owning a radio set (AC-IARS)
	- Percentage of households owning a television set (AC-IATS)
	- Percentage of households with road access (AC-IARA)
	- Percentage of households with access to market (AC-IAMA)
	Livelihood Strategies (LS)
	- Percentage of households who move their livestock during harsh climatic conditions (AC-LSLM)
	- Percentage of households having alternative sources of income (AC-LSSI)
	- Percentage of households with diversified livestock species (AC-LSDL)
	- Percentage of households reducing livestock sizes as a result of harsh climatic conditions (AC-LSRL)
	- Percentage of households that get credit from friends, relatives and other sources (AC-LSCF)
	- Percentage of households having have animal insurances (AC-LSAI)
	Information & Knowledge Networks (IK)
	- Percentage of households that have access to development agents (AC-IKDA)
	- Percentage of households who seek information from to *Uusa**(AC-IKUU)
	- Percentage of households that have access to climate information (AC-IKCI)
	- Percentage of households that have access to Early Warning Systems (AC-IKEW)

	Food & Water (FW)
	- Percentage of households that face feed scarcity for animals (AC – FWFS01)
	- Percentage of households with food aid facilities (AC – FWFS02)
	- Percentage of households that face water scarcity for animals (AC – FWWSF1)
	- Percentage of households that face water scarcity for domestic use (AC – FWWSF2)
Sensitivity (SE)	Socio-demographic Profile (SP)
	- Average age of the household heads (SE-SPAG)
	- Percentage of the female household heads (SE-SPGE)
	- Percentage of divorced or widowed household heads (SE-SPMS)
	- Average household size (SE-SPHS)
	- Average years of the household head lived in the area (SE-SPL
	- Average education level of the household head (SE-SPEL)

Source: Own survey, 2019

The LVI sub-component values for each district as well as the minimum and maximum values for both combined is presented in Appendices Table 4. The major components and the composite LVI for each Madda are presented in Appendices Table 5.

As illustrated in Appendices Table 2 and 3 Gobso (0.925) showed greater vulnerability on the Natural Disasters & Climate Variability (NC) index followed by Dillo (0.921), Madhacho (0.759) whereas Sodda and Haraweyu are the least vulnerable with a score of 0.75. Sodda PA has the highest vulnerability score of 0.669 with respect to Infrastructure & Assets (IA), whereas Madhacho was found to be the second most vulnerable PA with a score of 0.651, followed by Gobso, Dillo and Goray with 0.433, 0.425 and 0.396 respectively. Haraweyu was the least vulnerable PA (0.392) on this component.

Based on the weighted average score for the Livelihood Strategies component, Gobso was found to be the most vulnerable PA with a score of 0.550, whereas Dillo and Haraweyu was found to be the second and third most vulnerable PAs with 0.523 and 0.514 respectively and Madhacho was the least Vulnerable with 0.322 score.

In the Information and Knowledge Network component four indicators were considered. Sodda (0.660) and Goray (0.656) have greater vulnerablity, whereas Haraweyu, Dillo and Madhacho had scores of 0.573, 0.572 and 560 respectively, Gobso PA has the least vulnerability for this component with a score of 0.438.Goray and haraweyu was shown to be the most vulnerable PA for the food and water component with a score of 1.00, whereas Madhacho has a greater vulnerability of 0.983 than Soda PA with 0.960 index, Gobso and Dillo were found to be least vulnerable with a score of 0.875 and 0.868 respectively. Indicators for this component shows that food and water scarcity are the major problems for pastoralists households in Borana.

As shown in Appendix Table 2 and 3, Sodda was the most vulnerable in terms of the socio-demographic profile, with a weighted average score of 0.312, followed by Haraweyu with 0.283, whereas Gobso and Madhacho respectively had a score of 0.255 and 0.251.Goray had

the lowest vulnerability for this component, with an average score of 0.216 after Dillo which have a score of 0.23.

This study calculated livelihood vulnerability index for each of the six PAs of Borana zone. The communities were categorized into highly vulnerable, moderately vulnerable and less vulnerable communities in the study area. The calculated results of the major components or domains of the LVI are presented in spider diagrams and the contributing factor scores are depicted in a triangular diagram in Figure 6 and 7.

The LVI-IPCC scores demonstrate that sodda (0.0271) was the least vulnerable PA compared to other PAs as illustrated in Table 12. In the assessments, although Sodda is the most sensitive in the study region but due to its least exposure, we identified that Sodda may have better and more robust economic conditions and practice climate adaptation measures compared to the other PAs. On the other hand, among the six PAs, Gobso was found to be the highly vulnerable PA with very high exposure to natural hazards and only a least adaptive capacity compared to other PAs. This could be due to ecological gradient and severities of the effect of climate change which mostly result a stressful drought compared to other PAs.

The overall **LVI-IPCC** scores pointed to the vulnerability of Borana zone with a score of **0.0571** meaning that most of the households fall within the moderately vulnerable category, which is illustrated in Table 12 and Figure 6 and 7. Altogether, Borana zone is one of the most hazard-prone areas in Ethiopia, and suffers from the impact of climate change.

Table 12. Contributing factors and the overall calculation of Livelihood Vulnerability Index

Contributing Factor	Goray	Dillo	Madhacho	Sooda	Haraweyu	Gobso
Adaptive Capacity	0.5491	0.5591	0.6051	0.6632	0.5688	0.5453
Sensitivity	0.2165	0.2350	0.2513	0.3124	0.2831	0.2553
Exposure	0.7500	0.9210	0.7585	0.7500	0.7500	0.9250
LVI-IPCC - Peasant Association	0.0435	0.0850	0.0386	0.0271	0.0513	0.0970
Overall LVI-IPCC of Borana Area						**0.0571**

The LVI–IPCC was scaled from 0.01 (least vulnerable) to 0.10 (most vulnerable).

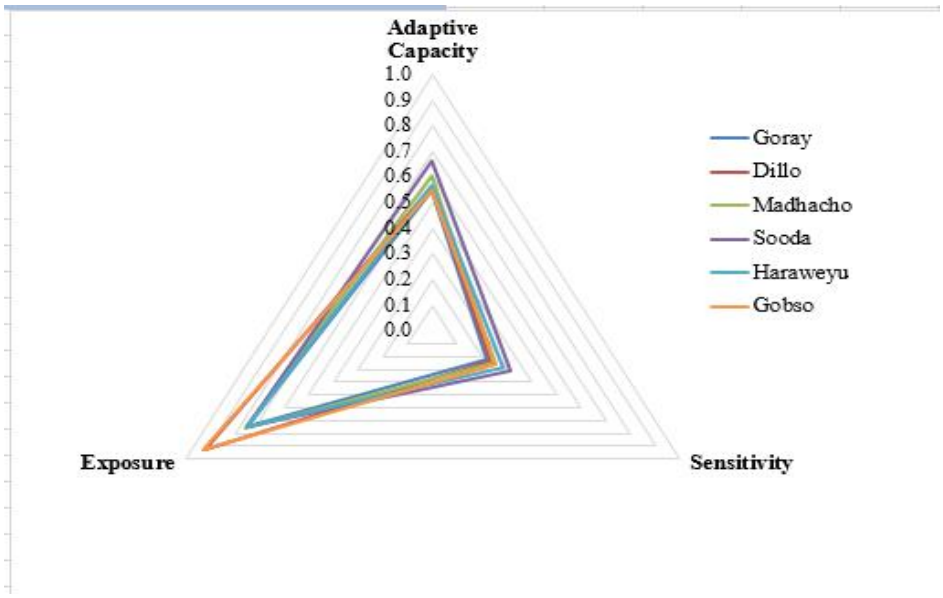

Figure 8. Contributing factors (vulnerability triangle) for the Livelihood Vulnerability Index

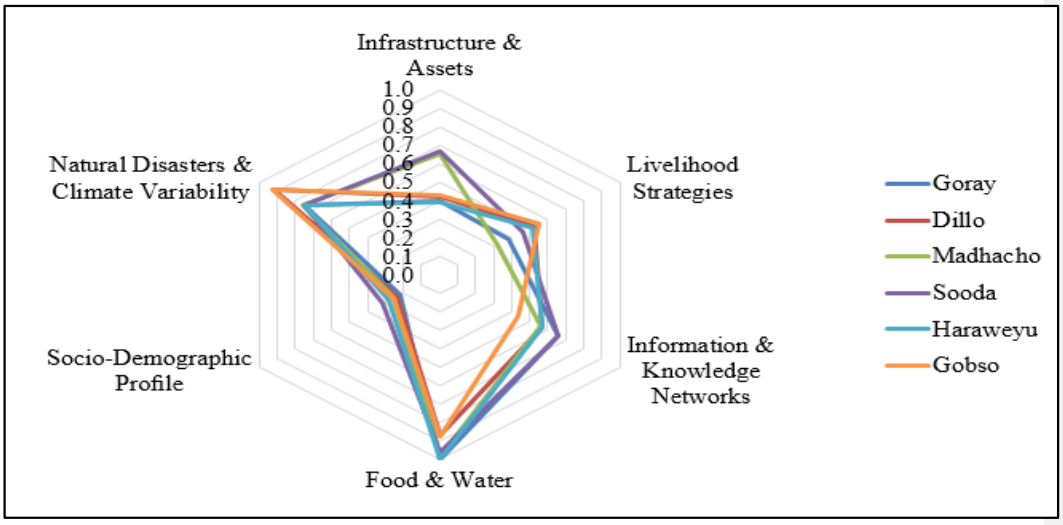

Figure 9. Major components (spider diagram) for the Livelihood Vulnerability Index

4.4. Adaptation and Coping Strategies of Communities to Climate Change and Variability

4.4.1. Importance of adaptation strategies

The Borana households were asked to rate the adaptation strategies based on their level of importance. A five-point rating scale was used to rate the level of importance of the adaptation strategies to the Borana pastoralist households in dirre rangeland. The 5 point ordinal scale were graded either as 4= very important, 3= important, 2= moderate importance, 1= low importance, 0= no importance.

Table 13. Importance of Adaptation strategies used by the Borana

	No importance	Low importance	Moderately important	Important	Very important
Prayers and other rites	0.0	0.0	9.4	19.4	71.3
Kalo	0.0	1.3	0.0	29.4	69.4
Mobility	0.0	0.0	10.6	30.6	58.8
Using borehole	2.5	5.0	7.5	35.0	50.0
Sending children to school	0.0	3.1	16.3	34.4	46.3
Destocking	0.0	10.0	12.5	36.9	40.6
Building dams	3.1	0.0	5.0	52.5	39.4
Animal health trainning	0.0	0.0	15.6	46.3	38.1
Rain harvesting	0.0	0.0	26.9	35.6	37.5
Paddock grazing	15.6	22.5	2.5	22.5	36.9
Use of crop residue	5.6	0.0	17.5	42.5	34.4
Diversify livelihood	4.4	14.4	16.3	35.0	30.0
Use of fodder trees	9.4	5.6	16.9	38.8	29.4
Diversification of herds	0.0	1.3	24.4	46.3	28.1
Buying hey	9.4	26.3	26.9	14.4	23.1
Harvesting of wild fruit	7.5	13.8	38.1	18.8	21.9
Irrigated farming	6.9	33.8	18.1	20.0	21.3

Source: survey, 2019

Mobility

Mobility is one of the main adaptation strategies used by Borana pastoralist particularly in times of drought and dry spell. About 59% of respondent reported that herd mobility is a very important adaptation strategy and 30.6% reported it as an important adaptation strategy (Table 13). In the Borana *Geda* system, ***mobility*** has been one of the mechanisms in utilizing the grazing resource properly that varies highly in space and time. Usually young men move with dry cows and bulls (*Forra* herds), while old people, women and children stay behind with milking cows and calves (*Warra* herds). Whereas mobility is associated with environmental variability, traditional herd mobility is also a result of different socio-economic status (Turner, 2011).

Among all the practices the mobility (transhumance) is declared by pastoralists as one of the most effective strategy to adapt to climate change and variability. Taking into account the socio-economic implications, mobility ahead of feed supplementation is more accessible to herders. However, for how long will herd mobility remain effective to climate change and variabilities? Facing the increasing challenges such as reduction of grazing lands due to land degradation, increase in livestock routes, expansion of farm land, and bush encroachment, livestock mobility to adapt to climate change is likely to be compromised in the coming decades (Sanou *et al.* 2018).

In times of extreme drought, pastoralists graze their animals in private grazing reserves (*kalos*) and sometimes cross the border to Kenya in search of pasture and water. Focus group discussant reported that herd mobility in Borana is increasing due to the obstruction of livestock routes, the reduction of watering points, and the qualitative and quantitative decline in forage biomass due to increased variability in temporal and geographic rainfall distribution and increased temperature and the recurrence of conflicts between land users. Therefore, mobility as an adaptation strategy is now challenged in the area.

Kalo (enclosures)

Reserving a section of the communal rangeland for later use is an integral part of pastoralist practice (Tache, 2013). As illustrated in Table 13, About 69.4% reported that it is very important adaptation strategy, 29.4% reported that it is important and 1.3% reported low importance. These communal pasture reserves locally known as *kallo* provided an important response to drought. Respondents reveled that it is possibly one of the most important interventions, not only in the context of natural resources rehabilitation, but also with respect to livelihood security. Once grasses were emerged in the enclosure, pastoralists traditionally divide the pasture land into blocks and sustainably graze turn by turn. It was commonly used as dry season grazing reserves for weak and lactating animals and many others. Mobility is augmented with homestead pasture reserves that target those physically weaker and more drought-vulnerable herd classes (Tache, 2013).

One of the KII stated that:

"Kalo is an important drought reserve among borana community. in the past the restricted area were not fenced and everyone knew that a particular area is an enclosure for calves not to be used by other herd classes, but recently people fence their own kalo and do not allow others to use it. Also we are witnessing a dramatic shrinkage of the resource base resulting in major land use change and shrinkage in available dry season grazing and reduction in communally managed grazing reserves."

Prayers and other rites

Prayers or other rites are practices of last resort where herders are desperate seeing their livestock die as a result of lack of resources (feed, water). Table 13 Shows that 71.3% of respondent believed that Prayers or other rites is a very important adaptation strategy, 19.4% believed it is important, 9.5% believed it is moderately important. Pastoralists fear that climate change induced calamities may continue to affect their livelihoods and even get worst in the

future. They believe that they have to strengthen their existing adaptation and mitigation strategies. While responding to the query *'if climate change makes pastoralist mode of livelihood impossible, what they think will be the feature of pastoralism and pastoralists?'* they responded that *'prayer'* and *'sacrifices'* will be the only means.

According to the *Soda* villagers the role the *Geda* system plays during drought is very minimal and mainly making prayers to God. The *Geda* informs the people about the situation and call for meetings to make prayers and sacrifices to God, a phenomenon known as *Dhiba-You-Baa*. In this process they bring milk, coffee and tobacco (*Daraaraa*) under a big tree near to a river and make the prayer. Then they make *Buna-Kela* (boil mixture of milk, coffee and butter) upon returning back home from the prayer.

Prayers and performance of other rites may not be seen as an effective form of adaptation to drought, however, for the respondents it is a major practice. Previous studies by (Kebebew *et al* 2001) and (Yilma *et al.,* 2009) also reported Prayers and other rites as a viable adaptation option in Borana community.

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). As coping option, about 40.6% of the respondents reported that destocking is very important, 37% reported important, 12.5% and 10% reported moderately and low important respectively (Table 13). The respondent indicated that beyond reducing livestock size, they sell their livestock before the sever effect of drought for purchase of food, livestock feed and other social cost.

Though the main target of destocking is to reduce livestock death and to moderate the feed competition during severe drought, the respondent observed destocking as the last option attributable to a probability of survival of livestock from drought. The key informant also indicated that though pastoralists favor this option than complete loss, they fear the capacity to

purchase livestock after drought because the pre- and post-drought price of livestock is extremely imbalanced. Studies (Yilma *et al.,* 2009, Ayal *et al.* 2018) revealed that when climate extremes begin to hit, pastoralists engage in commercial emergency destocking, thus helping them salvage all they can before the animal dies. Such action of reducing livestock number helps manage climate-related risks.

Using borehole

The results show that respondents believed that solving water problem through water resource development such as sinking boreholes, and water pans is a very important adaptation strategy in Borana. About 50% reported that using borehole is very important strategy, 35% reported that it is important, 7.5% reported moderately importance, 5% reported low importance and 2.5% reported no importance (Table 13). Interviews with water managers (*abba herega*) revealed that the boreholes and deep wells in Borana are still operative and very important. Basically, one is entitled for access to water by maintaining a relationship to the person who initially has established the water source (*konfi*). The right to water from wells is organised by clan-membership (*goosa*), whereas pond users are the adjacent inhabitants. However, the access to water is handled with flexibility and extra rights are accorded through social relationships and in emergency situations. The users of water, from wells and boreholes join in assemblies for common co-ordination and control (*kora ela*). They decide upon supplementary restrictions: After rainfall, the open water sources are used and the wells and boreholes are closed temporarily. With ongoing dry-season, the herds are successively shifted to more distant ponds, and traditional wells are re-opened to preserve the water near the encampments. According to the livestock's water needs, horses have always precedence, followed by cattle and small ruminants, and dromedaries drink at last. With progressing scarcity in water, the drinking frequency of cattle is gradually reduced to drinking once a day (*dhabsuu*), every two days (*limmaalimma*), and every three days (*sadeen*). The importance of using boreholes was echoed by the FGDs with one of the discussants stating:

"Climate change is increasing uncertainties in water availabilities in borana, therefore using boreholes and ponds will probably become even more important in the future in the face of climate change."Several studies (Riché *et al*., 2009, Yilma *et al.,* 2009) also reported using boreholes as a viable adaptation option in ASAL of Borana

Sending children to school

Table 13 shows that 46.3% of respondent reported that child education is a very important adaptation strategy, 34.4% believed it is important, 16.3% believed it is moderately important, 3.1% said it's of low importance. In almost all sites, the interviewed households believed that child education is a long-term adaptation strategy to climate change. Certain changes have been realized in the formal education system as a result of the drought effect. According to respondents increased migration resulting from droughts and conflicts leads to increased school dropouts. However, child education is now seen as the best way to prepare for an uncertain future. Most households reported that they were using the education of their children as an investment for future economic diversification. Previous studies by (Riché *et al*., 2009) and (Tache, 2008) also reported child education as a long-term adaptation strategy in ASALs of Borana.

Diversification of herds

The study by Bati, (2013) showed that the convergence of climate change and its variability, and rangeland ecosystem changes have posed considerable pressure on cattle production resulting in livestock diversification. Table 13 shows that 28.1% respondents reported that livestock diversification is a very important adaptation strategy in the study area, 52.5% reported that it is important, 5% reported moderate importance, 0% reported low importance and 3.1% said it is of no importance. The Borena pastoralists keep various types of livestock species, including cattle, goats, sheep, camels and donkeys. To the Borena pastoralists, maintaining diversified herd has many purposes, and one of these is its contribution to climate

change. Herd species diversification also reduces risk associated with different diseases (Ayal *et al.* 2018).

Respondents reported that while camels give income value in addition to milk, goats due to their rapid reproduction rate can recover quickly post-drought and consume less forage when compared to cattle and they also produce nutritious milk. Cattle, over and above their economic value, also give prestige and social status in Borena communities. Respondent also explained that recently, the number of camels has increased because of the camel's high market value and drought-resilient. The study agrees with the finding of (Berhanu and Fekadu, 2015) who stated that Herd diversification in favor of browsers (camel and goats) is an important strategy of pastoralist adaptive response to climate-induced shifts in rangeland ecosystems.

Other strategies

The other important strategies used by respondent to adapt to climate change and variability are: Buying hey where only 23.1% reported to be very important, 14.4% reported important and 27%, 26.3% and 9.4% reported Moderately important, Low importance and No importance respectively. Majority of the respondent believed purchasing of hay to be of moderately and low importance due to its additional cost. Paddock grazing is another important strategy used by respondent, about 37% of respondent whose majority own small herd size reported it to be very important. Another important adaptation strategy adopted by respondent is diversification of livelihood which has become a necessity and not a free choice to moderate harm from both climatic and non-climatic stresses. Diversification of livelihood activities includes the shift into non-farm employment areas such as traditional mining, charcoal production, labor work and working/keeping another's farm/livestock on payment basis, petty trade and handcraft were common. From survey result, about 30% and 35% of the respondents reported livelihood diversification to be very important and important respectively. Other strategies used by the households include irrigated farming, building dams, animal health training, harvesting of wild fruit, use of fodder trees and use of crop residue.

4.4.2. Role of external organization in enhancing adaptive capacity

The government agencies, NGOs and social assistants play crucial role in enhancing the adaptive capacity of the Borana to climate change. Respondents reported that government organizations such as National Adaptation Programme of Action (NAPA) give early warning during extreme climatic events. They also reported that the government ensure the availability and efficient distribution of emergency food aid and cash support during extreme drought. They however stated that the quantity of food aid is usually very small compared to the devastating effect of the droughts. Respondents stressed the need to concentrate on long term projects such as drilling boreholes and constructing water pans, Support Livestock marketing and diversification activities, including adding value to livestock products such as milk, ghee, hides and horns, which they believe could contribute to increased pastoral incomes, providing infrastructures such as good roads and electricity, and also work to resolve internal boundary issues and engage with traditional social institutions in conflict prevention and resolution.

Furthermore, building the future of the society, need a priority program attention. Specially, most of the external assistant such as food aid should shift their operation from emergency assistant fixated to the build of the future resources of the society. During drought, huge of resources were invested but focused on merely emergency assistant. However, it is the important if the emergency fund raised before the drought breakout to building the resources of the pastoralists that enable them to withstand the effect of drought. Otherwise, if the intervention continues in the emergency operation, the future of the society in the dry land of southern Ethiopia is questionable. Thus, the emergency fund raising should consider the future livelihood of a society besides the emergency aid.

NGOs play crucial roles in enhancing adaptive capacity of pastoralist in the study area. Some of the roles identified by respondents includes (1) promote education and capacity building on climate change adaptation (2) Give food aid (3) provide savings and credit services (4) create local awareness raising, and (5) involvement of youth and women in decision making.

Though, the declining of the Borena social assistant experience has been reported, respondent mentioned as one response to the impact of climate change and variability. Respondent reported clan support such as *buusaa gonofaa* (food and other resources sharing) and *Ameessa* (milking cow loan) is still 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 Jema, 2015).

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary

This study was initiated to fill the gap of information on perception of Borana pastoralist to climate change impacts on mobile herding and the socio-economic conditions that create vulnerability to climate change and variability, and how the community cope with or adapt to it and how this is changing in Borana zone of southern Ethiopia. Cross-sectional data were collected from sample of 160 pastoralists selected through multistage sampling method following probability proportional to sample size techniques. Descriptive statistics and vulnerability analysis methods were employed.

From respondents' perspectives, changes in climate conditions as well as their impacts on mobile herding, are indisputable within Borana zone. Respondents consulted in study areas are observing climate trends that are consistent (but not always) with scientific climate change observations and projections, including increasing drought frequency, decreasing rainfall predictability, decreasing length of rainy seasons, and increasing temperatures, increasing floods and animal's diseases as well. Deterioration in climate conditions affects both livestock production and reproduction performance and herders' livelihoods. It results an increasing pressure/competition for natural resources which results of conflicts within pastoralists communities.

In this study, we have examined the vulnerability of households in the six PAs of Borana zone by calculating the Livelihood Vulnerability index using Livelihood Vulnerability Index (LVI) and the IPCC framework approach (LVI-IPCC). Although the individual indicators of different components show different trends for different PAs, the overall indexes indicate that pastoralist's households in Gobso PA are the most vulnerable. The study also found that exposure to natural hazards is the highest indicator for climate change vulnerability of pastoralist's households in the study area. This study confirms that pastoralist's households who fail to adopt any strategies for adaptation to the impacts of climate change are more

vulnerable than adapted households. The assessments come to the conclusion that lack of households' access to basic infrastructure, opportunities for additional income from farm or non-farm sources, experiencing prolonged droughts, decrease in precipitation and increase in temperature make households highly sensitive to the adverse effects of climate change.

The Borana community are already taking measures to adapt to climate extremes, especially drought. Given all the recent challenges, livestock mobility, a long-term adaptation strategy to harsh environment conditions, is declining because of different land fragmentation and private enclosures. Adaptation strategies such as livestock diversification, early warning system, rain harvesting and several others are being used by pastoralist to adapt to climate change and variability. However, increase in drought frequency in the last few years is reducing their resilience. Lack of basic amenities such as good roads and clean water is increasing vulnerability of pastoralist in the study area to climate change. The government, non-governmental organizations and private sector have a crucial role to play in enhancing adaptation and coping strategies of Borana pastoralist to climate change and variation.

5.2. Conclusions

The perception of the Borana pastoralists on rainfall trends in the last 10 years presented in Figure 3 shows that 88.8% of the respondents perceived that rainfall is reducing in the study area. 95% of the respondent also perceived that average temperature is increasing in the study area.Therefore, the study concludes that Pastoralists living in arid and semi-arid lands of Ethiopia are particularly vulnerable to climate induced stress due to over dependence on climate sensitive livelihood activities. Understanding their perception to rainfall pattern and change in temperature is therefore very important in addressing adaptation to extreme climatic events especially drought.

About 71% of respondents perceived that climate change had a very high impact on herd mobility. This shows that herd mobility which is a key survival and resource management strategy commonly practiced by herder societies for efficient use of meagre and scattered

rangeland resources for sustainable livelihoods in Borana is severely affected by climate change.

At last we conclude that because of various social, economic and biophysical determinants observed to influence households' vulnerability to climate-induced stresses, policies with emphasis on increasing the availability/accessibility of resources (feed, water) for livestock, promoting education, supporting extension services and enhancing diversifications of income sources and access to credit, supporting herd mobility and diversity, creating employments, and increasing access to markets and early warning information are likely to improve resilience of pastoral households. Furthermore, beyond development intervention, identifying and prioritizing of the key challenges of pastoral community need a prior action. Finally, drought effects can be minimized if accountable stakeholder act together and consecutively to sustain the best interventions.

5.3. Recommendations

This study has shown that vulnerability of pastoralist households to natural shocks has been worsened by climate change and variability. The study also revealed that household-level strategies for adapting to climate change and variability are constrained by frequent droughts compounded by conflicts and poor range conditions in Borana. Therefore, based on the results from this study, the following recommendations have been suggested for future research, policy and development intervention activities. These includes:

Local communities are already observing and experiencing the effects of climate change and variability on both mobile herds and their livelihood, as well as implementing coping and adaptation strategies. Efforts to support climate change adaptation by policy makers and/or development planners should be based on an understanding of what people are already doing on the ground, assessing the effectiveness of current adaptation strategies and how they might fare over the longer-term with climate change. Therefore, using of indigenous households' perceptions of climate change and variability impact on both mobile herding and herder's

livelihood and Using traditional knowledge and starting from what people are already doing on the ground are necessary for better planning and targeting of interventions.

In order to overcome the exacerbation of constraints related to mobile herds, local institution urgently needs to undertake actions to reduce the number of transhumant herds and to increase the availability/accessibility of resources (feed, water) for livestock. This might be ensured by: (1) Development of compulsory resources, feed and water, with sustainable exploitation; (2) encouraging and supporting gradual shift of herders from transhumance to the sedentary breeding; and (3) supporting and organizing forage production by farmers.

This study points out that the lack of adaptive capacity and exposure to natural hazards is the highest indicator for climate change vulnerability of pastoralist's households in the study area. Therefore, this study calls for local policy makers and/or development planners to prepare disaster risk management to reduce exposure, and climate change vulnerability of the communities and to promote climate change mitigation and adaptation strategies, and strengthen the adaptive capacity of farm households to overcome future scenarios of climate variability and change. More efforts by local institutions and the government in general should also focus on expanding opportunities for diversification of livelihoods, safe livestock mobility and herd diversification. Furthermore, interventions that promote women empowerment, support education, enhance access to markets and climate information are necessary for climate resilient households in Borana.

-Adaptation strategies should be location specific: The high variation in LVI-IPCC of different PAs shows that locations are impacted differently by climate change and variability. Climate adaptation options that are suitable for the highlands of Madhacho and Soda may not be necessary be suitable for the lowlands of Gobso and Dillo. Location specific interventions are therefore necessary to address the impacts of climate change in the region.

Education, training and awareness creation for pastoralists: Adaptation to climate change for Borana will reduce the potential effects caused by the projected changes in temperature and

rainfall. Subsequently, drought resistant livestock are the most recommended. However, shifting and switching of livestock requires educational programmes and trainings on climate change and incremental benefits to be accumulated from adaptation. Therefore, local governance and institutions need to build a strategic program to build awareness and strengthen the extension service and capacitate extension workers with knowledge on climate change risks and climate smart agriculture. The study also recommends investment in education to improve literacy levels which is a major constraint to desired adaptations that are key in addressing cyclic drought vulnerability in the area.

Efficient early warning system: The study recommends the adoption of early warning systems through improved delivery of weather forecast information, inducing early livestock off-take and timely feed resource mobilization to enhance resilience to climate change.

-This study only assessed the livelihoods vulnerability of pastoralist's communities in six PAs of Borana zone, and could therefore only provide location specific information. Additional measurement in different pastoralists region within Ethiopia should be carried out to gain a deeper understanding of climate change vulnerability and regional climate adaptation measurements.

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7. APPENDICES

Appedix Table 1. Average number of livestock owned by household head

Animal category	Conversion factor
Cattle	0.7
Goat	0.1
Sheep	0.1
Horse	1.1
Camel	1.0
Donkey	0.4
Chicken	0.013

Source: (FAO, 1986).

Appedix Table 2. Contributing factors (CF) and the overall calculation of Livelihood Vulnerability Index (LVI–IPCC) for the Goray, Dillo & Madhacho peasant associations in Borana Area

Contributing factors (CF)	Major Component (MC)	MC Values	No. of SC per MC	CF Values	LVI Value
Goray Peasant Association					
Adaptive Capacity (AC)	Infrastructure & Assets (IA)	0.396	8.000	0.549	0.043
	Livelihood Strategies (LS)	0.382	6.000		
	Information & Knowledge Networks (IK)	0.656	4.000		
	Food & Water (FW)	1.000	4.000		
Sensitivity (SE)	Socio-Demographic Profile (SP)	0.216	6.000	0.216	
Exposure (EX)	Natural Disasters & Climate Variability (NC)	0.750	4.000	0.750	
Dillo Peasant Association					
Adaptive Capacity (AC)	Infrastructure & Assets (IA)	0.425	8.000	0.559	0.085
	Livelihood Strategies (LS)	0.523	6.000		
	Information & Knowledge Networks (IK)	0.572	4.000		
	Food & Water (FW)	0.868	4.000		
Sensitivity (SE)	Socio-Demographic	0.235	6.000	0.235	

	Profile (SP)				
Exposure (EX)	Natural Disasters & Climate Variability (NC)	0.921	4.000	0.921	
Madhacho Peasant Association					
Adaptive Capacity (AC)	Infrastructure & Assets (IA)	0.651	8.000	0.605	0.039
	Livelihood Strategies (LS)	0.322	6.000		
	Information & Knowledge Networks (IK)	0.560	4.000		
	Food & Water (FW)	0.983	4.000		
Sensitivity (SE)	Socio-Demographic Profile (SP)	0.251	6.000	0.251	
Exposure (EX)	Natural Disasters & Climate Variability (NC)	0.759	4.000	0.759	

Appedix Table 3. Contributing factors (CF) and the overall calculation of Livelihood Vulnerability Index (LVI–IPCC) for the Sooda, Haraweyu & Gobso peasant associations in Borana Area

Contributing factors (CF)	Major Component (MC)	MC Values	No. of SC per MC	CF Values	LVI Value
Sooda Peasant Association					
Adaptive Capacity (AC)	Infrastructure & Assets (IA)	0.669	8.000	0.663	0.027
	Livelihood Strategies (LS)	0.460	6.000		
	Information & Knowledge Networks (IK)	0.660	4.000		
	Food & Water (FW)	0.960	4.000		
Sensitivity (SE)	Socio-Demographic Profile (SP)	0.312	6.000	0.312	
Exposure (EX)	Natural Disasters & Climate Variability (NC)	0.750	4.000	0.750	
Haraweyu Peasant Association					

Adaptive Capacity (AC)	Infrastructure & Assets (IA)	0.392	8	0.569	0.051
	Livelihood Strategies (LS)	0.514	6		
	Information & Knowledge Networks (IK)	0.573	4		
	Food & Water (FW)	1.000	4		
Sensitivity (SE)	Socio-Demographic Profile (SP)	0.283	6	0.283	
Exposure (EX)	Natural Disasters & Climate Variability (NC)	0.750	4	0.75	
Gobso Peasant Association					
Adaptive Capacity (AC)	Infrastructure & Assets (IA)	0.431	8	0.545	0.097
	Livelihood Strategies (LS)	0.550	6		
	Information & Knowledge Networks (IK)	0.438	4		
	Food & Water (FW)	0.875	4		
Sensitivity (SE)	Socio-Demographic Profile (SP)	0.255	6	0.255	
Exposure (EX)	Natural Disasters & Climate Variability (NC)	0.925	4	0.925	

Sub-Components	Units	Goray (n=24)	Dillo (n=38)	Madhacho (n=29)	Sooda (25)	Harawey u(24)	Gobso (20)	Minimum Value of PAs	Maximum Value of PAs
EX-NCFL	Percent	0	68.4	3.4	0	0	70	0	100
EX-NCDR	Percent	100	100	100	100	100	100	0	100
EX-NCPR	Percent	100	100	100	100	100	100	0	100
EX-NCTE	Percent	100	100	100	100	100	100	0	100
AC-IAEL	Percent	0	0	100	100	0	0	0	100
AC-IAPL	Percent	100	100	100	100	100	100	0	100
AC-IAHC	Percent	100	100	100	100	100	100	0	100
AC-IARA	Percent	100	100	100	100	100	100	0	100
AC-IAMA	Percent	0	0	100	100	0	0	0	100
AC-IAHS	Percent	74.88	51.92	48.41	86.12	63.25	66.3	2	443
AC-IARS	Percent	0	28.9	10.3	16	0	30	0	100
AC-IATS	Percent	0	0	0	0	0	0	0	100
AC-LSSI	Percent	37.5	34.5	58.6	44	95.8	60	0	100
AC-LSDL	Percent	45.8	13.2	0	28	58.3	20	0	100
AC-LSLM	Percent	100	92.1	82.8	76	66.7	90	0	100
AC-LSRL	Percent	45.8	34.2	27.6	44	41.7	30	0	100
AC-LSCF	Percent	0	100	24.1	84	45.8	100	0	100
AC-LSAI	Percent	0	39.5	0	0	0	30	0	100
AC-IKEW	Percent	62.5	76.3	55.2	56	33.3	15	0	100
AC-IKCI	Percent	0	28.9	51.7	92	75	30	0	100
AC-IKUU	Percent	100	73.7	79.3	92	91.7	75	0	100
AC-IKDA	Percent	100	50	37.9	24	29.2	55	0	100
AC FWFS01	Percent	100	76.3	100	100	100	80	0	100
AC FWFS02	Percent	100	86.8	93.1	84	100	80	0	100
AC FWWSF1	Percent	100	84.2	100	100	100	90	0	100
AC FWWSF2	Percent	100	100	100	100	100	100	0	100

SE-SPAG	Average	41.17	47.11	50.28	56.88	39.46	45.3	24	96
SE-SPGE	Percent	8.3	5.3	24.1	16	20.8	10	0	100
SE-SPMS	Percent	8.3	13.2	0	24	12.5	15	0	100
SE-SPLA	Average	28.38	32.68	13.28	36.48	35.38	33.45	3	96
SE-SPEL	Average	1.92	1.08	1.62	1.64	1.42	1.45	1	6

Appedix Table 4. Sub-component values for the six (6) peasant association of the Borana

Appedix Table 5. Indexed Sub-Components and Major Components Values for the selected Peasant Associations

SC	Goray	Dillo	Madhacho	Sooda	Haraweyu	Gobso	MC	Goray	Dillo	Madhacho	Sooda	Harawey u	Gobso
EX-NCFL	0.000	0.684	0.034	0.000	0.000	0.700	NC	0.750	0.921	0.759	0.750	0.750	0.925
EX-NCDR	1.000	1.000	1.000	1.000	1.000	1.000							
EX-NCPR	1.000	1.000	1.000	1.000	1.000	1.000							
EX-NCTE	1.000	1.000	1.000	1.000	1.000	1.000							
AC-IAEL	0.000	0.000	1.000	1.000	0.000	0.000	IA	0.396	0.425	0.651	0.669	0.392	0.4331
AC-IAPL	1.000	1.000	1.000	1.000	1.000	1.000							
AC-IAHC	1.000	1.000	1.000	1.000	1.000	1.000							
AC-IARA	1.000	1.000	1.000	1.000	1.000	1.000							
AC-IAMA	0.000	0.000	1.000	1.000	0.000	0.000							
AC-IAHS	0.165	0.113	0.105	0.191	0.139	0.146							
AC-IARS	0.000	0.289	0.103	0.160	0.000	0.300							
AC-IATS	0.000	0.000	0.000	0.000	0.000	0.000							
AC-LSSI	0.375	0.345	0.586	0.440	0.958	0.600	LS	0.382	0.523	0.322	0.460	0.514	0.550
AC-LSDL	0.458	0.132	0.000	0.280	0.583	0.200							
AC-LSLM	1.000	0.921	0.828	0.760	0.667	0.900							

AC-LSRL	0.458	0.342	0.276	0.440	0.417	0.300							
AC-LSCF	0.000	1.000	0.241	0.840	0.458	1.000							
AC-LSAI	0.000	0.395	0.000	0.000	0.000	0.300							
AC-IKEW	0.625	0.763	0.552	0.560	0.333	0.150	IK	0.656	0.572	0.560	0.660	0.573	0.438
AC-IKCI	0.000	0.289	0.517	0.920	0.750	0.300							
AC-IKUU	1.000	0.737	0.793	0.920	0.917	0.750							
AC-IKDA	1.000	0.500	0.379	0.240	0.292	0.550							
AC FWFS01	1.000	0.763	1.000	1.000	1.000	0.800	FW	1.000	0.868	0.983	0.960	1.000	0.875
AC FWFS02	1.000	0.868	0.931	0.840	1.000	0.800							
AC FWWSF1	1.000	0.842	1.000	1.000	1.000	0.900							
AC FWWSF2	1.000	1.000	1.000	1.000	1.000	1.000							
SE-SPAG	0.238	0.321	0.365	0.457	0.215	0.296	SP	0.216	0.235	0.251	0.312	0.283	0.255
SE-SPGE	0.083	0.053	0.241	0.160	0.208	0.100							
SE-SPMS	0.083	0.132	0.000	0.240	0.125	0.150							
SE-SPHS	0.438	0.569	0.668	0.530	0.719	0.569							
SE-SPLA	0.273	0.319	0.111	0.360	0.348	0.327							
SE-SPEL	0.184	0.016	0.124	0.128	0.084	0.090							

QUESTIONNAIRE

Comment [U1]: some of the question you suggest i should remove are used for the analyzing vulnerability.

Questionnaire for household head in Borana zone

This questionnaire will be administered to head of selected households in Borana zone. The aim of the questionnaire is to (1) determine general household and economic characteristics (2) access the perception of Borana to climate change and variability (3) evaluate the impact of climate change and variability on livelihood of Borana pastoralists (4) describe adaptation and coping strategies of pastoralist communities and the challenges they face while adapting to climate change and variability

Questionnaire No----------

Part A: - Household demographics

1. Location (Madda) ----------
2. Village----------
3. Community----------
4. What is the gender of household head?

1. Male 0. Female

5. What is the age of the household head in years? ----------
6. What is the educational level of household head?

1. Unable to read and write 2. Informal education 3. .Primary (grade 1-8) 4. Secondary (grade 9-12) 5. Diploma 6. University

7. What number of years has the household head lived in the area? ----------

8. What is the marital status of the household head? 1. Single 2. Married 3. Divorced 4. Widowed

9. What are your sources of water for domestic use?

1. Boreholes 2. Dam 3. Water pans 4. Rivers 5. Tap/pump water 6. Pond water

0. Any other_____

Part B: - Socio economic characteristics

1. Household labour endowment

Sex/number	Age(years)	Index	Total labour unit
M___F____	Less than 11	0	
M___F____	11-15	0.25	
M___F____	16-20	0.50	
M___	21-60	1	
F____	21-60	0.67	
M___F____	Over 60	0.50	
Total			

2. Which of these facilities do you have access to?

Facilities	Yes/No
Electricity	
Toilet	
Hospital	
School	
Clean drinking water	
Specify others	

3. What are the sources of your family income and amount made per year?

sources	Yes/No	Amount/year
Livestock keeping		
Livestock trading		
Crop farming		
Tourism		
Business		
Services		
Government employment		
Others (specify)		

4. Use the table below and provide an estimate of the average number of livestock you owned

	Number of livestock owned		Variations over the years
Livestock group	Last 10 years	Now 2019	1. Same 2. Increasing 3. Decreasing 4. Fluctuating
Cow			
Goat			
Sheep			
Horse			
Camel			
Donkey			
Poultry			
Others			

5. What do you think is the reason for this variation over the years? ----------
---

6. What is the approximate distance to the nearest livestock market in hours? 4. > 6Hr 3. 3 - 5Hr 2. 1 – 2Hr 1. Less than 1Hr,

7. Have you lived to another place prior to moving to the current location? 1. Yes O. No

8. If your answer for No. 7 is yes, why did you leave your previous location?

_____
_____
_____

9. If your answer for No. 7 is No, What were your specific reasons for choosing your current location?_____
_____

10. Do you have a plan to leave this place? 1. Yes 0. No

11. If your answer for No. 10 is yes, why do you intend to leave this place? _____

12. If your answer for No. 10 is no, why do you prefer to stay in this place?

_____

13. Have you sold a livestock currently? 1. Yes 0. No

14. If your answer for No. 13 is yes, what are the possible reasons for selling your livestock?

1. Drought, 2. School fee, 3. Medication, 4. Buy food, 5. Veterinary services, 6. Cultural festival, 7. Please specify other _____

15. What are the type of grazing used in the area? 1. Paddock 0. Herded?

16. How do you prefer your livestock to be grazed? Why?

1. Paddock 0. Herded?

_____
_____

17. Do you keep sheep, goats and camels in your herd? 1. Yes 0.No

18. If your answer for No. 17 is yes, why do you keep sheep, goats and camels in your herd?

_____

19. If your answer for No. 17 is No, why don't you keep sheep, goats and camels in your herd?

_____
_____
_____

20. Do you combine your Livestock in one herd during movement? 1. Yes 0.No

21. If your answer for No. 20 is Yes, why do you combine your Livestock in one herd during movement?_____

_____

22. If your answer for No. 20 is No, why don't you combine your Livestock in one herd during movement? _____

23. Who looks after your livestock/herds?

1. father of the family (*abbaa warraa*)
2. older children *(ijolle foora*)

3. Specify others please_____

24. How many times do you move your livestock in a year?

1. Depends 2. Once 3. Twice 4. multiple time 5. I don't know

25. When do you move your livestock?

_____

26. Where do you move to?

_____
_____

27. How long do you stay at each stock post/ camp?

1. Depends 2. < Month 3. 1-3 Months 4.4-5 Months 5. > 5 Months

28. Are you able to move your livestock freely to the communal areas? 1 Yes, 0. No

29. If your answer for No. 28 is No, why?

30. Did you ever move out of the communal area? 1. Yes, 0. No

31. If your answer is Yes for question 30, Why do you move out of the communal area? -
_____
_____

32. If your answer is No for question 30, why didn't you move?

_____
_____

33. What is the arrangement for you to move out of the communal area?

_____
_____

34. Do you interact with other herders? 1. Yes 0. No

35. If your answer is Yes for question 34, when do you interact?

36. If your answer is No for question 35, what is your reason for not interacting?

_____
_____
_____

37. What are the main challenges you experience as a livestock herder? (Multiple Response Allowed) 1. Drought 2. Disease 3. Long Distance Travel 4. Feed Scarcity 5. Water scarcity 6. Market 7. Others

Part C:-Perception on Climate Change and variability impacts on mobile herding

1. Do you perceive that there is climate change in your area? 1. Yes, 0. No

2. If your answer for No. 1 is Yes for question 1, have you noticed any changes in temperature in your area? 1. Yes, 0. No

3. If your answer for No. 2 is Yes, how can you describe the temperature changes?

(1) Increasing

(2) Decreasing

(3) No change

(4) Varies continuously

(5) Don't know

4. If your answer for No. 1 is yes, have you noticed any changes in rainfall in your area? 1. Yes, 0. No

5. If your answer for No.4 is yes, how would you describe rainfall changes?

1=increased,

2=decreased,

3=same/unchanged,

4=fluctuated,

5=don't know

6. In your opinion do you think the following climate change impact has effect on mobile herds? Rank codes, 5= very high 4= high 3= average 2= low 1=Very low 0=No effect

Impacts	**Rank 0-5**
Animals travel longer distances for feed and drink	
Decrease in the number of births per year	
Drop in Milk production	
Death of livestock	
Excessive loss of weight	
Increase of infectious and parasitic diseases	
Appearance of new animals' diseases	
Abortion of livestock	
Specify others	

7. In your opinion do you think the following climate change impact has effect on mobile herder's livelihoods? Rank codes 5= very high 4= high 3= average 2= low 1=Very low 0=No effect

Impacts	**Rank 0-5**
Long distance to fetch water for domestic use	
Increase in physical effort in herding	
Food insecurity	
Regression of animal heritage	
Decrease in incomes	
Loss of prestige	
Specify others	

7. How do you think climate change is affecting herder's transhumance practice?

Practices	effect	5 years ago	10 years ago	20 years ago
Destination zone	Change=1 Unchanged=0			
Transhumance route	Change=1 Unchanged=0			
Departure in transhumance	Earlier=1 Late=0			
Duration to reach destination Zone	Increased=1 Decrease=0			
Duration within destination zone	Increased=1 Decrease=0			

Part D: - Adaptation and coping strategies of households to climate change and variability

1. How does your household respond to the following climatic factors?

Climatic factor	Adaptation strategies (multiple possible)
Drought	
Floods	
Late rain	
Short rain	
Dry spell	
Strong wind	
Increased temperature	
Specify others	

2. Rate the adaptation strategies below based on their level of importance.

S/N	Adaptation/coping strategy	Very important	Important	Moderately important	Less important	No importance
1	mobility					
2	Destocking					

3	Buying hey					
4	Paddock grazing					
5	Diversify livelihood					
6	Irrigated farming					
7	Using borehole					
8	Rain harvesting					
9	Sending children to school					
10	Building dams					
11	Diversification of herds					
12	Animal health training					
13	Harvesting of wild fruits					
14	Use of fodder trees					
15	Use of crop residues					
16	Prayers and other rites					
17	Kalo					
18	Specify others					

3. What are the challenges in trying to adapt to the effect of change in climate factors?

Climatic factor	Challenges (multiple possible)
Drought	
Floods	
Late rain	
Short rain	
Dry spell	
Strong wind	
Increased temperature	
Specify others	

4. What are the opportunities in coping and adapting to the effect of changes in climate factors?

Climatic factor	Opportunities (multiple possible)
Drought	
Floods	

Late rain	
Short rain	
Dry spell	
Strong wind	
Increased temperature	
Specify others	

5. Do you have free mobility of your livestock during extreme climatic event? 1. Yes 0. No

6. If your answer for No. 5 is Yes, How far can you move freely?

7. If your answer for No. 5 is No, why don't you move freely?

8. Have you ever received support or credit facilities during climate induced problem?

1. Yes 0. No

9. If your answer for No. 8 is Yes, indicate type of support and source

Type of support	Sources	Beneficiary (1)household Head (2) Women (3) children	Comments appropriateness or effectiveness

10. Do you use traditional coping strategies? 1. Yes 0. No

11. If your answer for No. 10 is Yes, Do you perceive that traditional coping strategies are affective?

12. If your answer for No. 10 is No, why don't you use traditional coping strategies?

13. Do you receive any climate information? 1. Yes 0. No

14. If your answer for No. 13 is yes, please complete the following table

Type of information	Primary sources	How often do you receive it	Who receives it (1) HH head (2) women (3) children (4) everybody
Daily forecast			
Weekly forecast			
Monthly forecast			
Seasonal forecast			
Drought forecast			
Specify others			

E. Knowledge about Policy issues

1. Do you have any knowledge about policies of pastoralism in Ethiopia? Yes 0. No
2. If your answer for No. 1 is Yes, what do you know about policies of pastoralism in Ethiopia?
3. If your answer for No. 1 is No, what are the reason for not knowing about the policies?
4. What is your thought about the future of pastoralism in relation to current policies?
5. What is your suggestion (s) for pastoralist livelihood improvement? (If any)

Focus Group Discussion Questions

1. What are your sources of livelihood?
2. What do you think are the condition that create vulnerability to climate change and variability in your area?
3. How has climate change affected your livelihoods?
4. How has climate change affected your finances?

Coping and adaptation strategies

1. What coping strategies have you been using to adapt to climate change and variability?

2. What coping strategies do you think will be useful to adapt to climate change that you are not yet using either due to the cost or expertise?

3. What kind of livelihood can you diversify so that you can reduce the negative effect of climate change on your household?

4. What are the main challenges in adapting to climate change and variability and how do you think they can be improved?

5. Do you always have government assistance during drought? If yes, how do they assist

6. What do you think government can do more to reduce the effect of climate change and variability?

Key Informant Interview Questions

1. Is there any form of climate change in your zone or district? If your answer is yes, please can you explain?
2. How do you view change in climate (rainfall and temperature) in your community
3. Do you have indigenous ways of predicting rainfall? If yes what are the ways
4. How often do you experience drought in your area?
5. Do you think mobility can be a sustainable adaptation strategy to climate change for Borana pastoralist?
6. Do you think climate change has impact on mobile herding?
7. Can you give years and local names of major drought in your area?
8. How has vegetation, land use and livestock species been affected by climate change?
9. Has drought lead to the emergence of new human or animal disease in your area?
10. How can conditions for pastoralists be improved in Borana?
11. What do you think about the future of pastoralism?
12. What do you think about the future of mobile herding?

Coping and adaptation strategies

1. What coping strategies have you been using to adapt to climate change and variability?

2. What options do pastoral communities have to reduce the effect of climate change and variability?

3. What coping strategies do you think will be useful to adapt to climate change that you are not yet using either due to the cost or expertise?

4. What are the main challenges in adapting to climate change and variability and how do you think they can be improved?

5. Which organizations assist your communities during drought?

6. Do you always have government assistance during drought? If yes, how do they assist?

7. What do you think government can do more to reduce the effect of climate change and variability?

8. What role does NGOs play during drought?

9. If we want to assist the community to adapt to climate change and variability, what do you think are the most important priority now?