ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
COLLEGE OF DEVELOPMENT STUDIES (CDS)

A COMPARATIVE ANALYSIS OF VULNERABILITY TO CLIMATE CHANGE BETWEEN PASTORAL AND AGROPASTORAL HOUSEHOLDS: A CASE STUDY IN YABELLO WOREDA OF OROMIA REGIONAL STATE

BY
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A thesis submitted to the School of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the Degree of Master of Arts in Development Studies

(Environment and Development)

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Title

A Comparative Analysis of Vulnerability to Climate Change Between Pastoral and Agropastoral Households: A Case Study in Yabello Woreda of Oromia Regional State.

By

Abinet Kebede

DEVELOPMENT STUDIES

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Table of Contents

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ACRONYMS

AP	Agropastoralist
CSA	Central Statistical Agency
GHG	Green House Gas
GOs	Governmental Organizations
HHs	Households
IPCC	Intergovernmental Panel on Climate Change
KII	Key Informant Interview
NAPA	National Adaptation Program of Action
NGO	Non- Governmental Organization
NMA	National Metrological Agency
NMSA	National Metrological Service Agency
PAS	Pastoralist
PCA	Principal Component Analysis
STATA	Statistical and Data Analysis Software
TLU	Tropical Livestock Unit
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Program
VI_{HH}	Household Vulnerability Index
VI_{sg}	Social group Vulnerability Index

Glossary

Bonna	The second rain period in the study area. Usually from September to November
Ganna	The main rainy season in the study area. Usually from March to May
Kebele	Lowest administrative unit in Ethiopia
Kolla	Agro climatic zone that lies between 500 and 1500 meters above sea level
Timad	A unit locally used to measure land size (Four timad is equal to one hectare)
Woina Dega	Agro climatic zone that lies between 1500 and 2400 meters above sea level
Woreda	An administrative unit in Ethiopia that is above kebeles and below zone

List of Tables

List of Figures and Boxes

List of Annexes

Abstract

There is now scientific consensus that the global climate is changing. Though, impacts of climate change are not limited spatially and temporally, the vulnerability of regions, countries, social groups and households to effects of climatic variability and shocks are not uniformly distributed. To reduce or fully tackle vulnerability to climate change in a certain community, a locally contextualized understanding and identification of the system's adaptive capacity, exposure and sensitivity play a crucial role.

With this aspect, the study was aimed at measuring and comparing the relative degree of vulnerability by taking the case of agropastoral and pastoral households of Yabello worda in Borena zone of Oramia Regional state. To measure vulnerability, the study adopts the integrated vulnerability approach and used vulnerability indicator methods to determine the level of vulnerability of households and social groups. The indicators include socioeconomic and biophysical variables that show adaptive capacity, exposure and sensitivity of the system.

To indicate the relative vulnerability of households and social groups, vulnerability index was constructed using systematic combinations of the indicator variables. A statistical method, principal component analysis (PCA), was used to determine the relative weight of the indicator variables in constructing the index. Then household vulnerability index (VI_{HH}) and social group vulnerability index (VI_{sg}) were calculated for the pastoral and agropastoral households of the study subjects using primary data generated through household survey. Information gathered from in-depth case studies, KII and secondary sources were used to triangulate the quantitative results.

The VI_{HH} result showed half of sample households have a VI_{HH} value less than 0, which implies the net effect of households' adaptive capacity to be less than their sensitivity and exposure. These groups of households were classified as 'highly vulnerable' to impacts of climate change. Analysis of VI_{HH} by households' economic activity indicates, from households that are classed as 'highly vulnerable' the agropastoralists take the upper hand and constitute 60.53% of the class. This implies the relatively higher vulnerability of agropastoralist households in the study area. The comparison of VI_{sg} score of agropastoralists' (0.003) with that of pastoralists' (0.035) indicate the relatively lesser vulnerability of the pastoral social group. Holding exposure and sensitivity constant, this implies a relatively higher resilience of the pastoral livelihood system to climatic shocks and variability's in the study area.

The reasons for higher vulnerability of agropastoralists in the study area include; lower economic status of members of the group, less experience of farming practice, and low application of modern inputs and new techniques of production. In addition to these higher exposure (erratic rainfall conditions) of the area makes rainfed agriculture highly risky venture and hence, aggravated the relative vulnerability of the group.

Chapter One

1. Introduction

1.1. Background

The issue of climate change has become one of the hottest and debatable agenda for both developed and developing countries in these days. It has been presented as a global issue resulting from an increase in greenhouse gas emissions linked to human activities (O'Brien and Leichenko, 2005). The problem is recognized as one of the most serious global challenges of the 21st century with multiple effects on basic human support systems such as agriculture (crop and livestock production), forests, water resources, and the ecosystem (Aklilu and Alebachew, 2009).

Although the impacts of climate change are not limited spatially and temporally, it has become a common knowledge that the poor are likely to be hit hardest by climate change, and that capacity to respond to climate change is lowest in developing countries and among the poorest people in those countries. It seems clear that vulnerability to climate change is closely related to poverty, as the poor are least able to respond to climatic stimuli. Furthermore, certain regions of the world are more severely affected by the effects of climate change than others (Olmos, 2001).

Recent evidence and predictions indicate that climate changes are accelerating and will lead to wide-ranging shifts in climate variables. There will be changes in the mean and variance of rainfall and temperature, extreme weather events, food and agriculture production and prices, water availability and access, nutrition and health status. The most adverse impacts are predicted in the developing world because of geographic exposure, reliance on climate sensitive sectors, low incomes, and weak adaptive capacity (IPCC, 2007 ; Heltberg *et al.*, 2009).

Though, vulnerability represents the interface between exposure to the physical threats to human well-being and the capacity of people and communities to cope with those threats, the ability of people and societies to adapt to and cope with change is very varied.

Developing countries, particularly the least developed, have less capacity to adapt to change and are more vulnerable to environmental threats and global change, just as they are more vulnerable to other stresses. This condition is most extreme among the poorest people (IPCC, 2001) and disadvantaged groups such as women and children.

The level of vulnerability of different social groups to climate change is determined by both socioeconomic and environmental factors. The socioeconomic factors most cited in the literature include the level of technological development, infrastructure, institutions, and political setups (Kelly and Adger, 2000; McCarthy *et al.*, 2001). The environmental attributes mainly include climatic conditions, quality of soil, and availability of water for irrigation (Canadian International Development Agency [CIDA] 2003; O'Brien *et al.*, 2004). The variations of these socioeconomic and environmental factors across different social groups are responsible for the differences in their levels of vulnerability to climate change.

Climatic predictions indicate that average temperature will continue to increase and there will be change in the pattern of rainfall. Extreme weather events (hurricanes, storms, flooding, drought, heat waves) are likely to become more common (i.e. increased frequency) more widespread spatially and of increased severity (Heltberg *et al*, 2009).These changes in the mean climate have brought direct negative impacts on livelihood assets, health, food and water security. Increased pressure on local coping strategies, social protection measures and the ability to recover from shocks in many instances have led to resource degradation and scarcity, social tension and conflicts (Aklilu and Alebachew, 2009).

According to IPCC (2001) a nation's adaptive capacity is highly dependent on its; stable and prosperous economy, high degree of access to technology at all levels, well delineated roles and responsibilities for implementation of adaptive strategies, systems in place for the national, regional and an equitable distribution of access to resources. But less developing countries do not have the economic status or the institutional arrangement that meet these criteria's, which explains their low adaptive capacity. Accordingly, Africa

is the most vulnerable region to climate change as a result of the low adaptive capacity of the African population. This low capacity is due to the extreme poverty of many Africans, frequent natural disasters such as drought and floods and agriculture heavily dependent on rainfall (Huq *et al.*, 2003).

The most vulnerable households are those with assets and livelihoods exposed and sensitive to climatic risks and who have weak risk management capacity. While all households are exposed to risks associated with climate change and could potentially be rendered vulnerable, the poorer households are the most at risk. This is because their assets and livelihoods tend to be highly exposed and sensitive to the direct and indirect risks associated with climate change, and because they lack access to formal and informal risk management arrangements. People that depend on agriculture (especially rainfed), livestock, and fisheries would be at risk. Within households, impacts will sometimes fall disproportionately on vulnerable individuals such as children, women, elderly, and disabled (Heltber *et al.*, 2009).

Climate change may have far reaching implication to Ethiopia for various reasons. Its economy mainly depends on agriculture which is very sensitive to climate variations. A large part of the country is arid and semi arid and highly prone to desertification and drought. It has also fragile highland ecosystem, which is currently under stress due to population pressure. Forest, water and biodiversity resources of the country are also climate sensitive. Vector born diseases such as malaria also affect Ethiopia, which are closely associated with climate variations. Climate change is, therefore, a case for concern (NMSA, 2001).

1.2. Statement of the problem

Pastoralism is the key agricultural production system in the dry lands. As dry lands constitute nearly half of the land area of Sub Saharan Africa, pastoralism/agropastoralism is of particular importance for the continent. Dry lands are defined by UNCCD (1994) as arid, semi arid or dry sub humid areas, in which the ratio of mean annual precipitation to

mean annual potential evapotranspiration lies between 0.05 to 0.65. They cover about 40% of the world's land surface and 54% of the world's productive land. A characteristic feature of the dry land is the low but highly variable rainfall (inter annual coefficient of variation of 25 to 35 percent)(Rass, 2006:p7).

Pastoralism is uniquely well adapted to dry land environments. As an economic and social system, it operates effectively in low and highly variable rainfall conditions. However, in Ethiopia pastoralist/ agropastoralist livelihoods systems are becoming increasingly vulnerable. The losses of productive assets and increasing household food insecurity due to drought have become defining features of lowland poverty in Ethiopia. Human populations are rising, the climate is changing and international markets are setting ever higher barriers for access. Infrastructure is poorly developed, education and literacy levels remain very low and competition for scarce resources is increasing (Pantuliano and Wekesa, 2008).

The simple relationship which used to exist between the social and natural environment in the lowland areas has become complicated due to the enhanced demands (arising from high population growth) and reduced supplies (depletion of the natural resource bases). As the intensification of hazards was taking place gradually in the past, people had adequate time to adapt to the new circumstances. Since recently, however, the pace of those changes has gained momentum and the adaptation mechanisms of the past have become obsolete or inadequate. Most of these hazard factors are attributed to global warming, for which the poor have a negligible input. The problem is further complicated due to extreme poverty, resource degradation and disruption of local coping mechanisms. The main climate change impacts are on water resources, food security and agriculture, natural resources depletion, biodiversity and human health (Aklilu and Alebachew, 2009:p4).

Ethiopia has different agro-ecological zones, diverse culture and different livelihood strategies that are mainly dependent on the natural resource bases, which is believed to increase its exposure to effects of climate change. Despite such crude explanation,

exhaustive research based analysis that measures vulnerability of different sectors and livelihood system at regional, district or household level are not well undertaken. If the attempts to increase the adaptive capacity are not supported through such empirically researched facts, then the success of different intervention mechanisms that are undertaken to reduce vulnerability to effects of climate change would become minimal.

Identifying the level of vulnerability of the different social groups in the woreda enables to identify the most resilient livelihood strategy that suit with the changing conditions of climate. Moreover, it assists to determine infrastructural and investment activities that increase the adaptive capacity of the area.

1.3. Objective of the Study

The General Objective is

> To measure and compare the vulnerability of agropastoral and pastoral households in Yabello *woreda* to the effects of climate change.

The Specific objectives are to:

- Assess the variables that affect household vulnerability
- Compare the relative vulnerability between agropastoral and pastoral households by constructing household and social group vulnerability indicator index
- Discuss factors that aggravate higher vulnerability of the specific social group

1.4. Significance of the study

In relation with the increased variability of climatic variables, vulnerability of areas associated with climatic variability and shocks has become a common phenomenon in now days. Despite wide distribution of the problem its consequences vary from place to place and community to community. Hence, to reduce or fully tackle impacts of climate change in a certain community, a locally contextualized understanding and identification of the system's adaptive capacity, exposure and sensitivity play a crucial role.

In this aspect the paper has assessed and identified variables that affect household vulnerability in the study area. By using a systematically constructed vulnerability index, the study has identified the relatively more vulnerable social group in the study area. This will be an important input for local authorities in designing and implementation of appropriate adaptive mechanisms that suit the area. Moreover it helps implementing agencies and development partners in designing strategies and intervention mechanisms that are tailored with actual environmental, ecological and economic context of the *woreda* specifically and Borena zone in general. Finally it will serve as information source for researchers and academicians that are interested in the thematic area.

1.5. Limitation of the Study

To determine the degree of vulnerability of the study subjects, vulnerability index was calculated through a systematic combination of selected variables that indicate adaptive capacity, exposure and sensitivity. Since there is no objective decision criterion in the selection of these variables the researcher select the indicator variables based on review of literature and context of the study population, hence, the value of the index becomes too subjective.

The other point is lack of cutoff values that specify degree of vulnerability in objective terms so that after calculating the vulnerability index for each household's objective categorization of households into different classes of vulnerability was not possible.

Therefore, to overcome the problem the researcher has identified three distinct relative categories of vulnerability based on the findings.

To determine household adaptive capacity wealth has been taken as one of the major indicator components. Livestock possession is the main wealth status indicator in the area, hence, the questionnaire was designed in such a way that to capture both the number and type of animals a household owns. But in the study area revealing the exact number of animals is considered as taboo and was not acceptable by the respondents. Though, efforts were made to convince the respondents by specifying the purpose of the study, what has been achieved do not reveal the exact situations. The researcher believes it is unethical and wrong making conclusions based such unreliable data and, therefore, household wealth ranking and classification were not undertaken.

1.6. Organization of the paper

The remaining part of the study is presented in 6 chapters. Chapter two gives a brief review of definitions, concepts and methodological approaches of vulnerability analysis. It also contains the conceptual frame work of the study.

Chapter three describes the geographic location and the economic activities of the study area. The fourth chapter sets the research design and process employed in the study. Model variables definition and specification is also found in this section.

Chapter five and six present the findings of the study. Chapter five discusses demographic and socioeconomic characters of the study population. In addition to these it gives the assessment of determinants of vulnerability across pastoral and agropastoral households. Results of vulnerability indices and discussion are made in chapter six. Finally, chapter seven gives conclusion and recommendation of the study.

Chapter Two

2. Review of Literature

2.1. Definitions and Concepts

2.1.1. Definitions of vulnerability

Different academicians from different disciplines have defined the term vulnerability in their own ways and it has different understanding across these disciplines. Hiddinott and Quisumbing (2003) explain this situation by saying 'vulnerability – like risk and love- means different things to different people; there are many definitions of vulnerability, and seemingly, no consensus on its definition or measurement'.

The following box adopted from cutter (1996: p531-532) gives summary of selected definitions of vulnerability from different perspectives.

Box 2.1 Some selected definitions of vulnerability

Timmerman (1981)

Vulnerability is the degree to which a system acts adversely to the occurrence of a hazardous event. The degree and quality of adverse reaction are conditioned by a system's resilience (a measure of the systems capacity to absorb and recover from the event).

UNDRO (1982)

Vulnerability is the degree of loss to a given element or set of elements at risk resulting from the occurrence of a natural phenomenon of a given magnitude.

Susman et al. (1984)

Vulnerability is the degree to which different classes of society are differentially at risk.

Liverman (1990)

Distinguishes between vulnerability as a biophysical and vulnerability as defined by political, social and economic conditions of society. She argues for vulnerability in geographic space (where vulnerable people and places are located) and vulnerability in social space (who in that place is vulnerable).

Box 2.1. Continued…

Downing (1991)

Vulnerability has three connotations: it refers to a consequence (e.g., famine) rather than a cause (e.g., drought); it implies an adverse consequence (e.g., maize yields are sensitive to drought; households are vulnerable to hunger); and it is a relative term that differentiates among socioeconomic groups or regions, rather than an absolute measure of deprivation.

Dow (1991)

Vulnerability is the differential capacity of groups and individuals to deal with hazards, based on their positions within physical and social worlds.

Cutter (1993)

Vulnerability is the likelihood that an individual or group will be exposed and adversely affected by a hazard. It is the interaction of hazards of place (risk and mitigation) with the social profile of communities.

Blaikie et al. (1994)

By vulnerability we mean the characterstics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of natural hazard. It involves a combination of factors that determine the degree to which someone's life and livelihood are put at risk by a discrete and identifiable event in nature or in society.

Bohle et al. (1994)

Vulnerability is best defined as an aggregate measure of human welfare that integrates environmental, social economic and political exposure to a range of potential harmful perturbations. Vulnerability is a multilayered and multidimensional social space defined by the determinate, political, economic and institutional capabilities of people in specific places at specific times.

Dow and Downing (1995)

Vulnerability is the differential susceptibility of circumstances contributing to vulnerability. Biophysical, demographic, economic, social and technological factors such as population ages, economic dependency, racism and age of infrastructure are some factors which have been examined in association with natural hazards.

*Adger (1999)**

Social vulnerability to climate change is the exposure of groups or individuals to stress as a result of the impacts of climate change and related climate extremes

*IPCC (2001)**

Vulnerability is the degree to which a system is susceptible or unable to cope with adverse effects of climate change including climate variability and extremes. 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.

Source: Cutter, 1996

** These are included by the researcher*

From the summary we learn that to talk about vulnerability meaningfully, it is essential to stress about a specified system to a specified hazard or range of hazards (Brooks, 2003; Fussel, 2007). Hazard being referring to physical manifestation of climatic variability or change such as drought, floods, storms, episodes of heavy rainfall, long term changes in the mean values of climatic variables, potential shifts in climatic regimes and so on (Brooks, 2003).

Fussel and Klein (2006) assume the conceptual ambiguities to rise in relation with the way it handles the following functions:

I. Whether vulnerability is the starting point, an intermediate element, or the out come of an assessment.
II. Weather it should be defined in relation to an external stressor such as climate change, or in relation to an undesirable outcome such as famine;
III. Weather it is an inherent property of a system or contingent up on a specific scenario of external stress and internal responses.
IV. Weather it is a static or dynamic concept.

Vulnerability is a concept that is widely used in natural hazards, food security and climate change communities. Yet there are diverse definitions and interpretations (Fussel and Klein, 2006; Eriksen and O'Brien, 2007). In general, it refers to the likelihood of injury, death, loss, disruption of livelihoods or other harm as the result of initial shocks, such as floods, earth quakes or other hazards, or economic restructuring. Vulnerability to climate variability and change is closely related to the dynamic social, economic, political, institutional, technological and environmental conditions that characterize a particular context and contribute to negative outcomes (Kelly and Adger, 2000).

Reviews of the interpretations of 'vulnerability' in climate change research have generally identified two different vulnerability concepts; the 'end-point' interpretation and a 'starting-point' interpretation of vulnerability (Fussel, 2007: p163). For the purpose of this study the researcher adopt the 'end-point' interpretation which represents

vulnerability as the expected net impacts of a certain level of climate change, taking into account feasible adaptations. This is selected because it is highly relevant in the context of mitigation and compensation policy, for prioritization of assistance and adaptation techniques (Fussel, 2007: p163) which are the end goals of the study.

2.1.2. Definitions of Pastoralist/Agropastoralist Households

For the purpose of this study, definitions of pastoralist and agro-pastoralist were adopted from the definition given by Swift (1988). Accordingly, pastoral households are defined as households that obtain more than 50 percent of their total gross income (i.e. including the value of own produce consumed within the household) from mobile livestock rearing on unimproved, communal pastures. Whereas agropastoralists are defined as households which obtain more than 25 percent but less than 50 percent of their gross incomes from livestock on communal grazing land and more than 50 percent from cropping activities (Swift, 1988 cited by Rass; 2006: p7).

2.1.3 Definition of Climate Change

Climate change in Intergovernmental Panel on Climate Change (IPCC) usage refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 2007).

2.2 Conceptual Approaches to Vulnerability Analysis

Three main models for conceptualizing and assessing vulnerability can be distinguished (Fussel and Klein 2006, Deressa *et al.*, 2008). These are the biophysical, socioeconomic and the integrated assessment approaches.

2.2.1. Biophysical Approach

Biophysical approach is concerned with the climate impacts of a hazard event, and is often viewed in terms of the amount of damage experienced by a system as a result of an encounter with a hazard. In this approach venerability is measured by indicators such as monetary cost, human mortality, production cost or ecosystem damage (Brooks, 2003: p4). This approach is also known as risk-hazard framework (Cutter, 1996; Fussel and Klein,2006; Cutter *et al.*, 2009) is characterized by a focus on the distribution of some hazardous condition, the human occupancy of this hazardous zone (e.g. Flood plains, coastal areas, seismic zones) and the degree of loss (life and property) associated with the occurrence of a particular event (flood, hurricane, earthquake) (cutter, 1996: p532). In general this approach conceptualizes vulnerability as the dose-response relationship between an exogenous hazard to a system and its adverse effects (Fussel and Klein, 2006). The risk-hazard researchers, by taking the biophysical threats as a point of departure, set out to describe on a very broad scale (a) to what we are vulnerable, (b) what consequence might be expected, and (c) when and where those impacts may occur (Eakin and Luers, 2006: p369).

The hazards and impacts approach typically views the vulnerability of a human system as determined by the nature of the physical hazard(s), the extent of human exposure to hazard, and the system's sensitivity to the impact of the hazard(s) (Adger *et al.*, 2004:p30).

A key aspect of the risk-hazard approach is the clear distinction between two factors that determine the risk to a particular system: 'hazard,' which "a potentially damaging physical event, phenomenon or human activity that is characterized by its location, intensity, frequency and probability"; and the 'vulnerability' which denotes the "relationship between the severity of hazard and the degree of damage caused" (Fussel, 2007:p160).

In this approach vulnerability is measured by indicators such as monetary cost, human mortality, production cost of ecosystem damage (Brooks, 2003) that is caused by the hazards. The damage is most often estimated by taking forecasts of estimates from climate prediction models or by creating indicators of sensitivity by identifying potential or actual hazards and their frequency (Deressa *et al.,* 2008).

The limitation of the biophysical approach according to Deressa *et al.* (2008) is that it focuses mainly on physical damages, such as on yield, income and so on. This type of studies emphasize on the outcomes but not on the root causes, i.e. impact of climate change on total yield productivity rather than the marginal effect of the reduction for different people. In general, the approach focuses on sensitivity (change in yield, income, health) to climate change and misses much of the adaptive capacity of individuals or social groups, which is more explained by their inherent or internal characteristics or by the architecture of entitlements, as suggested by Adger (1999).

2.2.2. Socioeconomic approach

To analyze the vulnerability of social groups or individuals to climate change impacts, this approach gives due attention to socioeconomic and potential status of individuals or social groups (Adger, 1999; Fussel, 2007). Individuals in a community often vary in terms of education, gender, wealth, health status, access to credit, access to information and technology, formal and informal (social) capital, political power, and therefore these factors are considered responsible for the variability in the levels of vulnerability (Deressa *et al.*, 2008; Smit and Wandel, 2006).

Social vulnerability is determined by factors such as poverty and inequality, marginalization, food entitlements, access to insurance, health, access to resources, and social status (Adger, 1999; Brooks, 2003). It emphasizes the sociopolitical, cultural and economic factors that together explain different exposures to hazards, differential impacts, and, most importantly, differential capacities to recuperate from past impacts and/or to cope and adapt to future threats (Eakin and Luers, 2006).

Here, vulnerability is considered to be a starting or a state (i.e. a variable describing the internal state of a system) that exists within a system before it encounters a hazard event, thus to be constructed by society as a result of institutional and economic changes (Kelly and Adger, 2000; Adger and Kelly, 1999).

According to Brooks (2003: p5) 'social vulnerability' in its broad sense can be used to describe all factors that determine the outcome of a hazard event of a given nature and severity. It 'encompasses all those properties of a system independent of a hazard(s) to which it is exposed that mediate the outcome of a hazard event. This may include environmental variables and measure of exposure. Exposure will depend on where population choose to (or are forced to) live and how they construct their settlements, communities and livelihoods. With respect to environmental variables, as population exploit resources and manage the environment for their benefit in the short or long term, social vulnerability, therefore encompasses elements of the physical environment as they relate to human systems' (Brooks 2003: p5).

The limitation of this approach includes its ignorance of intensity and frequency of hazards. The increased frequency of extremes may lead to the deterioration of once strong social institution and infrastructures. Study by Kebebew *et al.* (2001) has shown that the occurrence of acute and repeated drought to weaken the traditional wealth redistribution schemes of Afar (*Tihatia*) and Borena (*Buusa Gonofa*) pastoralists, which had been a strong social institution in making poor households less vulnerable to drought. The other critique of the model is its failure to address the role of interaction between the social and natural system in the production of the hazard in first place (Cutter *et al.*, 2009).

2.2.3. Integrated assessment approach

In this approach the biophysical and the socioeconomic approaches are combined together to determine vulnerability. Fussel (2007: p161) states 'the risk-hazard approach

and political economy approach have been combined and extended in various integrated approaches'. The hazard of place model (Cutter, 1996; cutter *et al.*, 2000) and vulnerability mapping by O'Brian *et al.* (2004) are good examples in which the biophysical and the socioeconomic factors are combined systematically to show the vulnerability level of different places.

The main limitation of this approach according to Deressa *et al.* (2008:p3) is that 'there is no standard method for combining the biophysical factors (drought, flood) and the socioeconomic data sets (e.g. race, age, education of household) while it is obvious that these data sets have different and yet unknown weights'. The other critique is 'its failure to examine the root causes of the social vulnerability and the failure to include the larger contexts within which such vulnerability exists' (Cutter *et al.*, 2009: p4).

Despite these weaknesses, the approach has much to offer in terms of policy decisions (Dressa *et al.*, 2008: p4) and 'is the most amenable to empirical testing and the use of geo-spatial techniques' (Cutter *et al.,* 2009: p4). Realizing these facts and the objectives, the researcher adopts the approach to make the vulnerability assessment of pastoral and agro-pastoral households in the study area.

2.3. Methods for measuring vulnerability to climate change

Given that vulnerability can exist on different spatial levels and in reference to a wide variety of potential hazards, it is no surprise that there are many ways in which to measure vulnerability (Naude *et al.*, 2009). Various efforts are now underway to measure vulnerability at a level of household, countries and regional and local areas (Naude *et al.*, 2009).

Despite their variety, these methods could be categorized in to two basic groups. Econometric method, that roots in economic literatures, and the Indicator methods (Deressa *et al.*, 2008; Hoddinot and Quisumsing, 2003; Naude *et al.*, 2009).

2.3.1. Econometric method

Tracing back its roots in development economics literatures, the method use household level socioeconomic survey data to analyze the level of vulnerability of different social groups (Deressa *et al.*, 2008). In this method 'there are three principal approaches to assessing vulnerability: vulnerability as expected poverty (VEP), vulnerability as low expected utility (VEU) and vulnerability as uninsured exposure to risk (VER)' (Hoddinott and Quisumbing, 2003). To analyze the vulnerability, all the three approaches use to construct a model that predicts a measure of welfare loss attributed to shocks (Hoddinott and Quisumbing, 2003).

Vulnerability as expected poverty (VEP)

In the expected poverty framework, vulnerability of a person is conceived as the prospect of that person becoming poor in the future, if currently not poor or the prospect of that person continuing to be poor, if currently poor. Thus, vulnerability is seen as expected poverty, and consumption (income) is used as a proxy for well-being. This method is based on estimating the probability that a given shock, or set of shocks, moves consumption below a given minimum level (e.g. consumption poverty line) or forces the consumption level to stay below the given minimum requirement if it is already below that level (chaudhuri *et al.*, 2002; cited in Deressa *et al.*, 2008; p4).

Vulnerability as expected low utility (VEU)

In this approach, vulnerability is define as the difference between the utility derived from some level of certainty equivalent consumption at and above which the household is not considered vulnerable and the expected utility of consumption. In other words, this certainly equivalent consumption is akin to a poverty line (Gaiha and Imai, 2008)

Vulnerability as uninsured exposure to risk (VER)

In the absence of effective risk management tools, such shocks impose welfare less to the extent that they lead to a reduction in consumption (Hoddinott and Quisumbing, 2003). In this sense, it is a consequence of uninsured exposure to risk. VER is designed to assess

expose welfare loss from a negative shock, as opposed to an ex-ante assessment of future poverty in VEP (Gaiha and Imai, 2008).

2.3.2. Indicator method

The indicator method of quantifying vulnerability is based on selecting some indicators from the whole set of potential indicators and then systematically combining the selected indicators to indicate the levels of vulnerability (Deressa *et al.*, 2008). Indicators are quantitative measures intended to represent a characteristics or a parameter of a system of interest using a single value, (Cutter *et al.*, 2009). These indicators could be developed by using different scales of analysis. Examples include at local levels (Adger, 1999; Hein *et al.*,2009; Young *et al.*, 2009;Hahn *et al.*,2009), national (O'Brien *et al.*, 2004; Deressa *et al.*, 2008; Cutter *et al.*, 2003), regional (Leichenko and O'Brien, 2001; Freman *et al.*, 2008; Hamouda *et al.*, 2009) and global (Brooks *et al.*, 2005).

The following table, which is adopted from Deressa *et al.* (2008), shows different indicators of vulnerability and the scales at which they could be used. From the table we learn that, level of education of literacy rate is a household characteristics (HHC) that can be analyzed at household scale (by taking the education level of head of household). The district (D) scale (by taking the average of the education of the head of household in the district), or the national (N) scale (by taking the average for the nation). The references listed in the 4th Columns of table 2.2 are studies that are based on different characteristics at different scales.

Table 2.1. Indicators of proxy variables used in vulnerability analysis

Type of indicator*	Indicator	Scale of Analysis**	References
HHC	Level of education or litracy rate	HH,D,N	Kuhl 2004; Nyong et al. 2003; Paavola 2004; Brooks, Adger, and Kelly 2005; Haan, Farmer, and Wheeler 2001
HHC	Age	HH	Nyong et al. 2003; Kuhl 2004; Haan, Farmer, and Wheeler 2001; Næss et al. 2006
HHC	Labor unit/ consumer unit	HH	Nyong et al. 2003
HHC	Assets, land value, house value (standard)	HH, D	Moser 1998; Nyong et al. 2003; Aandahi and O'Brien 2001
HHC	Household size, female-headed households	HH, D	Nyong et al. 2003; O'Brien et al. 2004; Paavola 2004; Kuhl 2004
HHC	Drinking water source	HH	Aandahi and O'Brien 2001; Paavola 2004
HHC	Household members	HH	Nyong et al. 2003
HHC	Non-farm income, diversity of income sources	HH, D	Nyong et al. 2003; Adger 1996, 1999; Eakin 2002; Ford, Barry, and Wandel 2005; Haan, Farmer, and Wheeler 2001
HHC	Food sufficiency	HH,D,N	Nyong et al. 2003
HHC	Adjustments measures	HH	Ford, Barry, and Wandel 2005
BP	Soil conditions	HH,D,N	O'Brien et al. 2004
BP	Current climate	HH,D,N	O'Brien et al. 2004
BP	Vegetation	D, N	Haan, Farmer, and Wheeler 2001
INST	Social networks (member of group or association)	HH	Ford, Barry and Wandel 2005; Nyong et al. 2003
INST	Institutional arrangements	D, N	Ford, Barry, and Wandel 2005; O'Brien et al. 2004
FC	Livestock ownership	HH	Paavola 2004
FC	Crop types, cropping systems (monocropping, multiple cropping), fertilizer consumption or input use	HH	Bantilan and Anupama 2002; Aandahi and O'Brien 2001
FC	Irrigation rate, irrigation source	HH, D	Aandahi and O'Brien 2001; O'Brien et al. 2004
BP	Drought and flood-prone areas	D, N	CIDA 2003; O'Brien et al. 2004
ECO	Income level	HH	Adger 1996; Haan, Farmer, and Wheeler 2001
ECO	Percentage of households below poverty line	D	Aandahi and O'Brien 2001; Adger 1996
ECO	Food expenditure	HH	Paavola 2004
ECO	Infrastructure	HH,N,D	O'Brien et al. 2004; Haan, Farmer, and Wheeler 2001

Source: Adopted from Deressa et al., 2008

*Type of indicator: HHC = household characteristic, INST = institutional, FC = farm characteristic, BP = biophysical, ECO= economy

**Scale of analysis: HH = household, D = district, N = national

The main weakness of this approach is that 'while there is considerable research and policy interest in the development of vulnerability indicator and indices, especially in the area of climate change, general agreement on measuring vulnerability (data, variables and indices construction) remain elusive' (Cutter *et al.*, 2009). The methodologies and indicators adopted by the following literatures might be a good indicator of this fact.

The livelihood vulnerability index (LVI) developed by Hahn *et al.* (2009), for example used several indicators to assess the impacts of climate change and variability among individuals residing in two districts of Mozambique. They use primary data from household survey which has the following seven major components: socio-demographic characters, livelihood strategies, social networks, health, food, water and natural disaster and climate variability each is also composed of several subcomponents. They use equal weights across these indicators to determine the vulnerability index of the place.

In their assessment of water resource systems vulnerability in eastern Nile basin countries, Hamouda *et al.* (2009) used the graphical indicator presentation methods to elaborate the differences and peculiarities of the status of vulnerability in eastern Nile basin countries by using 31 indicator variables that are grouped in 5 major indicator categories.

In this thesis to analyze the vulnerability of pastoral and agropastoral households the indicator method is used. By identifying common variables that can explain the livelihood of the two groups, a vulnerability index is calculated to identify the relatively higher vulnerable social group or households.

2.4. Conceptual Framework of the Study

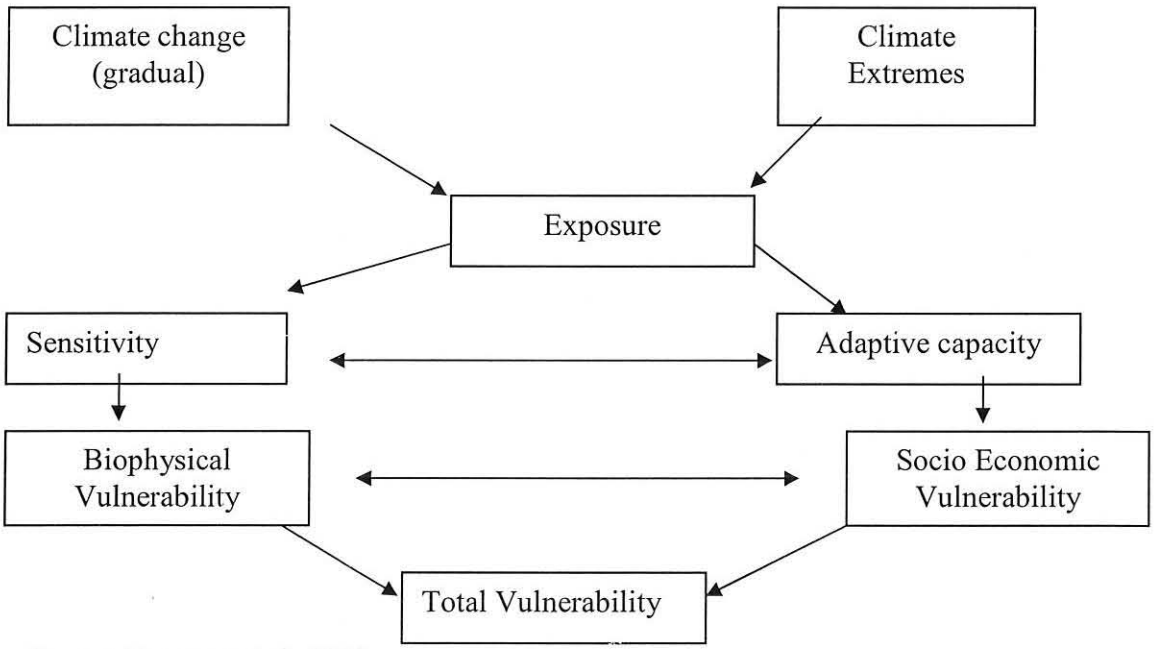
The study adopts the IPCC (2001) definition of vulnerability to analyze the vulnerability of pastoral and agropastoral households in Yabello *woreda* of Oromia regional State. IPCC defines vulnerability as "the degree to which a system is susceptible or unable to cope with adverse effects of climate 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" (IPCC, 2001: p995).

The study is based on the integrated vulnerability assessment approach since the IPCC definition accommodates the concept of both biophysical and the socio economic indicators in assessing the vulnerability (Deressa *et al.*, 2008).

The *woreda* is exposed to both gradual climate change (temperature and precipitation) and extreme climate conditions (drought). Exposure affects sensitivity, which means that exposure to higher frequencies and intensities of climate risk highly affects the outcome. Exposure is linked to adaptive capacity in such a way that higher adaptive capacity reduces the potential damage from higher exposure. Sensitivity and adaptive capacity are also linked. Given a fixed level of exposure, the adaptive capacity influences the level of sensitivity. In other words higher adaptive capacity (socio economic vulnerability) results in lower sensitivity (biophysical vulnerability) and vice versa. Therefore, sensitivity and adaptive capacity add up to total vulnerability.

Figure 2.1. Shows the conceptual frameworks of vulnerability for the study



Source: Derressa et al., 2008.

2.5. Global trends of climate change

There is now scientific consensus that the global climate is changing. The temperature increase is widespread over the globe; the increase in sea level, decrease in snow and ice extents are observed changes that are consistent with warming. At continental, regional and ocean basin scales, numerous long term changes in other aspects of climate have also been observed. For instance trends of precipitation amount from1900-2005 have been observed in many large regions, and the result indicates precipitation increased significantly in eastern parts of north and South America, Northern Europe and northern and central Asia whereas precipitation declined in the Sahel, the Mediterranean, southern Africa and parts of southern Asia. Globally, the area affected by drought has likely increased since the 1970's (IPPC, 2007: p30).

Climate change is expected to increase the frequency and magnitude of many types of extreme events, including floods, drought, tropical cyclones and wild fires. The review of these events over the last 50 years indicates that:

- It is very likely that cold days, cold nights and frosts have become less frequent over the most land areas, while hot days, hot nights have become more frequent.
- It is likely that the frequency of heavy precipitation events (or proportion of total rainfall from heavy falls) has increased over most areas.
- It is likely that the heat waves have become more frequent over most land areas.
- It is likely that the incidence of extreme high sea level has increased at a broad range of sites world wide since1975 (IPCC, 2007: p30).

From these statements we understand that vulnerability of places from extreme climatic conditions increases through time unless we identify the causing factors of the changes, and try to manage their effects. The following section discusses the causes of climate change.

2.6. Causes of climate change

Changes in the atmospheric concentration of green house gas (GHG) and aerosols, land cover and solar radiation alter the energy balance of the climate system and are drivers of climate change. They affect the absorption, scattering and emission of radiation within the atmosphere and at the earth's surface (IPCC, 2007).

Under natural conditions climate change occurs as a result of internal variability within the climate system due to natural, geologic, hydrologic atmospheric and biotic factors. Nevertheless, anthropogenic factors could disturb the normal climate phenomena and cause sever climate anomalies with drastic impacts on people, economies and ecosystems. Scientific and empirical evidences clearly indicate human activities to be the main contributors of the currently prevailing global climate change (IPCC, 2007).

Human activities result in emission of four long lived GHG. Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O) and halocarbons (a group of gasses containing fluorine, chlorine or bromine). Atmospheric concentration of GHGs increases when emissions are larger than removal process (IPCC, 2007: p37).

Population growth and economic expansion have intensified the pressure on the global climate system through industrialization, increased use of fossil fuels, transport development and land use /cover changes. Subsequently, these have led to the release of a considerably amount of greenhouse gases into the atmosphere. Such increase in the level of greenhouse gas emissions is likely to change the yearly average values and annual patterns of temperature and rainfall around the globe (Aklilu and Alebachew, 2009).

2.7. Impacts of climate change

Recent evidences and predictions indicate that climate change are accelerating and will lead to wide ranging shifts in climate variables. There will be changes in the mean and variance of rainfall and temperature, extreme weather events, food and agriculture

production and prices, water availability and access, nutrition and health status. The most adverse impacts are predicted in developing world because of geographic exposure, reliance on climate sensitive sectors, low incomes and weak adaptive capacity (IPCC, 2007; Heltberg *et al.*, 2009; Huq *et al.*, 2003; Aklilu and Alebachew, 2009).

Impacts on Agriculture and Food production

Agriculture, which is the major source of livelihood for millions of people in developing world, is one of the major susceptible sectors for effects of climate change. Changes in the normal pattern of climate affects agricultural production (crops and livestock) by reducing the length of growing periods and forcing marginal areas out of production (Aklilu and Alebachew, 2009). According to IPCC (2007), on seasonally dry and tropical regions a small increase in local temperature (1 to 2°c) to have a reduction effect on crop productivity, and as a result, the risk of hunger is expected to increase. Similar report indicates some African countries to face up to 50% yield reduction from rain fed agriculture by 2020.

Impacts on water resources

Climate change is expected to exacerbate current stress on water resources from population growth and economic and land-use change, including urbanization. Wide spread mass losses from glaciers and reductions in snow cover over recent decades are projected to accelerate throughout the 21st century, reducing water availability, hydropower potential, and changing seasonality of flows in regions supplied by melt water from major mountain ranges, where more than one sixth of the world population currently lives. Changes in precipitation and temperature lead to changes in runoff and water availability. Semiarid and dry regions will suffer a decrease in water resources due to decrease in rainfall and higher rates of evaporation. On the other hand, at higher latitudes and some wet tropical areas flood risks are expected to increase due to heavy rainfall events in the regions. Increased temperatures will affect the physical, chemical and biological properties of fresh water lakes and rivers, with predominantly adverse impacts on many individual freshwater species, community composition and water

quality. In general, increases in temperature, frequency and severity of floods and droughts are projected to adversely affect sustainable development (IPCC, 2007: p49).

Impacts on natural resources

Climate change causes degradation and loss of important natural resources and ecosystem. Resources like soils, rangelands, forests and wetlands are highly susceptible to the effects of climate change. Climate change affects biodiversity by influencing species distribution, composition and function directly and indirectly (Aklilu and Alebachew, 2009). Variability in the spatial and temporal patterns of temperature and rainfall will affect the productivity of forest species, and thus increase vulnerability of the populations that are dependent on these resources for their subsistence. Besides, natural reserves will become less effective as the vegetation and animal species that they seek to protect will no longer be in their preferred bioclimatic region. The migration of animals will be constrained by ecosystem fragmentation and the potential hostility of certain land escapes (Huq *et al.*, 2003; IPCC 2001). According to IPCC (2007), if a global average temperature increase exceeds from 1.5 to 2.5 ^{o}C, then approximately 20 to 30% of plant and animal species will be subjected to the risk of extinction.

Impacts on Health

Frequent occurrence of weather extremes (floods, cyclones, droughts) increase associated injuries and deaths of human beings and livestock. Climate change jeopardized the health status of millions of people by aggravating malnutrition and expansion of infectious diseases (IPCC 2007). The outbreaks of diseases such as malaria, dengue fever, meningitis and cholera among others have high correlation with climate variability and change. In association with higher concentration of ground level ozone, the frequency of cardio-respiratory diseases has increased in urban areas.

2.8. Empirical Review

Despite the complex concepts of vulnerability and various methodological and conceptual approaches over the past decades, several authors have been comparing and

ranking vulnerability across regions, countries and populations, with the objective of aiding government bodies and other organizations in allocation of resources for vulnerability reduction (Eakin and Luers, 2006). Among these researches some of them are reviewed as follows.

To analyze the potential local economic impacts of climate change in 'Ferlo' in western Sahel (Hein *et al.*, 2009) construct a model, that bases on long term time series data of range land productivity and livestock prices under different rainfall conditions. The model follows a social planner approach, calculating impacts of climate change to the pastoralist society as a whole. The model illustrates how changes in annual rainfall in combination with changes in rainfall variability affect the optimal livestock stocking density, as well as the stocking density that can be expected under open access condition. The model has been run for 30 years period for seven different scenarios and the result presented in the form of profit functions. Some of the scenarios highlight that, in case of a rainfall decrease by 15%, the optimal stocking density is reduced from 0.1 to 0.08 Tropical livestock unit (TLU) per hectare. If rainfall decreases with 30%, the optimal stocking density is further reduced to 0.06 TLU per hectare. The corresponding maximum profits the pastoralist can obtain reduced to 330 and 165 West African franc per hectare per year. The model show that a 15% decrease in rainfall combined with a 20% variability of rainfall to lead for a 15% reduction in the open access stocking density. In moment like this, provided that there is no alternative source of income in the area, significant part of population is expected to move out of the area.

To estimate the risks from climate variability and change Hahn *et al.* (2009) developed the livelihood vulnerability index (LVI) and used it to indicate the vulnerability levels of two districts found in Mozambique. The method uses multiple indicators, to assess exposure to natural disasters and climate variability, social and economic characteristics of households that affect their adaptive capacity, and current health, food and water resource characteristics that determine their sensitivity to climate change impacts. Two approaches were presented: the first expresses the LVI as a composite index comprised of seven major components while the second aggregates the seven into IPCC's three

contributing factors to vulnerability:- exposure, sensitivity and adaptive capacity. To construct the index they used primary data from household survey. The LVI used seven major components that are also comprised of several indicators or subcomponents. To overcome the problem of difference in scale of measurement, they made standardization of indices and then followed the balanced weighted average approach to arrive at the final overall index level.

The second method, LVI-IPCC, incorporates the IPCC's vulnerability definition. Exposure of the study population is measured by the number of natural disasters, and average standard deviation of the maximum and minimum monthly temperature and monthly precipitations over the past six years were considered. Sensitivity was measured by assessing the current state of districts food and water security and health status. Adaptive capacity is quantified by demographic profile of the districts and the strength of social networks.

The LVI values for the two districts shows 'Moma' to be more vulnerable in health and water structures than 'Mabote' by scoring 0.317 and 0.370 while the vulnerability level in 'Mabote' is 0.241 and 0.099 respectively for the two indicators out of the seven. The overall calculation shows 'Mabote' had a higher LVI than 'Moma' (0.326 versus 0.316 respectively), indicating relatively greater vulnerability to climate change impacts. The socio demographic profile and natural disaster and climate variability contribute a lot for vulnerability of Mabote. The LVI-IPCC analysis yields similar results i.e. Mabote households to be more vulnerable than Moma households (0.005 versus -0.074 respectively). The main explanations are Mabote's exposure (0.409) to climate change impacts compared with Moma (0.312) is higher, and Mabote's adaptive capacity (0.388) is weaker compared to Moma's (0.522).

Cutter *et al.*(2003) construct an index of social vulnerability to environmental hazards, called the social vulnerability index (SoVI) for 3,141 united states (US) counties using country level socioeconomic and demographic data.

About 42 variables were identified to characterize the broader dimension of social vulnerability. Through further manipulation of the data 11 factors which explained 76.4% of the variance among all counties identified. Then these factor scores were added to the original county file as the composite SoVI score for each county. Here every factor was given equal weight assuming to have equal contribution to the county's overall vulnerability.

The finding shows that the vast majority of US counties exhibited moderate levels of social vulnerability. The SoVI ranges from -9.6 (low social vulnerability) to 49.51 (high social vulnerability) with mean variability score of 1.54 (SD = 3.38) for all US counties. 393 counties (12.5% of the total) were classified in the most vulnerable category and are located in southern half of the nation stretching from south Florida to California. The explanations for these are greater ethnic and racial inequalities, rapid population growth and socially dependent populations (those in poverty and lacking in education).

Counties labeled as the least vulnerable are clustered in New England, along the eastern slopes of the Appalachian Mountains from Virginia to North Carolina, and the great lakes states. The common features of these counties; sub urban, wealthy, white and highly educated characteristics had lowered the level of social vulnerability.

Hamouda *et al.* (2009) while assessing vulnerability of water resources system in Eastern Nile Basin countries, they focused on using internationally recognized indicators and indices that can provide an insight about the situation in the region in a concise and illustrative fashion. Based on their framework, they listed 31 indicators which are classified in five main categories. After calculating the specific values for these indicators, it was compared with a threshold value indicator to assess the vulnerability of water systems of the region.

They applied simple mathematical operation to calculate the indicator values and the subsequent aggregation of these sub-indices into an overall index. Finally they used the graphical display method (radar diagrams) to present the results. The finding shows

vulnerability of water resources to be highest in Sudan, followed by Ethiopia and then Egypt. In Sudan, out of the total 31 indicators 22 have surpassed the threshold levels. In Ethiopia 19 and in Egypt 16 indicators has surpassed the threshold levels.

The vulnerability in Egypt stems mainly from hydrophysical factors; most of the country's territory is under water stress and is located in arid areas. The higher stress in available water resources are due to increases in total withdrawals. In Sudan and Ethiopia the vulnerability is directly related to poverty and underdevelopment. In Sudan low institutional and political instability and infrastructure arrangement are critical factors while in Ethiopia high population pressure and low health and infrastructure coverage contribute a lot to the vulnerability. In Ethiopia and Sudan higher stress on available water resources is associated with water mal distribution and quality deterioration.

Brooks *et al.* (2005) present a set of indicators of vulnerability and capacity to adapt to climate variability and change using empirical analysis of data aggregated at the national level across 205 countries. Their purpose was to develop indicators of vulnerability to a range of climate hazards at a national level specifically by addressing vulnerability to mortality resulting from exposure to climate hazards for decadal periods. In the process they identified 11 key indicators that exhibit a strong relationship with decadal aggregated mortality associated with climate related hazards.

To increase the validation of the indicator and overcome the problem of relative weightings among the selected indicators, they present different set of weightings through experiment judgment data based on focus group exercise. Including the equal weight method they come up with 13 alternative composite indices at country level. Since individual country ranking was not possible due to the variation in rank across indices a more appropriate method which is based in placing countries in vulnerability categories or quintiles was adopted. Here they divide the ranking into quintiles to produce categories containing equal numbers of countries across all indices. They define vulnerable countries as those that occur in the top quintile in at least one of the composite indices

constructed using the different weighting sets, and the 'most' vulnerable countries as those that occur in the top quintile of 11 or more of the 13 indices.

Based on the classification, 30 countries fall in the most vulnerable category and 29 countries fall in the vulnerable category. From these total of 59 countries, 33 are sub-Saharan African national which reveal the high vulnerability and low adaptive capacity of the African continent to effects of climate variability. 5 were small island states or territories while the remaining were countries that had been experiencing conflict at the period.

Deressa *et al.* (2008) analyzed the vulnerability of Ethiopian farmers to climate change based on the integrated assessment approach using vulnerability indicators methods across seven regional states of Ethiopia. Classification of the different biophysical and socioeconomic indicators into the class of adaptive capacity, sensitivity and exposure was done based on IPCC's definition of vulnerability. They calculate vulnerability as the net effect of adaptive capacity over sensitivity and exposure.They used the principal component analysis method to determine the factor scores or relative weight of the selected indicator and subsequently the vulnerability indictor of each region.

Their findings show the Afar, Somali, Oromia and Tigray regional states to be the most vulnerable regions. The vulnerability of Afar and Somali was associated with low level of regional infrastructure development. The vulnerability of Oromia is associated with a high frequency of drought and flood, lower access to technology, institution and infrastructure. Similarly, the vulnerability of Tigray is attributed to lower access to technology, health service, food market and high frequency of drought and flood. Unlike Afar and Somali the lower access to technology, institutions, and infrastructure in Tigry and Oromia is due to their high population in proportion to what is available.

The southern nations and nationalities region is relatively the least vulnerable and the reasons are; its relatively higher access to technology and food market, its highest irrigation potential and higher literacy rate.

2.9. Vulnerability and Climate Change in Ethiopia

Ethiopia is vulnerable to climate change because of it greater reliance on climate sensitive economic sectors: subsistence crop cultivation and livestock production. Low level of socioeconomic development, inadequate infrastructure, lack of institutional capacity and higher dependency on natural resources base make the country more vulnerable to climatic factors including climate variability and extreme climate events (NMA, 2007: p17).

Ethiopia, being located in the tropics at latitudes of 4° to 15°N and 33° to 48°E, a large part of the country has arid and semiarid climatic condition and hence is highly prone to desertification and drought (NMSA, 2001). It has also fragile highland ecosystems that are currently under stress due to population pressure and associated socioeconomic practices. The country's history is associated, more often than not, with major natural and manmade hazards that have been affecting the population from time to time (NMA, 2007). These hazards have been the main sources of risk and vulnerability in most parts of the country.

Droughts, famine, epidemics and floods are also very common occurrences. In most instances, these disasters are associated with climatic variability and change (Aklilu and Alebachew, 2009). The outcome of these disasters has been loss of crops, destruction of built infrastructure, death of livestock and millions of people, and caused displacement of people. In general by weakening the productivity and functioning of livelihood resources, they aggravate the vulnerability of the people that are dependent on these resources for their livings.

According to the vulnerability assessment undertaken by the national adaptation program of action (NAPA) team, in Ethiopia the most vulnerable sectors to climate variability and change are agriculture, water and human health. In terms of livelihood approach,

smallholder rain-fed farmers and pastoralists are found to be the most vulnerable. The arid, semiarid and the dry subhumid parts of the country are highly prone to drought.

Climate is a key natural resource on which the others depend. It influences food production, water and energy availability. It sets the stage for the establishment of habitats, affects the pace of primary productivity and influences species density and distribution. Ethiopia's climate is mainly controlled by the seasonal migration of the inter- tropical convergence zone (ITCZ) following the position of the sun relative to the earth and the associated atmospheric circulation (NMSA, 2001; McSweeney *et al.*, 2008). It is also highly influenced by the complex topography of the country.

According to the UNDP climate change profile for Ethiopia, the mean annual temperature has increased by 1.3°c between 1960 and 2006 at an average rate of 0.28°c per decade. The report shows the average numbers of 'hot' days and 'hot' nights per year increased to 73 (an additional 20% days) and to 137 (an additional 37.5% of nights) between 1960 and 2003 respectively. During the same period the average number of 'cold' days per year and 'cold' nights per year has been decreased by 21 (5.8% of days) and 41 (11.2% of days) respectively (McSweeney *et al.*, 2008: p2).

Mean annual rainfall ranges from about 2000 mm over some pocket areas in the southwest to about less than 250 mm over the Afar lowlands in the northeast and Ogaden in the southeast. Temperatures are also modified by the varied altitude of the country. Mean annual temperature varies from about 10°c over the high table lands over north west, central and south east to about 35°c over the northeastern edges (NMSA, 2001;p23).

Trend analysis of rainfall shows that rainfall remained more or less constant when averaged over the whole country. This is due to high inter annual and inter decadal rainfall variability (NMA, 2007; NMSA, 2001; McSweeney *et al.*, 2008). Over the last 55 years the country has experienced 11 dry years and 10 wet years that demonstrate the strong inter annual variability (NMA, 2007: p20; Riche *et al.*, 2009: p24).

Climate related hazards in Ethiopia include drought, frost, heat waves (high temperature, lightening etc.) (NMA, 2007). From these extremes occurrence of drought has imposed a key challenge on the development process of the country. Though 'opinions vary on the severity and frequency of drought in the historical past, recent reports show that droughts have increased in frequency and intensity in recent times' and particularly, ' the southern lowlands are extremely vulnerable to drought and there have been notable droughts in this part of the country over the past several decades (Aklilu and Alebachew, 2009: p22).

Chapter Three

3. General Description of the Study Area

3.1. Location

Yabello *Woreda* is located in Borena zone of Oromia Regional State in the southern lowlands of Ethiopia around 565 km from Addis Ababa. It is located at 4°30' N to 5°30'N latitude and 37°45'E to 38°30'E longitudes. The *woreda* is bounded by Teltele, Arero, Dire and Dugdadawa *woredas*' of Borena zone in the west, east, south and north, respectively. The total land area of the *woreda* is estimated to be 555, 000km^2.

3.2. Population

According to the 2007 national housing and population census the total population of the *woreda* is 102, 385 (51,537 males and 50,848 females). The *woreda* is sub divided into three urban and 20 rural *kebeles*. From the total population 84,637 settle in rural *kebeles* and 17,748 reside in the urban centers. The population density of the study area is around 0.18 persons per km^2 (CSA, 2009).

3.3. Climate

The *woreda* is characterized by semi-arid climatic condition and the majority (80%) of the *woreda* belongs to *Kola* agro ecological zone, while the rest 20% belongs to *Woina Dega* category. The altitude of the *woreda* ranges from 1450 meter to 2250 meter above sea level dominated by plain grass land (YWPDB, 2009).

It has a biannual rainfall mode with average rainfall of 300mm/year. *Ganna* (March-May) is the main rainfall season. During this period the *woreda* gets from 500 mm up to 600 mm rainfall per year. *Bonna* (September- November) is the second rainy season where the *woreda* receives showers that account for 100mm/year. The average temperature is 28°C where the maximum and the minimum temperature levels are 37°C and 14°C respectively (YWPDB, 2009).

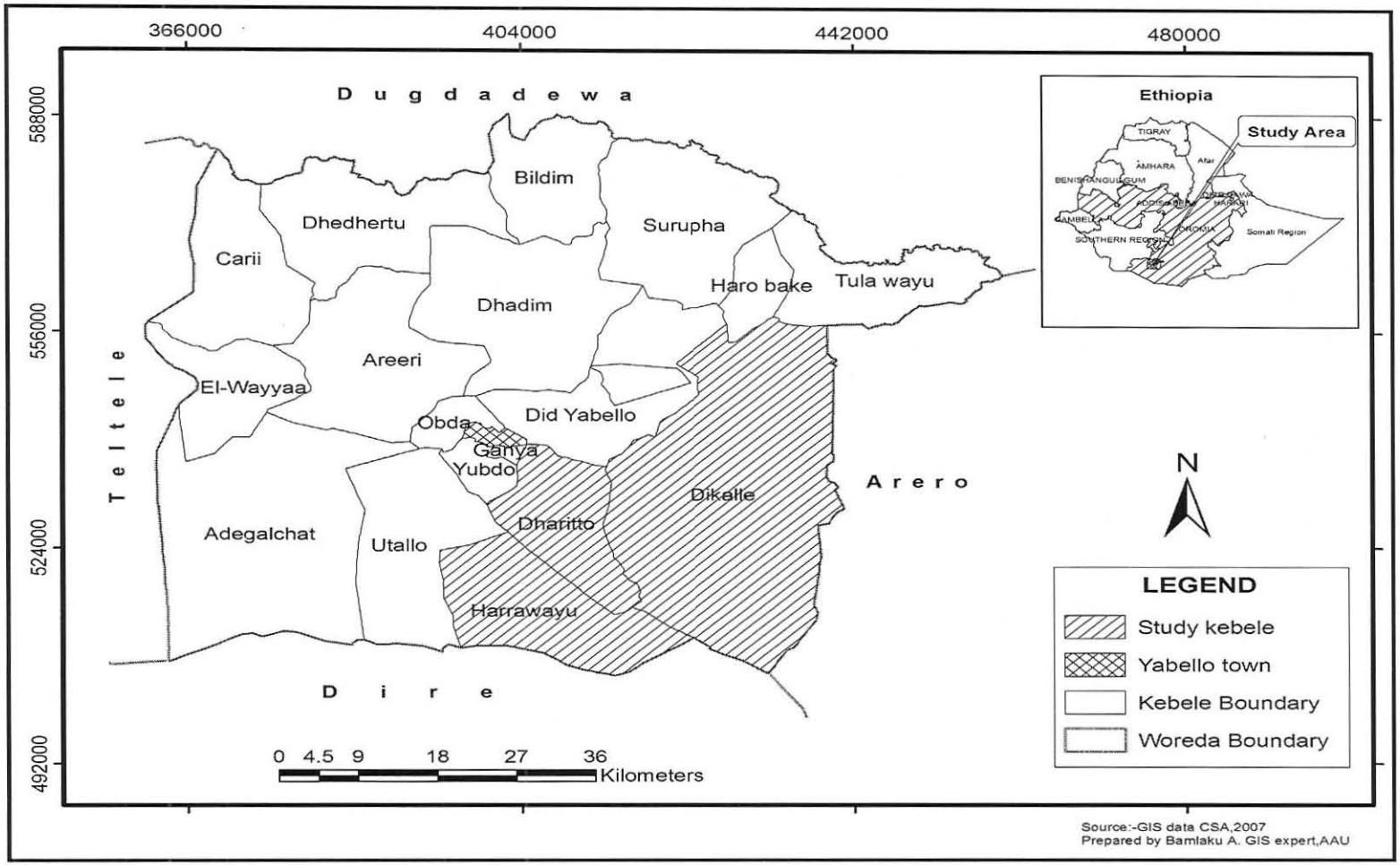


Figure 3.1 Map of the study area

3.4. Soil

According to *woreda* pastoral area development bureau information, the common soil types available in the area are red sandy soil, red soil and black soil. They constitute for 50, 25 and 20 percent soil composition of the area. The remaining 5 percent is composed of other soil types (YWPDB, 2009).

3.5. Forest cover

The *woreda* has 39,129 hectares of land covered by forest resource. Out of these 28, 777 hectare is covered by dryland evergreen junipurous forest. The forest landmass is located in *Obda, Yubdo* and in territorial parts of *Harrawayu* and *Dharitto kebeles*. Ownership title over forest resources belongs to the regional state (YWPDB, 2009).

3.6. Economic Activity

Pastoralism is the dominant livelihood strategy in the *woreda*. For generations it has served as the main source of income and food. The livestock population of the *woreda* is composed of 232949 cattle, 98872 goats, 39073 sheep, 22972 camels and 3752 equines. Poultry and Bee colony are some other resources that serve as source of food and income in the area. The *worda* has 292028 hectares of rangeland that serve as grazing land for these livestock population. 90 percent of the grazing land is owned communally while the remaining 10 percent is owned by individuals and serve as private grazing source (YWPDB, 2009).

Agropastoralism is another livelihood strategy that is found in the *woreda*. It has 62000 hectares of arable land. From these, the cultivated land equals 11971 hectares. Crops are produced in the main rainy season using traditional agricultural system. The common crops grown in the area are maize, wheat, haricot bean and *Teff*. The average yield per hectare for maize, wheat and haricot bean is 9 quintals while it is 8 quintals per hectare for *Teff* (YWPDB, 2009).

Land degradation and bush encroachment have posed challenge on productivity of these livelihood systems. Land degradation due to soil erosion by rain, continuous farming, overgrazing and deforestation has led to reduction of land and livestock productivity. Bush encroachment and expansion of herbaceous vegetations have shown an increasing trend. According to *woreda* pastoral development bureau, the extent of bush encroachment in terms of area cover equals 147000 hectares. This has created shortage of grazing land and decline of pasture quality.

Chapter Four

4. Research Methodology

4.1. Research Strategy and Study Design

Researchers from different disciplines have developed many conceptual and methodological approaches to vulnerability analysis. The major conceptual approaches in vulnerability analysis include the socioeconomic, biophysical, and integrated approaches. The socioeconomic approach is mainly concerned with the social, economic, and political aspects of society (Adger, 1999). The biophysical, or impact assessment, approach is mainly concerned with the physical impact of climate change on different attributes, such as yield and income (Füssel and Klein, 2006). The integrated assessment approach combines both the socioeconomic and the biophysical attributes in vulnerability analysis (Füssel, 2007).

The most commonly used methodological approaches in the climate change literature include the econometric and indicator methods. The econometric method, which has its roots in the poverty and development literature, makes use of household-level socioeconomic survey data to analyze the level of vulnerability of different social groups (Hoddinott and Quisumbing, 2003). The indicator method of quantifying vulnerability is based on selecting some indicators from the whole set of potential indicators and then systematically combining the selected indicators to indicate the levels of vulnerability (Cutter *et al.*, 2003; Deressa *et al.*, 2008).

To measure the vulnerability of agropastoral and pastoralist households found in Yabello *woreda*, this study adopts the concept of integrated vulnerability assessment and indicator method approaches.

The study was designed as a cross-sectional survey of households in the study area. The study design combines purposive sampling and simple random sampling techniques for

the selection of the study *woreda*, *kebeles*, and households. The quantitative data obtained through structured questionnaire has been triangulated with the qualitative information (i.e. from in-depth case studies and key informant interview) to support the analysis of the survey.

4.2. Sampling techniques

Sampling Procedure

For this research multi stage sampling techniques were employed to select the study *woreda, kebeles* and sample households.

Yabello *woreda* was purposively selected because the area is highly exposed to impacts of climate change and also the co-existence of both the agropastoral and pastoral livelihood systems within the same environment made it preferable site to meet the objective of this study. The *woreda* has 20 rural administrative *kebeles* that are classified into pastoral and agropastoral *kebeles*. Then, three *kebeles* were purposively selected taking into consideration access for transportation service and a balanced distribution of infrastructures and facilities in the *kebeles*. Based on these, *Dharitto* (agropastoralist), *Harrawayu* (pastoralist), and *Dhikalee* (mixed of both social groups) were selected as sample *kebeles*' for the study.

After selection of study *kebeles*, the sample size from each *kebele* was determined by dividing the total sample size in proportion to the total population size from each *kebeles*. Simple random sampling technique was employed to select sample households from these *kebeles*.

Sampling Frame

The sampling frame consists of 2042 household heads that live in the selected *kebeles*.

Sample size determination

From different sampling methods developed by different researchers, the one developed by Watson (2001) was used to determine the sample size of the study. The method is selected because it provides sample size value appropriate to different population size given different precision value and degree of variability, to meet the goal of the study. [The details of sample size value determined for different population size are given in annex 4].

According to the method, the sample size for this study needs to consist of 158 units of households. Therefore, to achieve this target 165 questionnaires were administered at the time of the survey. But, in the data cleaning process 14 questionnaires were rejected due to high prevalence of missing values and inconsistency of responses that could possibly reduce the quality of the data. And finally, the remaining 151 units of households served as a sample population for the analysis of the study.

Table 4.1. Sample size distribution of the study population

Sample *kebeles*	Total HH Size	Planned sample size	Actual sample size
Dharitto	855	66	60
Harrawayu	660	51	51
Dikalle	527	41	40
Total	2042	158	151

4.3. Data types, sources and method of collection

Quantitative and qualitative data were collected from primary and secondary sources. The primary source of data include sample households, key informants and case studies of households from the study area whereas the secondary sources include published and unpublished documents, research reports and websites. Different data collection tools have been employed to gather information from primary and secondary sources. The following sub sections discuss details on how the data collection was made.

4.3.1. Primary data collection

Primary data collection was made using tools like survey questionnaires, key informant interview and some case studies of households supplemented with informal interviews with some individuals. These different tools were employed in order to collect specific types of data and triangulation of information from these various tools were done to see the consistency of the data.

A. Survey questionnaires

This method was employed to assess and find out the basic demographic characteristics of households, access to technology, infrastructural and institutional arrangements and household perception on climatic elements. The household survey was conducted using questionnaire administered to 151 sample households. The survey questionnaire was prepared in such a way that it can capture information relevant to the research objectives. Pretest of the developed questionnaire was made in order to check the feasibility of the questionnaire on 10 respondents prior to the main survey. 5 enumerators were involved in the data collection process and these enumerators were given one day training on the objective of the research, content of questionnaire and other relevant aspects.

B. Key Informant Interview

To supplement the quality and reliability of the data collected through the questionnaire four interviews were conducted with four different experts that have been working in the area. The informants were selected based on their experience and their knowledge of the study area for long periods. The informants were taken from the *woreda* and zonal pastoral area development bureau. The informants were asked about the overall climatic conditions of the area and what opportunities and challenges have these conditions brought to the local community. A check list was used to guide the interview.

C. In-depth case studies

Since the survey questionnaire was highly structured, it was necessary to undertake some in-depth case studies to have a better insight of the study population. Based on this assumption three household heads were selected (two agropastoralists and one pastoralist) for the in-depth case study. These households were made to reveal their opinions about the climatic conditions of the area, their livelihood system, infrastructural development changes in the area and their opinions on different interventions and initiatives that are administered in the area by different local and international development agencies.

4.3.2. Secondary data

Secondary data that are relevant for the research work were gathered from different sources, that include published books, journals, reports prepared by international, federal and regional institutions, and unpublished materials available at the *woreda* pastoral area development bureau. Moreover, different websites from internet were also visited while searching for different literatures. These secondary information was used to backup the primary data obtained using the different tools mentioned previously.

4.4. Method of Data Analysis

In order to meet the general and specific objectives of the study both qualitative and quantitative methods of data analysis were employed. An indicator method has been used to calculate the level of vulnerability of households and social groups.

The principal component analysis (PCA) statistical method is employed to determine the weight of selected variables in constructing the vulnerability index. PCA is a way of identifying patterns in data, and expressing the data in such a way as to highlight their similarities and differences. Since patterns in data can be hard to find in data of high

dimensions, where the luxury of graphical representation is not available, PCA is a powerful tool for analyzing data (Smith, 2002: p12). PCA is used abundantly in all forms of analysis, because it is a simple, non-parametric method of extracting relevant information from confusing data sets (Shlens, 2003: p1).

To analyze the quantitative data household and social group vulnerability index calculation was made. In addition to these, descriptive statistics (such as percentage, mean, minimum, maximum, and standard deviation) were employed. The qualitative data collected from the in-depth case study and KII was contextually analyzed and triangulated with the quantitative results. STATA 10.0 version software package was used to organize, arrange and analyze the data.

4.4.1. Definition of Model Variables and expected signs

To determine vulnerability of households, the model variables of the study are categorized according to the study's conceptual framework. Adaptive capacity is the ability of a system to adjust to actual or expected climate stresses or to cope with the consequences of those stresses. Adaptive capacity at a household level will be determined by factors such as health and education, access to information, financial and natural resources, the existence of social networks, and the presence or absence of conflicts (Brooks, 2003).

In this paper household's adaptive capacity is represented by wealth, access to modern technology, infrastructure, institutions and information. Taking into context the wealth accumulation of the study population, possession of camels, saving in cash, access to non- agricultural income and financial support are used to express the wealth status of the households.

Camel ownership- In the study area the most common wealth accumulation mechanism is purchase of additional animals. According to Kebebew (2001) in the area camel is possessed by rich households and it ranges from 2 to 5 camels per household. Currently

the preference to have camels has increased due to market price and its resilience for climatic shocks. Taking this into consideration and the reluctance of the population to reveal the exact number of their livestock holdings, in the study possession of camels is defined as a dummy variable to indicate wealth. Irrespective of the number of camels, households that own camels are assigned the value of 1, and 0 otherwise. Households that own camel are assumed to be better off and, hence, have better adaptive capacity.

Saving in cash- Here the assumption is households that save in cash are expected to have less liquidity problems in period of crisis. Due to this they have the freedom to choose the appropriate coping strategies and the ability to cope with financial constraints. In the model it is defined as a dummy variable with a value of 1 representing households that save in cash, and 0 otherwise. Here, households with cash savings are expected to have higher adaptive capacity in comparison with households that do not save in cash.

Non-agricultural income- Agriculture being the main source of income for the study population and its high sensitivity to climatic shocks, having an alternative source of income plays important role in reducing household vulnerability when households face climatic shocks. In the study, households that get income from petty trading activities, rent and remittance are considered to have access for non-agricultural income. Households that have higher access to non-agricultural income are expected to have better adaptive capacity. In the study access to non-agricultural income is defined as a dummy variable, 1 representing those households that have access, and 0 otherwise. A shift of a household from 0 to 1 shows the improvement of the household's adaptive capacity.

Accesses to financial support- In this study, households that receive financial support from family members or relatives at the times of climatic shocks are considered to have access for financial support. The support provides the households with a financial liquidity and, hence, creates a better adaptive capacity. In the model it is defined as a dummy variable. 1 represents households that have someone to support them financially at the time of crisis, and 0 otherwise.

Access to modern technology

Household access to modern technology can be determined by household access to modern inputs such as fertilizer or pesticides and new agricultural practices. In the case of the study household utilization of extension service is taken since it can capture the interest of both groups.

Extension service- Application of modern and better techniques of production enable households to have a better adaptive capacity through its effect of increased productivity. In the study area application of modern techniques of production is very minimal. Both the farming and rearing activities are undertaken based on traditional ways. But there have been efforts by the government to improve the situation by using development workers to provide technical support on improved techniques of production that takes into consideration the demand of both agropastoral and pastoral households. Therefore, in this study household utilization of extension service is defined as a dummy variable, 1 representing utilization of the service, and 0 otherwise. The expected impact of the service is to increase adaptive capacity of households by increasing their respective productivity.

Access to institution and infrastructure

The level of development and availability of institutions and infrastructure plays an important role in adaptation to climate change by facilitating access to resources (Deressa *et al.*, 2008). Household strategies to maintain good health and achieve education for the children form important elements of securing wellbeing (Eriksen and O'Brien, 2006). Generally, household access to social infrastructure like health clinics, veterinary service, schools, market centers, and financial institutions play important role in enhancing adaptive capacity. In this study to measure adaptive capacity, we do assess household's utilization of such facilities.

Veterinary service- To maintain the productivity of livestock, their health condition need to be given due attention. All the sampled *kebeles* of the study have the facility in

their respective territories. But in this study we considered household utilization of the service by asking every individual household's whether they have benefited from the service provided by these facilities. It is defined as a dummy variable, 1 represents those households that use the service for their animals' health, and 0 otherwise. The provision of the service is expected to increase the adaptive capacity of households by increasing animals' resilience to shocks.

Access to market- Since there is no big livestock market in the sampled *kebeles*, household's frequency of visit of such markets found in the nearby town and *woreda* is used as a proxy to determine household's access to market. Based on this, households that pay a visit to market centers at least once in two weeks period are classified to have a better access for market and households that visit the market centers beyond this period are considered to have poor access to market. Therefore, in the model, access to market is defined as a dummy variable, 1 representing households that have better access to the market, and 0 representing households that have poor access. Access to market is expected to increase the adaptive capacity of households' by facilitating resource exchanging mechanisms and reducing associated transaction costs.

Micro financial Institutions- These institutions enable households to have access for credit without or with minimal amount of collateral. They also encourage households' saving behaviors. In general the wide distribution of such institutions enables households to have alternative source of financing when they undertake investment or activities that enhance their livelihood outcomes. In this paper access to such institutions is represented by households' membership to saving and credit associations. Members benefit from the sum they save and their preferential advantage for credit gives them a better hand over non-members. In the model, it is defined as a dummy variable, 1 representing member households, and 0 otherwise. The more households have access to such institutions, the higher their adaptive capacity.

Water sources- Water is one of the critical resource which both livelihood systems highly depend on it for their success. From the primary data it has been seen that water

sources for domestic consumption purpose and livestock watering are common in the study area. In the area there are no perennial water sources like river or lake. Most of the households collect their drinking water from seasonal water sources like pond and unprotected springs. From the water sources identified in the area, households that collect water from boreholes have relatively better water supply throughout the year. Therefore in this study sustainable water resource is defined as a dummy variable, 1 representing households that use boreholes as their primary source of drinking water, and 0 otherwise.

Health Facilities- Households that have these facilities in their vicinity are expected to have a higher adaptive capacity provided that the households are utilizing the services provided by the institutions. In the model access to health center is defined as a dummy variable, 1 shows household's that use these health facilities for their family health treatment purpose, and 0 otherwise. The more households utilize the service the lesser the vulnerability.

Access to Information

Household access to information is the other important factor that contributes to adaptation process of climate change. Households that have access to early warning systems can prepare themselves prior to exposure and hence reduce their sensitivity. In our case access to information is highly determined by household's social status i.e. those who have leadership role, membership to various social institutions and male headed households have better access to information. Possession of radio, and literacy contribute for better access and understanding of information provided through public media.

Sex- It is defined as a dummy variable representing the sex of the head of the household. 1 if the head is male, and 0 otherwise.

Literacy- Is defined as the educational status of the head of the household. 1 if the head is at least capable of read and write, and 0 otherwise. Provided that higher illiteracy rate in the study area, households with some educational exposure have greater acceptance in

present day administrative system and institutions. This enables households to have a good access for information and, therefore, can make an informed decision.

Radio ownership- Households that have radio can get first hand information on climatic conditions and forecasts. Therefore, households with such reliable information can make an informed decision. In the model it is defined as a dummy variable, 1 representing radio ownership, and 0 otherwise.

Leadership role- Head of households that have leadership role in various traditional institutions or who are member of various formal and informal institutions have better information access compared with head of households that have no such roles and entitlements. In the model, 1 represents head of households who have leadership position, and 0 otherwise.

Exposure and sensitivity are almost inseparable properties of a system (or community) and are dependent on the interaction between the characteristics of the system and on the attributes of the climate stimulus (Smit and Wandel, 2006). According to IPCC (2001) sensitivity is the degree to which a system is affected, either adversely or beneficially, by climate change stimuli, whereas exposure is the nature and the degree to which a system is exposed to climate variations.

In this study sensitivity of households to climate change is represented by its associated impacts i.e. shortage of food, loss of water sources, and conflicts faced by those households.

Food shortage- Change of climatic variables from their mean values and occurrence of drought brought a disastrous impact on livelihood assets and resources. In the study area food shortage is a common phenomenon after such incidents. In this thesis to determine households' sensitivity to this effect, it is analyzed by the percentage of households that face food shortage and subject to food aid in past five years. In the model by defining food shortage as a dummy variable, a value of 1 is assigned to represent those households

that are subject to food aid and have received food aid at least once in the past five years, and 0 otherwise. Here a movement of household from 0 to 1 indicates an increase of household sensitivity i.e. loss of welfare or a negative impact.

Water relief- As mentioned previously, in the study area water scarcity is the major problem. When climatic shock happens, the problem gets severe and households might be subjected to water relief or rationing to meet their daily water need. In the model it is defined as a dummy variable, 1 representing households that are subject to water relief, and 0 otherwise. Higher percentages of the households subjected to relief imply higher sensitivity of households.

Conflict- climate change induces loss of resources and factors of production. In such periods households try to cope with the situation by taking different actions. Among these, the major one is moving to other areas in search of these resources. Most of the times this leads to conflict between the host community and the new comers. These conflicts have negative impact both at a community and household levels and hence aggravate vulnerability. In the model conflict is defined as a dummy variable, 1 representing households that are experienced conflict, and 0 if not.

In the case of exposure, since both social groups are located in the same area, exposure is almost uniform across the people residing in the area. But in contrast to this fact, there has been variation in the perception of households in the direction of change of these climatic elements. This would definitely create variation on household's decision in selecting among the different adaptive mechanisms. Therefore, in this study it is argued that exposure to be expressed by household perception on the issue or risk and, hence, exposure is defined in the study based on what household's perception is on temperature and rainfall change patterns, rainfall starting period and occurrence and frequency of drought phenomena.

HH perception on temperature- the direction in which household perceives temperature is changing. In the model it is defined as a dummy variable, 0 as temperature increase,

and 1 as temperature decrease. Here the perception of the households (how they feel the exposure) determine their next action. If higher percentages of households' state increase of temperature, it shows higher exposure and, therefore, vulnerability is expected to increase.

HH perception on Precipitation- the direction in which household perceives rainfall is changing. It is defined as a dummy variable, 0 as rainfall decrease, and 1 as rainfall increase. If higher percentages of households' state decrease of rainfall, it shows higher exposure and, therefore, vulnerability is expected to increase.

HH perception on Rainfall variability- rainfall starting time and duration period has been changing in the study area. Shortening of rainy days, holding rainfall amount constant, causes shorter germination period for crops that resulted in reduction of productivity. Defined as a dummy variable, 1 indicates normal or no variation from previous periods, and 0 if there happens a change. Higher percentage of variation indicates higher exposure and hence, increased vulnerability.

HH perception on Drought-the direction in which households perceive drought occurrence and frequency have shown changes. In the study, it is defined as a dummy variable, 1 representing shortening of drought cycle or increased frequency of drought hazards, and 0 otherwise. Increased frequency implies higher exposure and, hence, higher vulnerability.

Table 4. 2. Definition of vulnerability indicators, units of measurements and their hypothesized direction

Determinants vulnerability	Vulnerability indicator	Explanatory variables of the indicators	Unit of measurement	Hypothesized functional relationship between indicators and community vulnerability
Adaptive capacity	Wealth	Camel ownership	Percentage of total HHs who own or have access to	The higher the percentage of total households with asset ownership and access to these income sources the lesser the vulnerability
		Saving in cash		
		Non agricultural income		
		Access to financial support		
	Technology	Access to development Workers support	Percentage of total HHs who use the service	The higher the percentage the lesser the vulnerability
	Infrastructure and institution	Veterinary service	Percentage of total HHs who utilize the services provided by these facilities	The higher the percentage of the users the lesser the vulnerability
		Health center		
		Market center		
		Access to credit		
		Clean water access		
	Access to information	Radio possession	Total percentage of HHs who own or classified into the category	The higher the percentage the lesser the vulnerability
		HH sex		
		Literacy		
		Membership in associations		
Sensitivity	HH level impact of climate change	Food shortage	Percentage of HHs subject to	The higher the percentage the higher the vulnerability
		Water scarcity		
		Conflict		
Exposure	HH perception about climate change	Change in temperature	Percentage of HHs that perceive increased temperature	Increasing temperature and decreasing rainfall increase vulnerability
		Change in precipitation	Percentage of HHs that perceive increased RF	
		Change in rainfall timing	Percentage of HHs that perceive more deviation	The higher the variability the higher the vulnerability
		Frequency and occurrence of drought	Percentage of HHs that perceived increased frequency	The higher the frequency the more vulnerability

4.4.2 Vulnerability Index Specification

To determine the level of vulnerability the study attempts to analyze vulnerability based on the integrated approach by making the use of vulnerability index. The use of indices is challenged by many ambiguities, some of which are the choices of the right indicators, directions of relationships with vulnerability, weights attached and the optimal scale Deressa *et al.* (2008). The choice of indices was undertaken based on a review of the literature and adjusting to the context of the study population. The direction of relationship in vulnerability indicators (i.e. their sign) was adopted from the procedure followed by (Deressa *et al.*, 2008) who assigned a negative value to sensitivity and exposure and a positive value to adaptive capacity.

In this research, it is assumed that households with higher adaptive capacity are less sensitive to impacts of climate change keeping the level of exposure constant. Hence, vulnerability is the net effect of adaptive capacity, sensitivity and exposure.

$$Vulnerability = Adaptive\ Capacity + Sensitivity + Exposure \text{ ---------}(1)$$

From this, higher net value indicates a relatively lesser vulnerability of household or social group and vice versa. In this case the values of the indices are only relative values and have no further meaning.

Instead of simply assigning equal or average weight across the variables, a statistical technique, principle component analysis (PCA), is used to determine the weights in the index. PCA is an essential tool for summarizing variability among a set of variable, specially it seeks to describe the variation of a set of variables as a set of linear combinations of the original variables, in which each consecutive linear combination is derived so as to explain as much as possible of the variation in the original data, while being uncorrelated with other linear combinations. PCA as a technique extracts from a set of variables those few orthogonal linear combinations of the variables that capture the

common information most successfully. Intuitively the first principal component of a set of variables is the linear index of all the variables that captures the largest amount of information that is common to all the variables (Filmer and Pritchett, 2001; Longyintuo *et al.*, 2005; Deressa *et al.*, 2008).

i. Household Vulnerability Index (VI_{HH})

Suppose we have a set of K variables (a^*_{1j} to a^*_{Zj}) that represents the K- variables (attributes) of each household. PCA starts by specifying each variable normalized by its mean and standard deviation. For instance, $a_{1j} = (a^*_{1j} - a^*_i)/s^*_1$, where a^*_1 is the mean of a^*_{1j} across regions and s^*_1 is its standard deviation. The selected variables are expressed as linear combinations of a set of underlying components for each household j:

$$a_{1j} = V_1 A_{1j} + V_{12} A_{2j} + \text{----------} + V_{1k} A_{kj}$$

$$a_{k1j} = V_{k1} A_{1j} + V_{k2} A_{2j} + \text{------} + V_{kk} A_{kj}$$

-------- j= 1,..j. -----(2)

Where the A's are the components and the V's are the coefficients on each component for each variable (and don't vary across households). Because only the left hand side of each line is observed, the solution to the problem is indeterminate. Principal component analysis overcomes this indeterminacy by finding the linear combination of the variables with maximum variance, usually the first principal component A_{1j}, and then finding a second linear combination of variable orthogonal to the first, with maximal remaining variance and so on. Technically the procedure solves the equations $(\mathbf{R}-\lambda\mathbf{I})v_n = 0$ for λ_n and v_n where **R** is the matrix of correlations between the n^{th} component for each variables. Solving the equation yields the characteristic roots of **R**, λ_n (also known as eigenvalues) and their associated eigenvectors, v_n. The final set of estimates is produced by scaling the v_ns so that the sum of their square sums to the total variance, another restriction imposed to achieve determinacy of the problem.

The scoring factors from the model are recovered by inverting the system implied by equation (2). This yields a set of estimates for each of K principal components.

$$A_{1j} = f_{11} a_{1j} + f_{12} a_{2j} + \text{-------} + f_{1k} a_{kj}$$

$$j = 1, \ldots, j \quad \text{---------(3)}$$

$$A_{k1j} = f_{k1} a_{1j} = f_{k2} a_{2j} + \text{---------} + f_{kk} a_{kj}$$

The first principal component, expressed in terms of the original (unnormalized) Variables, is therefore an index for each household based on the following expression.

$$A_{1j} = f_{11} (a^*_{1j} - a_1^*) / (s_1^*) + \text{------} f_{1k} (a^*_{kj} - a_k^*) / (s_k^*) \text{-------} \quad (4)$$

The critical assumption of PCA is that, the undefined 'common information' is in fact determined by the underlining phenomenon that the index is trying to measure (in this case, vulnerability) which unfortunately cannot be statistically verified since it depends on the correct identification of relevant variables of indicators, and is, therefore, largely a mater of judgment. One of the advantages of PCA (apart from the objectivity of the weights) is that it estimates the contribution of each variable to the underlying common phenomenon, and thus enables us to rank the indicators according to their importance in determining the household level of vulnerability.

ii. Social group Vulnerability Index (VI_{sg})

An alternative method is developed to calculate the vulnerability of the social group at aggregate level using a simple mathematical approach.

In calculating the VI_{sg}, the same conceptual framework that has been used in constructing VI_{HH} is adopted. With regard to indicator variables, except two variables, the rest are maintained. The dropped variables are; Sex and Household head leadership role. The justification is that at a community level members would not be able to have these

entitlements at a time and if they do have, it means no variation and therefore, no need of consideration. The same factor score results that have been generated by the PCA are used to determine the weight of individual indicators' contribution to the overall index.

To start the construction of VI_{sg}, first we need to standardize every indicator as a scale free index. This process enable us to overcome the problem of scale of measurement incase the indicator variables are explained through different unit of measurements like percentage, ratio, hours etc. Hahn *et al.* (2009) in their calculation of livelihood vulnerability index (LVI) for two districts of Mozambique used the UNDP's Human Development Index (HDI) approach in standardizing their indices. According to UNDP, life expectancy index is calculated in HDI as a ratio of the difference of the actual life expectancy and a pre selected minimum, and the range of pre determined maximum and minimum life expectancy. In the study by taking this approach standardization of the selected variables is made using the equation given below;

$$Index\ P_{sg} = \frac{P_{sg} - P_{\min}}{P_{\max} - P_{\min}} \quad \text{---------- (5)}$$

Where P_{sg} is the actual observation of the social group and P_{min} and P_{max} are the minimum and the maximum values, respectively. In our case since all variables are measured in percentage the minimum and maximum values are 0 and 100 respectively. As an example for a variable of 'camel ownership' the possible maximum value is 100%, if all respondents have camels or it is 0 if no household owns a camel in that specific social group.

To get the specific contribution each determinant (adaptive capacity, sensitivity and exposure) to overall index, first we determine the value for these major components using the formula specified below. In the formula we multiply the standardized value of every indicator variable by its respective weight (derived from the first PCA result). Then we

add the multiples of every indicator variables together and divide the result to the sum of their weights to arrive at the final value of every determinant component.

$$A_{sg} / S_{sg} / E_{sg} = \frac{\sum_i^j f_i P_{sg}}{\sum_i^j f_i} \text{ ---------- (6)}$$

Where A_{sg}, S_{sg}, and E_{sg} are adaptive capacity, sensitivity and exposure of the social group, respectively. P_{sg} is the standardized value and f_i is the weight of the indicator variables.

To get the final VI_{sg} value, we subtract the sum of S_{sg} and E_{sg} values from A_{sg} value. But, here, instead of assigning equal weights to all the three major components, we allocate a relative weight based on the number of the total variables that constitute these components. Therefore, we can determine the final value of the social vulnerability index using the following equation:

$$VI_{sg} = \frac{K_a A_{sg} - K_s S_{sg} - K_e E_{sg}}{K_a + K_s + K_e} \text{ ---------- (7)}$$

Where VI_{sg} is the vulnerability index of a social group, A_{sg}, S_{sg}, and E_{sg} are adaptive capacity, sensitivity and exposure of the social group, respectively and K_a, K_s, and K_e show the number indicator variables that constitute for adaptive capacity, sensitivity and exposure, respectively.

As we stated earlier vulnerability to be the net effect of adaptive capacity, sensitivity and exposure higher net values show less vulnerability and vice versa.

Chapter Five

5. Descriptive Analysis of Sample Population

5.1. Demographic, Social and Economic Characteristic of Sample Population

A total of 151 household units are taken from 3 *Kebeles* to generate the survey data. These households are classified into two groups based on their livelihood system; agropastoral and pastoral. The composition of these sample population is in a way that consists 78 pastoral households and 73 agropastoral households. In the preceding sections of this chapter a detailed comparative description of the two social groups is presented

5.1.1 Demographic Characteristics of Respondents

i. Sex

In describing the demographic characteristics of a study population, sex is among the major features. Based on this, the sex distribution of the respondents shows that, among the pastoralist group male respondents account for 71 (91.03%) and females 7 (8.97%), while in the agropastoral group males account for 69 (94.52%) and females account for about 5%.

ii. Age Profile

Regarding the age profile of the sample population, around 70% of the agropastoral respondents and 67.95% of the pastoral respondents are under the age of 51. Seven (9.59%) of the agropastoral and 10 (12.82%) of pastoral respondents are above 65 years of age. The mean age of the agropastoral respondent is 46.10 years with a maximum 80, and a minimum 27 years. For the pastoral group, the mean age is 46.15 years, 27 and 75 being the minimum and maximum years of age, respectively.

iii. Marital Status

As to the marital status of the respondents, the majority of them (89.74%) of the pastoralists and (94.52%) of the agropastoralist are currently married. While the rest of

respondents i.e. (10.26%) of the pastoralist and (5.48%) of the agropastoralist household heads are widowed.

Table 5.1. Distribution of sampled population by major demographic characteristics

Background Variables	Agropastoral HH		Pastoral HH	
	Number	Percentage	Number	Percentage
Age				
20-30	16	21.92	9	11.54
31-40	13	17.80	26	33.33
41-50	22	30.14	18	23.08
51-65	15	20.55	15	19.23
> 65	7	9.59	10	12.82
Total	73	100	78	100
Sex				
Male	69	94.52	71	91.03
Female	4	5.48	7	8.97
Total	73	100	78	100
Marital Status				
Married	69	94.52	70	89.74
Widowed	4	5.48	8	10.26
Total	73	100	78	100
Family size				
2-5	24	32.88	22	28.57
6-10	44	60.27	39	50.65
11-15	5	6.85	12	15.59
> 15	-	-	4	5.19
Total	73	100	77	100

Source: Household survey, February, 2010.

iv. Family Size

Looking into the family size distribution of the two social groups, we can say that the pastoral have extended family size compared to the agropastoral group. As we can see from table 5.1, 16 (20.78%) of the pastoral respondents have more than 11 household members at the period of the survey while the agropastoral respondents that household size of 11 are only 5 (6.85%). Most of the respondents, i.e., 44 (60.27%) of agropastoral and 39 (50.65%) of pastoral households, have a family size of 6-10 members. About one-thirds (32.88%) of agropastoral and 22(28.57%) of pastoral respondents have a family size less than 6 members.

5.1.2 Social Characteristics of Respondents

i. Ethnicity

In relation with ethnicity distribution of the respondents, there is no variation as all respondents belong to one ethnic group i.e. Borana Oromo. Due to this fact, there is similarity on social norms and customs, despite variation in livelihood systems in which the two groups are engaged.

Table 5.2. Distribution of the sample population by social characteristics

Background Variables	Agropastoral		Pastoral	
	No.	%age	No.	%age
Ethnicity				
Oromo (Borana)	73	100	78	100
Total	73	100	78	100
Religion				
Traditional (Waqafatta)	73	100	76	97.44
Others			2	2.56
Total	73	100	78	100
Educational status				
Illiterates	69	94.52	73	94.81
Read and Write	1	1.37	2	2.60
Primary education (1-8)	3	4.11	2	2.60
Total	73	100	77	100

Source: Household survey, February, 2010.

ii. Religion

Here also there is high similarity between the two groups 149(98.68%) of the respondents are followers of traditional belief 'Waqafatta". Only 2 (1.32%) of respondents are found to be followers of other religions.

iii. Educational Status

Educational background of the sample population covered by study indicates that literacy rate is very low. From the total of 77 pastoral household heads, 73(94.81%) were illiterate. Only 2(2.6%) had attend formal schooling and the remaining 2(2.6%) are only capable of reading and writing. The educational background of the agropastoral group is also not much different from this situation. Out of 73 respondents 69(94.52) were illiterate, 1(1.37%) are able to read and write and 3(4.11%) have attended primary school. In general only 5(3.33%) household heads have attend formal education.

5.1.3 Economic Conditions of Sample Population

As described at the beginning of the chapter, the classification of the groups is made based in their primary economic activity. Hence in this part, the major economic activities of the sample population are discussed.

i. Agropastoral

Members of this social group are engaged in both farming and animal rearing for their livelihoods.

From table 5.3 we learn that 24 (32.88%) of households undertake their farming activity on a plot of land that amounts 3-5 *Timads*. 44(60.27%) households own 6-10 *Timads* of land and 5 (6.85%) households more than10 *Timads* of land. The average land holding is 6.5 *Timad*; 3 and 16 *Timad* of land being the minimum and the maximum land holding per household, respectively.

Table 5.3. Land holding of Agropastoral HHs [N= 73]

Land holding in 'Timad'	Number	Percentage
3-5	24	32.88
6-10	44	60.27
>10	5	6.85
Total	73	100

Source: Household survey, February, 2010

The main crops grown by these households are maize, *Teff*, wheat and haricot bean. Maize and haricot bean take the lion share of their production. About 99% of the respondents grow maize while Haricot bean growers reach 95.89%. Households that grow *Teff* and wheat stands at 57.53% and 50.68% respectively. According to the discussion held by the researcher with some members of the group (In-depth case study), production of maize and haricot bean is mainly for domestic consumption while *Teff* is produced for sale.

Table 5.4. Common crops grown by Agropastoral HHs [N= 73]

Crop type	Frequency	Percentage
Maize	72	98.63
Wheat	37	50.68
Teff	42	57.53
Haricot bean	70	95.89

Source: Household survey, February, 2010

Looking at the income source of the group, all respondents claim crop sales to be their main source of income closely followed by livestock sales, which is about 89%. Animal product sales (57.53%) and wage labor (15.07%) are other sources of income to the respondents. About 23% of the respondents have engaged in petty trade activities to diversify their sources of income. From the sampled population only 1.37% of the respondents have access to remittance.

Table 5.5. Income Sources of the Sample Population [N (AP)= 73, N(PAS)= 78]

Source of Income	Agropastoral		Pastoral	
	Frequency	Percentage	Frequency	Percentage
Crop sales	73	100	-	-
Livestock sales	65	89.04	74	96.10
Animal Product sales	42	57.53	71	92.21
Petty trade	17	23.29	24	31.17
Wage labor	11	15.07	4	5.19
Remittance	1	1.37	1	1.30
Rental Income	-	-	3	3.90

Source: Household survey, February, 2010

Regarding livestock holding of the social group (see Table 5.6) about 80.82% of agropastoral households don't own camel. Only 19.18% of the respondents have camels and their maximum holding goes up to 5 camels. We can also see that there is no a single household that does not own cattle from the respondents. Based on their percentage holdings, it is visible from the table that large numbers of the respondents prefer to have goats than sheep since goats' have a better resistance to drought and also they can browse the bushes that invaded the pasture land.

ii. Pastoralists

Households classified under this group are those who practice largely livestock rearing activities on communal pastures. For this group of households, the animals serve as their main source of food and income.

Table 5.6. Livestock holding distribution of the sample population [N(AP)= 73, N(PAS)=78]

Qty	HH type	Type of Animals							
		Camel		Cattle		Sheep		Goat	
		No	%	No	%	No	%	No	%
0	AP	59	80.82	-	-	21	28.77	6	8.22
	PAS	39	50	-	-	26	33.33	4	5.13
1-5	AP	14	19.18	25	34.24	42	57.53	18	24.65
	PAS	36	46.15	11	14.10	35	44.87	22	28.21
6-10	AP	-	-	16	21.92	10	13.70	19	26.03
	PAS	3	3.85	14	17.95	12	15.39	14	17.95
11-15	AP	-	-	13	17.81	-	-	23	31.51
	PAS	-	-	19	24.36	3	3.85	22	28.21
16-20	AP	-	-	11	15.07	-	-	2	2.74
	PAS	-	-	16	20.51	-	-	7	8.96
21-30	AP	-	-	4	5.48	-	-	4	5.48
	PAS	-	-	9	11.54	2	2.56	5	6.41
>30	AP	-	-	4	5.48	-	-	1	1.37
	PAS	-	-	9	11.54	-	-	4	5.13

Source: Household survey, February, 2010

Analyzing the income source of the group shows the above criteria to be meet by the sample population of the study group. About 96% of the respondents claim, livestock

sales to be their major source of income, followed by animal product sales that serve as income source for (92.21%) of sample population. With regard to non-agricultural income sources of the group, 31.17% of the respondents stated petty trade as their alternative source of income. 3.9% the respondents claimed to have rental income by building houses in urban areas. Remittance is source of income for 1.3% of the sample population.

In describing the economic behavior of the group, it is crucial to identify the type and number of livestock possessed by the respondents. The most common animals they keep include camel, cattle, sheep and goats. Half of the sampled pastoral households claimed not to have camel. 36(46.15%) of the respondents owned from 1 up to 5 camels while 3 (3.85%) claimed to own more than five camels. All respondents of the group stated to own cattle. About one-third (32.05%) of the respondents claimed to have up to 10 cattle. 44.87% replied to have cattle that range from 11 to 20 units. Households that have more than 20 units of cattle account about 23.08% of the sample population. From table 5.6 we learn that goats are more preferable than sheep. Households that owned more than 10 sheep accounted only for 6.41% while in the case of the goats it accounted for 48.71% of the respondents. One-third of the respondents don't own sheep at all while in the case of goats it is only 5.13%.

5.2 Determinants of Vulnerability

The notion of vulnerability of any system at any scale is a function of the exposure and sensitivity of that system to hazardous conditions and the ability or capacity or resilience of the system to cope, adapt or recover from the effects of those conditions (IPCC 2001; Smit and Wandel, 2006).The interaction of environmental and social forces determines exposure and sensitivity, and various social, cultural, political and economic forces shape adaptive capacity. These driving processes of exposure, sensitivity and adaptive capacity are interdependent and in general a system (a community) that is more exposed and sensitive to climate stimulus, condition or hazard will be more vulnerable, citrus paribus and a system that has more adaptive capacity will tend to be less vulnerable, citrus

paribus (Smit and Wandel, 2006). Having the scenario in mind, the following section discusses about the adaptive capacity, sensitivity and exposure of the study area.

5.2.1. Adaptive Capacity

Adaptations are manifestation of adaptive capacity. Adaptations or changes in the system to better deal with problematic exposures and sensitivities reflect adaptive capacity. It has been analyzed in various ways including via thresholds and 'coping ranges', defined by the conditions that a system can deal with, accommodate, adapt to, and recover from. It is context specific and varies from country to country from community to community among social groups and individuals and overtime (Simit and Wandel, 2006). This means, the process via which a household or local community adapts to changes in climatic conditions will be very different from those via which a nation state adapts. At a household level adaptation will be determined by factors such as health and education, access to information, financial and natural resources, the existence of social networks and the presence or absence of conflict (Brooks, 2003). Based on these assumptions, here after the adaptive capacity of the sample population will be assessed by taking the most appropriate variables that explains the livelihood system of the two social groups.

5.2.1.1. Wealth

Wealth is considered as a component of adaptive capacity because, it enables communities to absorb and recover from losses more quickly due to insurance, social safety nets, and entitlement programs (Cutter *et al.*, 2000). Diversification of wealth accumulation mechanisms also enable to reduce the level of risk associated to exposures.

The review of sample population wealth accumulation mechanisms show that purchase of additional livestock is found to be the major strategy, 87.67% of agropastoral respondents and 63.64% of the pastoral households adopt this mechanism. Nearly one-third of pastoral households and 12.33% agropastoral respondents claim to engage in petty trade activities to increase their income and simultaneously to widen their wealth holding approaches. Saving in cash which is adopted by 45.45% of pastoralist and 36.99% of the

agropastoral respondents of study subjects implies the wide acceptance of the strategy. But, most of the respondents, 60% of the pastoral and 88.89% the agropastoral households use to save in home.

Table 5.7. Wealth accumulation mechanisms of the sample HHs
[N(AP)= 73, N(PAS)= 77]

Wealth accumulation mechanisms	Pastoral HH		Agropastoral HH	
	Frequency	%	Frequency	%
Purchase of livestock	49	63.64	64	87.67
Engage in petty trade	25	32.47	9	12.33
Save in cash	35	45.45	27	36.99
Built rentable houses (in urban areas)	1	1.30	-	-

Source: Household survey, February, 2010

5.2.1.2. Access to Modern Technology

Applications of modern techniques of production enhance productivity (adaptive capacity) of households that practice them. Taking this into consideration, when we see the sample population, we realize that 65 (89.04%) of agropastoral respondent and 68(88.31%) of the pastoral respondents use the technical service provided by the development agents. 79.41% of pastoral household respondents mentioned to participate in both fodder improvement and veterinary service extension package at the time of the survey. Thos participating in breed improvement package account for 55.88% of the pastoral respondents.

The agropastoral respondents, in addition to the above mentioned 3 extension package services, they do participate in crop production and improved farming technique packages. From the sampled agropastoral households 53.13% and 67.19% responded to take part in these two packages, respectively. Looking into modern agricultural input utilization by these households, 33(45.21%) use improved seed and 31(42.47%) apply insecticides and pesticides. All the respondents claimed not to use fertilizer. The main reason for this is lack of supply of the input in their respective *kebeles*.

Irrigation's contribution for adapting shocks that arise from rainfall shortage and variability is very high. But, unfortunately all the sample population had no access to such schemes at the time of the survey.

5.2.1.3. Infrastructure and Institutions

Expansion of infrastructures and the existence of stable institutional functioning raise the adaptive capacity of a given community. In the sampled population these factors are analyzed by assessing the physical availability of the infrastructures or the facilities, and percentage of households that benefit from them.

i. Vet Service

In all the sampled *kebles*, there exists a veterinary facility. From total sample population, 66(90.41%) of the agropastoral households and 54(69.23%) of pastoral respondents state to use the vet service provided in these facilities. When compared, the agropastoral households' utilization rate of the services is far better than that of the pastoral households. According to pastoral household respondents, the main reasons for not using the service are; preference of traditional treatment (75%), inadequate service and drug provision (45.83) and unavailability of vet personnel's at the facility most of the times (25%). In the case of agropastoral households the main reasons are preference of traditional medicine (57.14%) and inadequacy of the service provision accounts for 14.29%.

ii. Health Center

Looking into health facility distribution of the sampled *Kebeles*, health center is available in *Dikalle Kebele*, while *Dharitto* and *Harawayu* have their own health posts. 95.89% of the agropastoral households and 89.74 of pastoral households state to use these facilities for their family health treatment.

iii. Market Center

Except for the weekly small grain market in *Dikalle kebele*, there is no livestock market center in the sampled *Kebeles*. To do market transaction, households need to travel to the nearby towns and *woreda*. The common market centers include Yabello twon (medium market for grain) and '*Harroboke*' and '*Dubuluq*' centers for livestock market. The maximum time to these centers' is 2 day walk on foot for round trip. Due to these facts, only 17(21.79%) and 15(19.23%) of the pastoral households respondents visit the market on a weekly bases and once in two weeks time, respectively. In the case of the agropastoral households, 27(36.99%) visit the market weekly and 4(5.48%) went to market centers at least once in two weeks.

iv. Saving and Credit Association

Saving and credit associations are available in all the sampled *Kebles*. Regarding the membership status of the sample population, 32(43.84%) of agropastoral households and 38(48.72%) of pastoral respondents are members of these associations at the period of the survey.

v. Schools

Nearly two-third of pastoral households and 49.32% of the agropastoral respondents of the study subjects witnessed the availability of both regular and mobile schools in their vicinity. 44.62% of the agropastoral households and 69.23% of pastoral household respondents claimed sending all their school aged children to the school.

vi. Water Sources

Water is an important and a key resource in determining the vulnerability of the sampling population. The source of water for drinking and livestock watering purposes in sampled area is found to be the same. Most of pastoral and agropastoral households (i.e.94.87% and 97.26% respectively) collect drinking water from ponds. Water from this source also takes the major role in fulfilling the demand for livestock watering.

The mean distance to these water points (round trip) for pastoral households' is 5.33hr, while the range is 11 hrs. In the case of agropastoral households the mean distance for round trip is 2.93 hrs and the range is similar as that of the pastoral households' response. The mean time required to water livestock is 4.04 hrs and 5.74 hrs across agropastoral and pastoral respondents respectively. Analyzing the watering frequency of livestock of the pastoral households, 33 (42.31%) water their animals once in a 2 days, 31 (39.74%) water their animals at least once in a day, and the rest 14 (17.95%) water their animals once in a three days time. In the case of agropastoral households 27 (36.99%) water their livestock daily, 29 (39.73%) claimed to water their livestock once in 2 days, and 17(23.29%) water their animals once in 3 days time.

Table 5.8. Distribution of Drinking water sources of the sample population. [N(AP)= 73, N(PAS)= 78]

Source of Drinking water	Pastoral HH		Agropastoral HH	
	Frequency	%	Frequency	%
Unprotected spring	17	21.79	34	46.58
Protected spring	6	7.69	-	-
Boreholes	43	55.13	17	23.29
Pond	74	94.87	71	97.26
Ella (Traditional deep well	47	60.26	23	31.51

Source: Household survey, February, 2010

5.2.1.4. Access to Information

Access to information has an important role in enhancing household adaptive capacity. Sources of information and household's social status have great impact on determining household's access to climate change and related information. Assessing the information sources of the sample population on climatic forecast indicate, the majority of the households to retrieve information from traditional ways and to relay more on this approach than the other mechanisms. The different ways in which households get information on weather forecast are; 70.51% and 31.94% community meetings, 66.67% and 58.33% traditional ways, 15.38% and 31.94% public media (Radio), and 12.82% and 8.33% are from different workshops organized by GO and NGO's across pastoral and agropastoral respondents of the study population, respectively.

The summary of the adaptive capacity of the study population indicates the majority of respondent to use purchase of additional livestock as the main wealth accumulation strategy. But the strategy by it self is not feasible at times of climatic shocks. In addition to this application of modern agricultural inputs and improved techniques of production systems is very poor.

Household utilization and access to infrastructures and improved services imply the study population to have a physical access for vet service, health centers and schools in their vicinity. In contrast to these, access for market centers and availability of sustainable water sources is very poor. The majority of households get weather forecast information through traditional ways, and the information generated by these approaches have no scientific base and are not reliable in face of the dynamic nature of the problem. In general, the overall assessment shows the respondents to have weak economic status and institutional arrangement which implies the poor adaptive capacity of the study population and, hence, their expected vulnerability to effects of climate change is very high.

5.2.2 Exposure to Climate Variability and Change

Exposure to climate change is defined by occurrence of extremes, change or variability of temperature and rainfall from their mean values. To explain the exposure of the sample population both primary and secondary data are used. The secondary sources revealed what has happened in the area at the aggregate level in scientific terms while the primary data is used to capture the perception of households on the issue.

i. Drought

According to the information obtained from the Zonal Disaster Preparedness and Prevention Committee, drought has occurred in *woreda* 3 times in the past 10 years. The sample populations' perception on the issue is that, 60(76.92%) of pastoral respondents and 47(64.38%) of agropastoral households replied that the occurrence of drought and

frequency showed an increasing trend. 25(34.25%) of agropastoral households and 18(23.08) of pastoral household respondents felt a decreasing trend in drought.

ii. Temperature

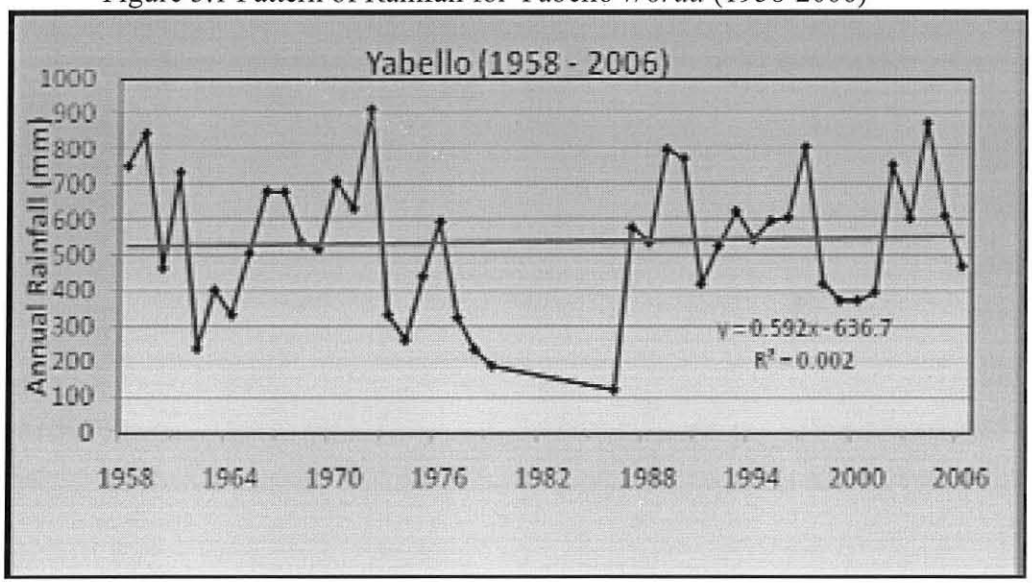
Temperature of the *woreda* is characterized by an increasing trend and high interannual variability. The average annual temperature of the *woreda* is about 25.8°C and it has been experiencing an increasing trend of temperature over the past decades (Aklilu and Alebachew, 2009). The perception of the sample population on the subject is similar to the above description. 73(93.59%) of pastoral households and 58(80.56%) of agropastoral respondents witnessed temperature increment in their area. 5(6.41%) of pastoral and 14(19.47%) of agropastoral households perceived a comparative decline of temperature in their surrounding.

iii. Rainfall

The study area has a biannual rainfall mode and on the main rainy season '*Ganna*' it receives up to 500 mm per year, and 100 mm in *'Bonna'* period averaging 300 mm per year. Fig 5.1, shows the seasonal rainfall variability of the *woreda*. Moreover assessments of the *Ganna* (main rainy season) at Borena (zonal level) between May 2006 and June 2009 revealed that rainfall received during the main season has been very low and scanty. The rainfall was not only below normal but also late by more than two weeks and stopped too early to enhance the normal growth of crops, grasses and herbaceous species in the zone (Aklilu and Alebachew, 2009).

Looking into the sample population perception of the issue, 51(65.38%) of pastoral households stated rainfall to show a decreasing pattern. But majority of the agropastoral (i.e. 57.53%) households opposed to this and claimed rainfall to show an increasing trend. The inconsistency might be a result of the high intervariability of rainfall in the area. Regarding to the timing of rainfall starting period, 40(54.79%) of agropastoral households and 73(93.59%) of pastoral respondents replied that rainfall not to start on usual time.

Figure 5.1 Pattern of Rainfall for Yabello *Worda* (1958-2006)



Source: Adopted from Aklilu and Alebachew, 2009

5.2.3 Sensitivity to Climate Change

Sensitivity to climate change is the degree to which a community is adversely or beneficially affected by climate related stimuli. It largely depends on livelihood activities of the community, its key livelihood resources and the impacts of climate hazard on these key resources (Riche *et al.*, 2009).

Both of the social groups of the study interest are highly dependent on environmental and natural resources for their survival and hence, they are highly sensitive to climate variability. Changes in rainfall pattern and temperature, recurrent occurrence of extreme events (like drought) aggravate their vulnerability by reducing the productivity of factors of production. According to IPCC (2001), in countries like Ethiopia where dry land Pastoralism and rainfed agriculture predominates, the productivity of many livestock, pasture and crop species, which are already near their maximum temperature and drought tolerance, is expected to decrease, even with minimal increase in temperature

.

In the study area, decline of range quality and pasture, bush encroachment, and drying of water sources are considered to be the main impacts of climate change at the community

level. The majority of respondents, 61.54% of pastoral households and 52.05% agropastoral households' stated that due to variability of the climatic condition of the area, the quality of grass has been decreasing and has become unable to meet their demands. Interview held with the key informants from the *Woreda* pastoral development bureau also coincides with this statement. According to the key informants, bush encroachment and expansion of some thorny species in the area have kept a wide range of land out of use or access. (See figure 5.2)

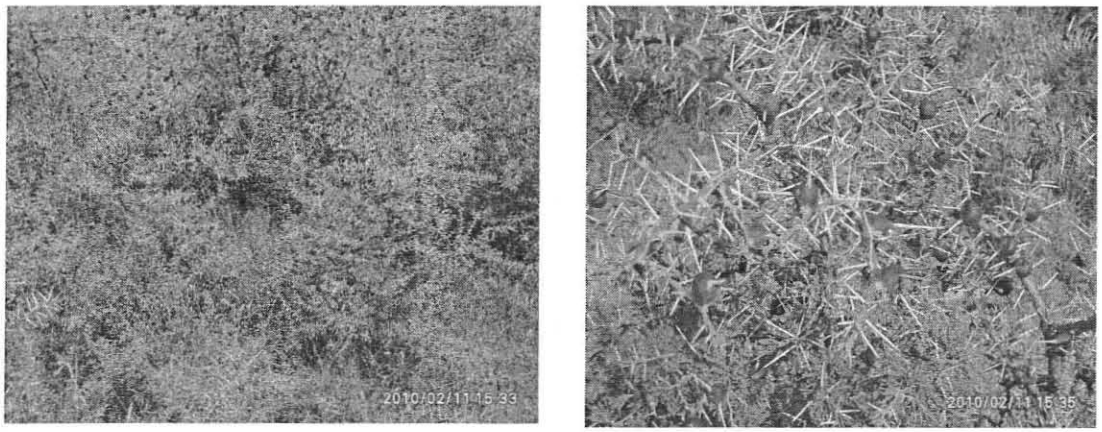


Figure 5.2. Pictures of thorny encroaching species (Acacia drepnolobium), taken in Dharitto Kebele

In the study area climate change has various impacts at a household level. Analyzing the impact of climate change in pastoral community at a household level revealed that, death of livestock to be the severe one. 82.05% of respondents claim to lose their livestock related to recurrent drought in the area. In addition to this, the market doesn't favor these households in such moments. 53.85% of the respondents indicate livestock price decrease and fall of demand made them unable to sell their animals, while 10.26% stated that the price of crops showed an increasing trend. And these have great implication on household income and food security status. 73.08% of the pastoral respondents state to face food shortage in such periods. As a consequence of these, 56.41% of pastoral respondents have experienced loss (death) of household members.

Table 5.9. HH level impact of climate change as perceived by the sample population [N(AP)= 73, N(PAS)= 78]

Impact of climate change	Pastoral HH		Agropastoral HH	
	Frequency	%	Frequency	%
Livestock death	64	82.05	71	97.26
Loss of harvest	-	-	61	83.56
Death of HH members	44	56.41	60	82.19
Food Shortage	57	73.03	33	45.21
Livestock price reduction	42	53.85	32	43.84
Increased price of crops	8	10.26	7	9.59

Source: Household survey, February, 2010

On the other hand, the agropastoral households face both harvest and livestock loss in such times. 97.26% and 83.56% of the respondents indicate to have lost their animals and to face loss of harvest in relation with climate change induced hazards, respectively. Though, we expect them to benefit from increased price of crops at these times, it is almost insignificant compared to their aggregate loss (death of livestock, loss of harvest and decreased price of livestock). 45.21% of the respondents of this group indicated climate change to aggravate food shortage. In general, these natural and economic shocks have made 82.19% of the respondents to experience a loss of their family members in such times.

Table 5.10. Impacts of climate change induced conflicts on households [N(AP)= 28, N(PAS)=35]

Consequence of Conflicts	Pastoral HH		Agropastoral HH	
	Frequency	%	Frequency	%
Death of livestock	19	54.29	4	14.29
Livestock raiding	10	28.57	4	14.29
Death of HH member	2	5.71	1	3.57
Death of relatives	3	8.57	2	7.14
Physical Injuries	3	8.57	4	14.29
No significant harm	5	14.29	18	64.29

Source: Household survey, February, 2010

Conflicts over resource utilization have been another impact of climate change. In the study area 35(44.87%) pastoral households and 28(40%) of agropastoral respondents have faced such incidences while moving in search of water and pasture in bad climatic

conditions. From the figures we can conclude that conflicts to be relatively higher in pastoral areas than agropastoral households.

Looking into what has been the consequence of these conflicts on households, 54.29% and 28.57% of pastoral respondents suffered from death and raiding of their livestock, respectively. Regarding impact on people, 5.71% of the sample respondents have lost a family member, while 8.57% of the respondents witnessed death of nearby relatives. Despite engagement in the conflict, 14.29% of the respondents faced no significant harm /damage while 8.57% of the respondents faced some physical injuries only.

In the case of agropastoral respondents, though engaged in conflict, the majority (64.29%) have not faced a significant harm. 14.29% of the respondents' stated physical injuries as a result of these conflicts. About 28% of the respondents of the group have experienced livestock raiding and death due to climate change induced conflicts and disputes.

In summary, the study populations' exposures for gradual climatic conditions like temperature and precipitation pattern change have increased. Increased temperature conditions and decline in rainfall amount accompanied with high variability has become the common feature of the area. The occurrence of extremes like drought has shown an increasing trend. In association with these climatic conditions the sensitivity of the environment and the population has increased. Due to these changes the productivity of range lands has decreased. Drying of water sources has shown an increasing trend that aggravates the scarcity of water in the area. And this has become a source of conflicts in the area. In general terms sensitivity and exposure of the area has shown an increasing trend and have aggravated the vulnerability of the local community that are highly dependent on the environmental resources for their livelihood.

Chapter Six

6. Estimation of vulnerability Indices and Discussions

To analyze the vulnerability of the study population, PCA was run on selected 21 indicator variables that were specified in Table 4.2 of section 4.4.1 using data analysis and statistical software (STATA). The number of principal components extracted can be defined by the user and a common method used is to select components where the associated eigenvalues is greater than 1 (Vias and Kumaranayake, 2006). In our case 21 components were extracted, but only the first eight were significant based on the above criterion or Kaiser criterion of an eigenvalues greater than 1*.

The eigenvalue (variance) for each principal component indicates the percentage of variation in the total data explained (Vias and Kumaranayake, 2006). In the studies reviewed by the author, the first principal component accounts for a range from 11.1% (Vias and Kumaranayake, 2006) to 56% (Deressa et al., 2008) of total variation.

In our case the first component explained about 10.24% of the total variance in the selected indicators. Based on earlier arguments for the use of PCA in constructing indices, the first principal component was used in calculating the vulnerability indices of households in the study area. The factor scores (weights) from the first PCA are negatively associated with all the indicators identified under exposure and sensitivity and with the exception of one variable, are positively associated with indicators identified under adaptive capacity (See Table 6.1 column 4).

Based on the factor scores weight distribution, variables that have higher weight or that contribute more to the aggregate index in the context of the study populations' adaptive capacity are; access to sustainable water sources (like boreholes), saving in cash, access to market centers and household leadership role rank the first four spots according to their

* The eigenvalue is a measure of standardized variance with a mean of 0 and standard deviation of 1. Each standardized variable (i.e. each of 21 indicators in this case) contributes at least the variance of 1 to the principal component extraction. The Kaiser criterion states that unless a principal component extracts at least as much as one of the original variables (i.e. has a standardized variance equal to or greater than 1), it should be dropped from further analysis (Filmer and Pritchett, 2001 cited in Longyintoo, 2005).

order. From variables that are identified under sensitivity the higher weight in absolute value (since sensitivity is loaded negatively) goes to water scarcity which is defined by percentage of household that are subject to water relief or rationing program followed by households that face conflict. In the case of exposure the higher weight goes to rainfall decrease followed by increased frequency of drought and increased temperature.

Thus, to construct the vulnerability indices, out of the 21 indicators selected initially only 20 indicators were used by dropping the variable that has negative sign in contrast to the initial assumption. Taking into account that adaptive capacity is loaded positively and exposure and sensitivity indicators negatively, we expect higher values of the vulnerability index to show less vulnerability, and vice versa.

Table 6.1 Summary statistics of selected variables and the factor score from the firstPCA

Indicator variables	Mean	Standard deviation	Factor score
Camel ownership	0.3510	0.4789	0.2125
Non agricultural income	0.2781	0.4496	0.2304
Saving in cash	0.4106	0.4936	0.3669
Extension service	0.1258	0.3328	0.0379
Veterinary service	0.7947	0.4053	0.1544
Access to market	0.4238	0.4958	0.3280
Micro financial Institutions	0.4636	0.5003	0.1083
Water sources	0.3974	0.4910	0.3681
Health facilities	0.9272	0.2608	0.1015
Sex	0.9272	0.2608	0.1043
Literacy	0.0530	0.2247	0.1250
Radio ownership	0.4702	0.5008	0.1501
Leadership role	0.1921	0.3952	0.3000
Food shortage	0.5166	0.5014	-0.1915
Water relief	0.6755	0.4697	-0.2303
Conflicts	0.5894	0.4936	-0.2283
Perception on temperature increase	0.1391	0.3472	-0.2388
Perception on rainfall decrease	0.4570	0.4998	-0.2665
Perception on rainfall variability	0.2517	0.4354	-0.0287
Perception on frequency of drought	0.3046	0.4898	-0.2585

Source: Household survey, February,2010

6.1 Results of Household Vulnerability Index (VI_{HH})

Using equation 4 (see section 4.5) and the factor score results from the first PCA were used to construct a normalized vulnerability index of a household applying the following formula:

$$VI_{HH} = [f_i (a_{ji} - x_i)]/s_i$$

Where VI_{HH} is a standardized vulnerability index of each household;
f_i factor score from the PCA assigned to the indicator variables (K= 20);
a_{ji} the value of each household on the indicator variables;
x_i the sample mean of each selected variables [column 2 of Table 6.1];
s_i the standard deviation [column 3 of Table 6.1]

Holding exposure and sensitivity constant a negative index shows the household to have relatively lower adaptive capacity when compared with a household that has a positive index value and vice versa.

Based on this a total of 151 indices were calculated for the sample population. After sorting these standardized indices (VI_{HH}) in ascending order, 3.28 and -2.93 were identified as the maximum and the minimum score of the sample population. The mean score of VI_{HH} for the total population is 0.01. Cutoff values were defined by the researcher to classify the households on their VI_{HH} score result into three different classes which imply different degree of household vulnerability. The classifications are; households that scored a negative index are categorized as 'highly vulnerable', households that score from 0 to 2 as 'vulnerable' and households that score an index value greater than 2 as 'less vulnerable'.

Table 6.2. HH classification into different vulnerability classes based on VI_{HH} index score

Category	Social group				Total	
	AP (N= 73)		PAS (N= 78)		N= 151	
	No	%	No	%	No	%
Highly vulnerable [VI_{HH} <0]	46	63.01	30	38.47	76	50.33
Vulnerable [$0 \leq VI_{HH} \leq 2$]	24	32.88	36	46.15	60	39.74
Less vulnerable [$VI_{HH} > 2$]	3	4.11	12	15.38	15	9.93

Source: Household survey, February, 2010

Based on our classification criteria, from the sampled population 76 (50.33%) of the households fall in 'highly vulnerable' category by scoring VI_{HH} value less than 0. The minimum scored index is -2.93. Nearly 40% of the sample households are categorized as 'vulnerable' by scoring VI_{HH} value between 0 and 2. From the total sample population 15 (9.93%) scored a VI_{HH} value greater than 2, and hence, they are classified as 'less vulnerable'.

When we analyze the distribution of VI_{HH} score by households' economic activity, 46 (63.01%) of agropastoral households score a VI_{HH} value less than zero while in the case of pastoral households' they account for 30 (38.47%). In the category of 'vulnerable' i.e. a VI_{HH} score between 0 and 2, there are 24 (32.88%) of agropastoral households and 36 (46.15%) of pastoral households. Higher percentages of pastoral households fall in this category. 3 (4.11%) of agropastoral households and 12 (15.38%) of the pastoral households are considered as 'less vulnerable' since they scored a VI_{HH} value greater than 2. When we compare the mean VI_{HH} score for the two social groups of households, the pastoralists have a relatively higher mean score of VI_{HH} against the agropastoral households (0.44 Vs -0.45).

In general, based on the VI_{HH} score distribution of the study subjects the majority (50.33%) of households are highly vulnerable i.e. compared with their exposure and sensitivity their adaptive capacity or ability to absorb these shocks is minimal. From the view of social groups, the VI_{HH} score distribution reveals that agropastoral households to be more vulnerable than pastoral households to climatic shocks in the study area.

Table 6.3. Social group vulnerability indicator variables and their respective standardized values

Major components	Indicator variables	Unit of measurement	AP	PAS	Standardized value $P_{sg} = \frac{P_{sg} - P_{\min}}{P_{\max} - P_{\min}}$	
					AP	PAS
Wealth	HH that own camels	Percent	19.18	50.00	0.1918	0.5000
	HH which save in cash	Percent	36.99	45.45	0.3699	0.4545
	HH that have access to non agricultural income	Percent	23.29	31.17	0.2329	0.3117
Technology	HH that use Extension service	Percent	89.04	88.31	0.8904	0.8831
Institution	HH that use vet service	Percent	90.41	69.23	0.9041	0.6923
and	HH that have good market access	Percent	42.47	41.03	0.4247	0.4103
Infrastructures	HH that are member to saving and credit association	Percent	43.84	48.72	0.4384	0.4872
	HH with better access to sustainable water sources	Percent	23.29	55.13	0.2329	0.5513
	HH that use health facilities	Percent	95.89	89.74	0.9589	0.8974
Information	HH literacy	Percent	5.48	5.20	0.0548	0.0520
source	HH that own radio	Percent	46.58	47.44	0.4658	0.4744
Sensitivity	HH that subject to food aid	Percent	52.11	50.00	0.5211	0.5000
	HH that faced conflicts	Percent	40.00	44.87	0.4000	0.4487
	HH that subject to water relief	Percent	82.19	53.85	0.8219	0.5385
Exposure	HH that perceive increased temperature	Percent	80.56	93.59	0.8056	0.9359
	HH that perceive decreased rainfall	Percent	42.47	65.38	0.4247	0.6538
	HH that perceive high rainfall variability	Percent	54.79	93.59	0.5479	0.9359
	HH that perceive increased frequency of drought	Percent	65.75	76.92	0.6575	0.7692

Source: Household survey, February, 2010

6.2 Results of the Social Vulnerability Index (VI_{sg})

To calculate the VI_{sg} first we need to standardize the indicator values into scale free measurements. The standardized values for the study subjects are given in Table 6.3.

Using these standardized values, the VI_{sg} is calculated based on equation (7) that is defined in section 4.4.2. The summarized results of the VI_{sg} of the study subjects are presented in Table 6.4. (Detailed calculating procedure of VI_{sg} for the two social groups is found in annex 1). As we can see from the table, the standardized social vulnerability index score for pastoralist is (0.035) while the agropastoralist vulnerability index equals (0.003).

Table 6.4. Results of VI_{sg} calculation for Pastoral and Agropastoral Social groups

Determinants of vulnerability	Agropastoralist	Pastoralist
Adaptive capacity	4.283	5.262
Sensitivity	(1.755)	(1.487)
Exposure	(2.479)	(3.147)
VI_{sg}	**0.003**	**0.035**

Source: Household survey, February, 2010

Based on our earlier assumption of higher net values indicate a relatively lesser vulnerability of social group argument, when we make the comparison of the study subjects using their respective scores, it can be seen that the agropastoralist group to be more vulnerable than the pastoralists (0.003 Vs 0.035).

The findings of the study reveal higher vulnerability of agropastoralist households in the study area. The VI_{HH} which gives the vulnerability score of household shows from the total sampled population, half of them to be 'highly vulnerable'. Among the 'highly vulnerable' sample households, the agropastoralists account for about 61%. In the case of VI_{sg} score, the agropastoralists have a relatively lower index value which implies a relatively higher vulnerability of the group.

6.3 Discussion of the finding

To explain the higher vulnerability of agropastoralists it is very important to look into the historical and actual practice of farming activity in the area. Historically, farming practices (crop production) was started in the area as an economic diversification strategy by destitute households that have lost their asset (i.e. livestock) through the recurrent droughts (Oba, 1998). From this statement we can learn that the economic status of agropastoral households to be lower. [They are either destitute or has lost their assets]. Since wealth and adaptive capacity are correlated positively, the lower economic status of these households implies their lower adaptive capacity. Given this low adaptive capacity, when these households are exposed to climatic shocks their sensitivity is higher. In addition to these in the study area higher rainfall variability and recurrent droughts have contributed towards shortening of recovery period. Due to these facts, these households were not able to come out of the trap yet, and hence, their vulnerability has been increasing.

Looking into the current agricultural practice of the study population the sampled agropastoral households' cultivate an average of 6.5 *Timad* of land using oxen draught power. Though, the *woreda* has a biannual rainfall mode, farming practices usually takes place in the longer (*Ganna*) rainy season only. Modern input utilization of these households' is very poor. According to the information gathered from the in-depth case studies with the members of the social group and the key informants, there is no consistent supply of agricultural inputs like fertilizer, improved seed, and pesticides and herbicides in the *woreda*. Based on the household survey result all the sampled households don't have access to fertilizer. About 45% of households' state to use improved seed whenever it is provided to them by the NGO's or in the form aid otherwise there is no regular supply of the input in the sampled *kebeles*.

In the sampled *kebeles* there are no irrigation schemes. Therefore all households practice rainfed agriculture. But as mentioned previously, the rainfall condition of the *woreda* is not in favor of these households. High rainfall variability, shortening of rainy days, and

increased temperature conditions have induced reduction of productivity, and when such conditions are accompanied by extremes like droughts the result is a complete loss of production. In our case, 70 (95.89%) of the agropastoral households stated to suffer from a complete loss of their harvest in such periods. Hence these situations dwindle households' income and food selfsufficiency conditions both in short term and long- run the vulnerability of these households is expected to increase.

In their assessment of impacts of drought on agriculture in two villages of Borena, Kebebew *et al.* (2001) have identified the problems that are related with farming activities in the area. According to the response of households interviewed by the authors, the households often sow crops at the beginning of the rainy season and when rainfall is inadequate they loose both planting seeds and the yield. Some times the impact goes beyond these and had a negative outcome due to the fact that some households have to sell animals to buy inputs for agricultural production. Finally, the households indicated that crop production not to be a sustainable venture in the rangelands, and even increase their dependency on food relief aid. In spite of these, they always try to produce crops but without success in most of the times (Kebebew et al., 2001). From these we can conclude that sensitivity of the agropastoral households to climatic variability and change to be relatively higher.

Selection of appropriate adaptive mechanisms prior to actual exposure has great impact in reducing sensitivity and hence aggregate vulnerability. A household's perception has important role in selecting adaptive strategies even when households are exposed to similar situation. In our case study in comparative terms, higher percentage of pastoral households have a better understanding of the changes of climatic conditions that coincide with the scientific or metrological data. The researcher believes that this has its own contribution to the higher vulnerability of agropastoral households in the study area. A good case that supports this argument is, despite increasing trend of short rainy days in the area the majority (99%) of agropastoral households in the area sow maize which requires a longer maturity period. Instead, if households shift to production of crops that

require shorter maturity period, the relative per capita productivity of a household increases and, hence, reduces household's vulnerability.

The other critical advantage of pastoral households over the agropastoralist is mobility. Based on the information collected from key informants from zonal office, though, the degree of movement has shown a decreasing trend in general terms, the pastorals still use the approach as a coping mechanism at times of climatic shocks. From our survey, 78% of pastoral households indicated sending their livestock elsewhere when the climatic conditions get worse in their vicinity. Though, the agropastoralists too adopt this strategy for their livestock, it is not possible for them to skip from the impacts that are associated with loss of harvest.

In conclusion, the arid condition of the area, high climatic variability, increased degradation of the environment, and low levels of technological development all together makes rainfed agriculture unsustainable practice in the study area. And this has made agropastoral households to become highly vulnerable to the effects of climatic change and variability.

Chapter Seven

7. Conclusion and Recommendations

7.1 Conclusion

Now it is widely accepted that the climate is changing and will continue to change at rates unprecedented in recent human history (Ford, 2008). Though the impacts of climate change are not limited spatially and temporally, the degree in which regions, countries, social groups and households are affected by these climatic variability's and shocks are not uniformly distributed.

Ethiopia is highly vulnerable to climate change because of its greater reliance on climate sensitive economic sectors like subsistence crop cultivation and livestock production. Moreover, the geographic location of large part of the country in arid and semiarid climatic conditions makes the country highly exposed to effects of desertification and droughts. Though symptoms are widespread in many places of the country the southern lowlands which are occupied by pastoral and agropastoral communities are among highly affected ones and suffer most from the impacts of climate change induced hazards (Akililu and Alebachew, 2009). This study was aimed at measuring and comparing the relative degree of vulnerability of households by taking the case of agropastoral and pastoral households of Yabello worda in Borena zone of Oramia Regional state.

To measure vulnerability, the study adopts the integrated vulnerability approach and used vulnerability indicator method to determine the level of vulnerability of households and social groups. The selection of vulnerability indicator variables was made based on review of literature and context of the study population. Then, household vulnerability index (VI_{HH}) and social group vulnerability index (VI_{sg}) was calculated to show the relative vulnerability of households and social group, respectively. In calculating the vulnerability indices adaptive capacity is loaded positively and exposure and sensitivity negatively, and therefore higher net values imply relatively lesser vulnerability of household or social group.

In this paper vulnerability was considered as the net effect of adaptive capacity, sensitivity and exposure of a system. These interdependent driving processes determine the vulnerability of a system or a household. In the study adaptive capacity was determined by wealth, access to modern technology, institutional and infrastructure availability and household access to information. The result of the survey show the majority 75.33% of the sample population use purchase of livestock to accumulate their wealth. The other strategies include save in cash (41.33%) and engage in petty trade activities (22.67%). The sample population has low access to modern techniques of production and inputs. With regard to institutional and infrastructure availability, the people have good access for vet service, health centers and primary schools, though, the service provided by these institution is not sufficient enough to meet the expectation of the local people. In the sampled *kebles* there are no sustainable water sources for both domestic consumption and livestock watering purposes. Therefore, the majority of households use unsafe and unclean water that increase vulnerability to water born deceases and associated health problems. Unavailability of livestock market centers in the sampled *kebeles* made regular market visit difficult and only 41.72% of the total sample population visit market centers at least once in two weeks time. In general terms, the points discussed above show the lower adaptive capacity of the study households.

Drought has been a common phenomenon in the *woreda* and the area is suffering from shortening of drought cycle in recent times. The mean temperature of the *woreda* is 25.8^0c and has been showing an increasing trend. Rainfall is characterized by higher variability, and shortening of rainy days have increased in the area. The perception of the sampled population in the direction of change of the climatic variables coincides with the above scientific facts. 87.33% and 54.30% of respondents stated increasing and decreasing tendency of temperature and rainfall conditions in the area, respectively. 70.86% of households indicated increased frequency of drought. These show the higher exposure of the *woreda* for both gradual and extreme conditions of climatic variability.

Sensitivity to climate change is the degree to which a community is adversely or beneficially affected by climate related stimuli. In the study area impacts of climate change include environmental degradation that aggravate pasture and range quality deterioration, expansion of encroaching species and drying of water sources. At a household level the impact include death of livestock and harvest loss. Due to these, food shortage has become a prominent problem in the area. In addition to these, 68.87% of the sampled population has experienced death of family members in association with climate induced hazards. In general, higher dependency of the study population on the environment have made them to become highly sensitive to effects of climate change and, hence, increased their vulnerability.

Vulnerability indices were constructed using selected indicator variables that show adaptive capacity, sensitivity and exposure of households and social groups. The calculation of VI_{HH} for the sample population shows 50.33% of households to score a VI_{HH} value less than 0, which implies the net effect of households' adaptive capacity to be less than their sensitivity and exposure. These are classified as 'highly vulnerable' households. Analysis of VI_{HH} score by household's economic activity indicates, from households that are classified as 'highly vulnerable' the agropastoralists take the upper hand and constitute 60.53% of the group. Generally, comparison of households by their VI_{HH} score reveals more agropastoralist households to be more vulnerable than pastoralist households in the study area.

The comparison of VI_{sg} index score of agropastoralists and pastoralists indicate the relatively lesser vulnerability of the pastoral group. The VI_{sg} score of pastoralists (0.035) is relatively higher than the VI_{sg} score of agropastoralists (0.003). Holding exposure and sensitivity constant, this implies a relatively higher resilience of the pastoral livelihood system to climatic shocks and variability in the study area.

The explanations for higher vulnerability of agropastoralists in the study area include a relatively lower economic status of members of the social group. Agriculture was started in the area by destitute and households that lost their asset through droughts as a

diversification strategy. But the increased frequency of drought and erratic rainfall conditions made these household unable to come out of the poverty trap and yet increased the vulnerability of these households.

In the study area agricultural activities are not supplemented by application of agricultural inputs and modern production techniques. There are no irrigation schemes or rainwater harvesting practice in the sampled kebeles to meet agricultural water demand that arise from shortage of rainfall. Therefore, a complete dependence on rainfall makes agricultural practice a highly risky venture in the lowlands. The other issue is that the households have no sufficient experience of agricultural knowledge (cropping practices) and this by it self has contributed for less performance of the sector.

Finally, the increased exposures of the area to climatic variability and shocks have led the deterioration of the environmental and natural resources in which these households have based their livelihood and as a result their sensitivity has been increasing. Moreover lack of technical, financial and institutional capacity at the *woreda* level has led to limitation of adaptive capacity and, hence, vulnerability of households to climate change is expected to increase.

7.2. Recommendations

- Due to higher climatic variability, low technological access, and input applications in the woreda, farming practice has increased the vulnerability of households that depend on it as their prime livelihood strategy. Therefore, prior to adoption of farming as a diversification strategy in the area, the mechanisms in which these factors could be supplied need to be given due consideration.

- Climate change has increased environmental degradation and expansion of encroaching vegetations that have led to decline of pasture land and quality. To tackle these challenges, implementing agencies and development partners need to take environmental conservation initiatives that involve the public at large. In

addition to these, research activities that enhance natural resource management practice and rangeland improvement and productivity need to be undertaken.

- To increase adaptive capacity interventions should aim to promote investment in and development of infrastructures and services. Provision of health facilities, vet service, schools and sustainable water sources reduce vulnerability by increasing the productivity of labor and livestock. These also help to reduce conflicts that are associated with scarce resources utilization. Improvement of market conditions and expansion of micro financial institutions encourage diversification by creating opportunities and resolving liquidity problems. These enable pastoral households to have an alternative wealth accumulation mechanism and promote non livestock savings.

- To reduce impacts of climate change access to weather forecast and early warning information have important role. To this end, a strong integration between information providers and receivers (from national up to grass root level) need to be established. Provision of early warnings and weather forecasts on community radios using local languages will help increasing accessibility of the information.

- Finally in designing adaptive strategies, incorporating traditional knowledge and involvement of local communities need to be considered. Capturing the local peoples' experience and perception on the issue helps to develop sustainable alternatives that are locally contextualized.

List of Reference

Adger, W.N. 1999. Social Vulnerability to Climate Change and Extremes in Coastal Vietnam World Development vol.27, No 2 pp 249, 1999

Adger, W.N. and Kelly, M. 1999. Social vulnerability to climate change and the architecture of entitlements. Mitigation and adaptation strategies for Global change 4: 253-266.

Adger, W.N. Brooks, N. Bentham, G. Agnew, M. and Eriksen, S. 2004. New indicators of vulnerability and adaptive capacity. Tyndall Center for Climate Change Research, Technical Report 7

Aklilu Amsalu and Alebachew Adem 2009. Assessment of Climate Change Induced Hazards, Impacts and Responses in the Southern Low lands of Ethiopia, FSS Research Report No. 4, A.A Ethiopia

Brooks, N. 2003. Vulnerability, risk and adaptation: A conceptual framework. Tyndall Center for Climate Change Research, Working Paper 38

Brooks, N., Adger, W.N. and Kelly, P.M. 2005. The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. Global Environmental change 15 (2005) 151-163

Central Statistical Agency (CSA) 2009. Summery and Stastical Report of the 2007 Population and Housing Census Population Size by Age and Sex.

Cutter, S.L. 1996. Vulnerability to Environmental Hazards. Progress in Human Geography 20,4 (1996) pp. 529-539

Cutter, S.L. Emrich, C.T. Webb, J.J. and Morath, D. 2009. Social Vulnerability to climate Variability Hazards: A review of the Literature, A final report to Oxfam America.

Cutter, S.L. Mitchell, J.T and Scott, M. 2000 Revealing the Vulnerability of people and places: A case study of Georgetown County, South Carolina. Annals of the Association of American Geographers, 90 (4), 2000, pp 713-737

Cutter, S.L., Boruff, B.J. and Shirley W.L 2003. Social vulnerability to environmental hazards. Social science quarterly, volume 84, Number 2, June 2003

Deressa, T. Hassan, R.M. Ringler, C. 2008. Measuring Ethiopian Farmers Vulnerability to Climate Change across Regional States. IFPRI Discussion Paper 00806

Eakin, H. and Luers, A.L. 2006. Assessing the Vulnerability of Social-Environmental Systems. Annu. Rev. Enviorn. Resour. 2006.31:365-394

Eriksen, S.H. and O'Brien, K. 2007. Vulnerability, poverty and the need for sustainable adaptation measures. Climate policy 7 (2007) pp 337-352

Filmer, D. and Pritchett, L.H. 2001. Estimating Wealth Effects without Expenditure Data- or Tears: An Application to Educational Enrollments in States of India. Demography, Vol. 38, No. 1 (Feb.,2001), pp 115-132

Freeman, H.A., Kaitibie, S., Moyo, S. and Perry, B.D. 2008. Livestock, livelihoods and vulnerability in Lesotho, Malawi and Zambia: Designing livestock interventions for emergency situations. ILRI Research report 8. Nairobi, Kenya.

Füssel, H. 2007. Vulnerability: A Generally Applicable Conceptual Framework for Climate Research. Global Environmental Change 17(2):155-167

Füssel, H. and Klein, R.J.T. 2006. Climate Change Vulnerability Assessments: And Evolution of Conceptual Thinking Climate Change 75(3):301-309

Gaiha, R. and Imai, K. 2008. Measuring Vulnerability and Poverty: Estimates for Rural India. UNU-WIDER Research paper No.2008/40.

Hahn, M.B., Riederer, A.M. and Foster, S.O. 2009. The livelihood vulnerability Index: A pragmatic approach to assessing risks from climate variability and change- A case study in Mozambique. Global Environmental Change 19 (2009)74-88

Hamouda, M.A., Nour El-Din, M.M. and Moursy, F.I. 2009. Vulnerability Assessment of water resources in the Eastern Nile Basin. Springer science + Business Media B.V. 2009

Hein, L. Metzger, M.J. Leemans, R. 2009. The local impacts of climate change in the Ferlo, Western Sahel. Climatic change (2009) 93:465-483.

Heltberg, R. Siegel, P.B., Jorgense, S.L. 2009. Addressing Human Vulnerability to Climate Change toward A No –Regrets' Approach Golobal Environmental Change 19 (2009) 89 – 99

Hoddinott, J. and Quisumbing A. 2003. Methods for Microeconometric Risk and Vulnerability Assessments. International Food Policy Research Institute, Washington D.C.

Huq,S. Rahmon, A. Konate, M.Sokona, Y and Reid, H. 2003. Mainstreaming Adaptation to Climate Change In Least Developed Countries (LDCS). International Institute for Environment and Development, Nottingham, UK

Intergovernmental Panel on Climate Change (IPCC) 2001. Climate Change the Scientific Basis. Available at http://www.ipcc.et/

Intergovernmental Panel on Climate Change (IPCC) 2007. Climate Change 2007: Synthesis Report :Available at http://www.ipcc.et/

Kebebew, F. Tsegaye, D. and Synnevag, G. 2001. Traditional coping strategies of the Afar and Borana Pastoralists in response to drought. Drylands coordinations group Report No. 17

Kelly, P.M. and Adger, W.N. 2000. Theory and practice in assessing vulnerability to climate change and facilitating adaptation. Climate change 47 (2000) pp 325-352

Langyintuo, A.S., Hamazakaza, P., Nawale, E. and Jere, I. 2005. Maize production System in Zambia: Setting Indicators for Impact Assessment and Targetting. Harare, Zimbabwe 2005

Leichenko, R and O'Brien, K. 2001. The dynamics of rural vulnerability to global change: The case of southern Africa. Mitigation and adaptation strategies for Global change 7:1-18, 2002.

McSweeney, C. New, M. and Lizcano 2008. UNDP Climate change country profile for Ethiopia. Available at: http://country-profiles.geog.ox.ac.uk

National Metrological Agency (NMA) 2007. Climate change national adaptation programme of action (NAPA) of Ethiopia. Addis Ababa, Ethiopia

National Metrological Service Agency (NMSA) 2001. Initial National Communication of Ethiopia to the United Nation Frame Work Convention on Climate Change (UNFCC), Addis Ababa, Ethiopia

Naude, W. Santos-Paulino, A.U. and McGillivray, M. 2009. Measuring Vulnerability: An overview and introduction. Oxford Development Studies, 37:3, 183-191

O'Brien, K., and Leichenko, R. 2005 Climate Change Equity and Human Security Human Security and Climate Change an International Workshop, Askel Near Oslo, 21-23 June 2005.

O'Brien, K., Leichenko, R., Kelkar, U., Venema, H., Aandahl, G., Tompkins, H., Javed, A., Bhadeval, S., Barg, S., Nygraad, L. West, J. 2004. Mapping Vulnerability to Multiple Stressors: Climate Change and Globalization In India JGEC 442, pp 1-11

Oba, G. 1998. Assessment of Indigenous Range Management Knowledge of the Boran Pastoralists of Southern Ethiopia.

Olmos, S. 2001. Vulnerability and Adaptation to Climate Change Concepts Issues Assessment Methods; Available at www.eckn.net.

Pantuliano, S and Wekesa, M. 2008. Improving Drought Response In Pastoral Areas of Ethiopia, Somali and Afar Regions and Borena Zone of Oromia Region. Humanitation Policy Group Overseas Development Institute, London

Rass, N 2006. Policies and Strategies to Address the Vulnerability of Pastoralists on Sub-Saharan Africa, PPLPT Working Paper No 37

Riche, B., Hachileka, E. and Awuor, C.B. 2009. Climate-related vulnerability and adaptive capacity in Ethiopia's Borana and Somali. Final assessment report, August 2009.

Shlens, J. 2003. A tutorial on Principal Components Analysis; Derivation, Discussion and Singular Value Decomposition.

Smit, B. and Wandel, J. 2006. Adaptation, adaptive capacity and vulnerability. Global Environmental Change 16 (2006)pp.282-292

Smith, L.I. 2002. A tutorial on Principal Components Analysis.

Vyas, S. and Kumaranayake, L. 2006. Constructing socio-economic status indices: how to use principal component analysis. HIV Tools Research Group, Health Policy Unit, Department of Public Health and Policy, London School of Hygien and Tropical Medicine, London ,UK.

Watson,J (2001). How to determine a sample size: Tipsheet#60, University park, PA: Penn state cooperative extension Available at: http://www.extension.psu.edu/evaluation /pdf/Ts60.pdf

Yabello Woreda Pastoral area Development Bureau (YWPDB) 2009. Annual and Monthly reports. Unpublished documents; Yabello, Borena Zone.

Young, G., Zavala, H., Wandel, J., Smit, B., Salas, S., Jimenez, E., Fiebig, M., Espinoza, R., Diaz, H. and Cepeda, J. 2009. Vulnerability and adaptation in a dryland community of the Elqui Valley, Chile. Climatic change published on October 10, 2009.

Annex 1. Vulnerability index calculation for social group

Adaptive capacity

$$A_{PAS} = \frac{\sum_i^j f_i P_{PAS}}{\sum_i^j f_i}$$

$$= \frac{\begin{array}{l}(0.5\times 0.2125)+(0.4545\times 0.3669)+(0.3117\times 0.2304)+(0.8831\times 0.0379)\\ +(0.6923\times 0.1544)+(0.4103\times 0.328)+(0.4872\times 0.1083)+(0.5513\times 0.3681)\\ +(0.8974\times 0.1015)+(0.052\times 0.125)+(0.4744\times 0.1501)\end{array}}{\begin{array}{l}(0.2125)+(0.3669)+(0.2304)+(0.0379)+(0.1544)+(0.328)+(0.1083)+(0.3681)\\ +(0.1015)+(0.125)+(0.1501)\end{array}}$$

=0.4783

Sensitivity

$$S_{PAS} = \frac{\sum_i^j f_i P_{PAS}}{\sum_i^j f_i}$$

$$= \frac{(0.5\times -0.1915)+(0.4487\times 0.2283)+(0.5385\times -0.2303)}{(-0.1915)+(0.2283)+(-0.2303)} = 0.4956$$

Exposure

$$E_{PAS} = \frac{\sum_i^j f_i P_{PAS}}{\sum_i^j f_i}$$

$$= \frac{(0.9359\times -0.2388)+(0.6538\times -0.2665)+(0.9359\times -0.02287)+(0.7692\times -0.2585)}{(-0.2388)+(-0.2665)+(-0.02287)+(-0.2585)}$$

=0.7867

Vulnerability index of PAS

$$VI_{PAS} = \frac{K_a A_{PAS} - K_s S_{PAS} - K_e E_{PAS}}{K_a + K_s + K_e}$$

$$= \frac{[(11\times 0.4783)-(3\times 0.4956)-(4\times 0.7867)]}{11+3+4} = 0.035$$

Adaptive capacity

$$A_{AP} = \frac{\sum_i^j f_i P_{AP}}{\sum_i^j f_i}$$

$$\frac{\begin{pmatrix}(0.1918*0.2125)+(0.3699*0.3669)+(0.2329*0.2304)+(0.8904*0.0379)\\+(0.9041*0.1544)+(0.4247*0.328)+(0.4384*0.1083)+(0.2329*0.3681)\\+(0.9589*0.1015)+(0.0548*0.125)+(0.4658*0.1501)\end{pmatrix}}{\begin{pmatrix}(0.2125)+(0.3669)+(0.2304)+(0.0379)+(0.1544)+(0.328)+(0.1083)+(0.3681)\\+(0.1015)+(0.125)+(0.1501)\end{pmatrix}}$$

$$= 0.3894$$

Sensitivity

$$S_{AP} = \frac{\sum_i^j f_i P_{AP}}{\sum_i^j f_i}$$

$$= \frac{[(0.5211\times -0.1915)+(0.4\times -0.2283)+(0.8219\times -0.2303)]}{[(-0.1915)+(-0.2283)+(-0.2303)]} = 0.5851$$

Exposure

$$E_{AP} = \frac{\sum_i^j f_i P_{AP}}{\sum_i^j f_i}$$

$$= \frac{[(0.8056\times -0.2388)+(0.4247\times -0.2665)+(0.5479\times -0.0287)+(0.6575\times -0.2585)]}{[(-0.2388)+(-0.2665)+(-0.0287)+(-0.2585)]}$$

$$=0.6199$$

Vulnerability index of AP

$$VI_{AP} = \frac{K_a A_{AP} - K_s S_{AP} - K_e E_{AP}}{K_a + K_s + K_e}$$

$$\frac{[(11\times 0.3894)-(3\times 0.5851)-(4\times 0.6199)]}{11+3+4} = 0.003$$

Adaptive capacity

$$A_{AP} = \frac{\sum_i^j f_i P_{AP}}{\sum_i^j f_i}$$

$$\frac{\begin{pmatrix}(0.1918*0.2125)+(0.3699*0.3669)+(0.2329*0.2304)+(0.8904*0.0379)\\+(0.9041*0.1544)+(0.4247*0.328)+(0.4384*0.1083)+(0.2329*0.3681)\\+(0.9589*0.1015)+(0.0548*0.125)+(0.4658*0.1501)\end{pmatrix}}{\begin{pmatrix}(0.2125)+(0.3669)+(0.2304)+(0.0379)+(0.1544)+(0.328)+(0.1083)+(0.3681)\\+(0.1015)+(0.125)+(0.1501)\end{pmatrix}}$$

$$= 0.3894$$

Sensitivity

$$S_{AP} = \frac{\sum_i^j f_i P_{AP}}{\sum_i^j f_i}$$

$$= \frac{[(0.5211\times -0.1915)+(0.4\times -0.2283)+(0.8219\times -0.2303)]}{[(-0.1915)+(-0.2283)+(-0.2303)]} = 0.5851$$

Exposure

$$E_{AP} = \frac{\sum_i^j f_i P_{AP}}{\sum_i^j f_i}$$

$$= \frac{[(0.8056\times -0.2388)+(0.4247\times -0.2665)+(0.5479\times -0.0287)+(0.6575\times -0.2585)]}{[(-0.2388)+(-0.2665)+(-0.0287)+(-0.2585)]}$$

$$=0.6199$$

Vulnerability index of AP

$$VI_{AP} = \frac{K_a A_{AP} - K_s S_{AP} - K_e E_{AP}}{K_a + K_s + K_e}$$

$$\frac{[(11\times 0.3894)-(3\times 0.5851)-(4\times 0.6199)]}{11+3+4} = 0.003$$

Annex -2 Household Survey Questionnaires

I. Back ground Information of H.H

1. Sex of household head M☐ F☐
2. Age of household head _____
3. Marital status

   1/ Married 2/ Single 3/ Divorced 4/ Widowed 5/ Other
4. Ethnicity of household head _____
5. Religion of household head _____
6. Educational status of the household head

   1/ Illiterate 2/ Read & write 3/ Primary 4/ Secondary & Above
7. What is the total household size? _____
8. Number of household members below Age 15? _____
9. Number of household members above 65? _____

II. Household Income, wealth and Economic activities

10. Type of household economy

    1. Pastoral 2. Agropastoral
11. In what type of house do you live?

    1/ Steel roof house 2/ Grass and mud roof hut

    3/ Temporary pastoral house 4/ other (specify) _____
12. How do you perceive yourself on wealth classification?

    1/ as rich 2/ as medium 3/ as poor
13. Do you have privately owned land? 1/ Yes 2/ No
14. If yes, how many hectares? _____
15. Currently how many hectares of land do you cultivate? _____
16. What types of crops do you grow?

    1/ maize 2/ wheat 3/ teff 4/ haricot bean 5/ other

17. What type of livestock's do you kept and specify their number

	Total
1/ camels	_____
2. Cattle's	_____
3/ sheep	_____
4/ goats	_____
5/ Equines	_____
6/ Poultry	_____

18. What are the major sources of income of the household? Rank accordingly

1. Crop sales 2. Livestock sales 3. Animal product sales

4. Petty trade 5. Wage labors income 6. Remittance

7. Rental income 8. Sales of charcoal and fire wood

9. Others

19. What mechanism do you follow to accumulate your wealth?

1/ Purchase of livestock 2/ Petty trade 3/ Save in money

4/ Built rentable house in urban areas 5/ Other (specify)_____

20. If save in money, where do you save the money?

1/ At home 2/ at bank 3/ with friends 4/ Other (specify)_____

III. Technology

21. Are there development agents in your kebele? 1/ Yes 2/ No

22. Do you use the technical service of the DA's 1/ Yes 2/ No

23. If yes, in which extension package do you participate?

1/ Breed improvement 2/ Fodder improvement 3/ Veterinary service

4/ Crop production 5/ Farming technique 6/ other (specify) _____

24. Do you have access for improved seed supply? 1/ Yes 2/ No

25. Do you use improved seeds? 1/ Yes 2/ No

26. If no, why?

1/ it's expensive

2/ because there is no regular supply

3/ lack of awareness

4/ other, specify_____

27. Do you use fertilizers? 1/ Yes 2/ No

28. If no, why?

1/ no fertilizer supply in our kebele 2/ it's very expensive

3/ lack of awareness 4/ other, specify _____

29. Do you use insecticides and pesticides whenever necessary? 1/ Yes 2/ No

30. If no, why?

1/ no supply of such inputs 2/ it's expensive

3/ lack of awareness 4/ other, specify_____

31. Do you have access for irrigation schemes? 1/ Yes 2/ No

32. If yes, for what purpose do you use it?

1/ to grow cash crop

2/ to water livestock

3/ to grow forage for private use

4/ other, specify_____

IV. Infrastructure and Institution

33. Do you have veterinary service in your kebele? 1/ Yes 2/ No

34. If No, how long it takes to reach to the one that is the most nearest to you?

_____ Hours/ walk

35. Do you take your animals to veterinary service when they get sick

1/ Yes 2/ No

36. If No, why don't you take them there, because?

1/ the service is expensive

2/ Traditional medicine is better

3/ Inadequate drugs & facilities

4/ Vet personnel are unqualified

5/ Vet personnel are not available most of the time

6/ Other (specify)_____

37. Do you have livestock market centers & marketing Facilities in your kebeles?

1/ yes 2/ No

38. If No, how long it takes to reach for the nearest market

_____hr/walk and specify the center _____

39. How frequently do you go to market?

1/ at least once in a week 2/ once in 15 days

3/ once in a month 4/ once in 3 month 5/ occasionally

40. How do you get information about market prices?

1/ self visit 2/ from neighbors 3/ from radio

4/ from government employees (teachers, Health workers)

5/ key informants in the community 6/ other (specify)_____

41. Are there micro finance institutes in your kebele? 1/ Yes b/ No

42. If yes, are you a member? 1/ Yes 2/ No

43. If you are a member how much do you save per month _____Birr/ Month?

44. Have you ever borrow money from such institutions? 1/ Yes 2/ No

45. If yes, for what purpose

1/ Consumption 2/ Medication 3/ Petty trade

4/ fattening of animals 5/ Children education expense

6/ for purchase of Agricultural input (pesticide, improved seed and the likes)

7/ Other (specify)_____

46. Do you have health service in your kebele? 1/ Yes 2/ No

47. If no, how long it take to the nearest health facility from your residential?

_____hrs/ walk on foot

48. Do you use this health center for you and your family health treatment?

1/ Yes 2/ No

49. If no, why

1/ because the service is expensive

2/ because the personnel's are unqualified

3/ there are no sufficient facility and drugs at the center

4/ I prefer urban health centers than this one

5/ traditional treatment is better

6/ the personnel are not available most of the time

50. What kind of school is available in your kebele?

1/ regular school only 2/ mobile school only

3/ both type of schools 4/ none

51. Which kind of school do you prefer to send your children? _____

52. What are your reasons? specify_____

53. Do you send all your school aged children (>=6 years old) to school?

1/ Yes 2/ No

54. If no, what are the reasons?

1/ far distance from school

2/ because children's contribute a lot in household activities

3/ I prefer to educate the boys only

4/ because education has no importance to our livelihood

5/ children's need to work in rich household to generate income to support the family 6/ Other (specify)_____

55. Do you have access for telephone service? 1/ Yes 2/ No

56. If yes, what kind of service

1/ Fixed line (in house) 2/ Fixed line (in tele center) 3/ Mobile phone

57. Is there radio in your house? 1/ Yes 2/ No

58. How many days in a week do you listen to the radio?

1/ Everyday 2/ 3 -4 days 3/ occasionally

59. Are you leader of any traditional or social association? 1/ Yes 2/ No

60. What are your sources of information on forecasts of climate?

1/ traditional meetings 2/ public information from radio

3/ workshops organized by GO/NGO 4/ other (specify)

61. From the above information sources on which one does you relay more? _____

62. What actions do you take if you have information that states there will be drought or shortage of rainfall in next season?

1/ sell my livestock immediately 2/ purchase and store grain

3/ store forage for livestock 4/ purchase additional livestock

5/ Take no action 6/ other (specify)_____

63. What are the water sources and points found in your kebele

1/ unprotected spring 2/ protected spring 3/ Boreholes

4/ Tap water 5/ Pond 6/ river 7/ Traditional ella

8/ Other (specify)_____

64. What is the distance of the water point from your house? _____hrs walk round trip

65. From where do you fetch water for your household consumption during normal periods?

1/ unprotected spring 2/ protected spring 3/ Boreholes

4/ Tap water 5/ Pond 6/ river 7/ Traditional ella

8/ Other (specify)_____

66. Where do you water your livestock's during normal periods?

1/ unprotected spring 2/ protected spring 3/ Boreholes

4/ Tap water 5/ Pond 6/ river 7/ Traditional ella

8/ Other (specify) _____

67. How much time it takes to reach to these points to water the livestock?

_____ hrs walk per round trip

68. How frequently do you water the animals at this time?

1/ At least once in a day 2/ once in 2 days 3/ once in 3 days

69. Are these water sources sufficient enough to support your water demand in bad climatic conditions (drought, short rainfall, and dry or high temperature times?)

1/. Yes 2/. No

70. If no, how do you fill the gap?

1/ water tankering 2/ reduce livestock watering frequency

3/ move to other areas in search of water 4/ use private cisterns

5/ other (specify) _____

71. Have you ever experienced conflict while you are moving with your animals in search of water? 1/ Yes 2/ No

72. If yes, what has been its consequence on the household?

1/ Death of animals

2/ Raiding of animals

3/ Death of household member

4/ Death of relatives

V. Perception on Climate Change and its consequence on the System

Specify the changes you have perceived on the pattern and occurrence of the following;

73. Change on the pattern of temperature? 1/ Yes 2/ No
74. If yes, in what direction? 1/ Increasing trend 2/ decreasing trend
75. Change on pattern of precipitation? 1/ Yes 2/ No
76. If yes, in what direction? 1/ Increased 2/ Decreased
77. Does the rain period start on usual time? 1/ Yes 2/ No
78. How about the frequency of drought occurrence?
    1/ Increased 2/ Decreased 3/ No change
79. What impacts do you face during such climatic conditions (drought, short rainfall, and dry or high temperature times?)
    1/ Death of livestock 2/ Loss of harvest 3/ Range quality decline
    4/ Death of household member 5/ Food shortage
    6/ reduced price of livestock 7/ Increased price of crops
    8/ other, specify
80. Up to how much percent of your livestock die during such times?
    1/ At most _____% 2/ At least _____%
81. How much is the damage on crops?
    1/ complete loss 2/ Partial loss
82. Do you have anyone that supports you in cash during the crisis periods?
    1/ Yes 2/ No
83. How many times do you receive food aid in the past 5 years?
    1/ every year 2/ 3 to 4 times in 5 year 3/ 1to 2 times in 5 year
    4/ Never received
84. Have you received tankerd water aid in the last 5 years? 1/ Yes 2/ No
85. Have you received "Busa Gonfaa" (traditional asset redistribution mechanism) in the last 5 years? 1/ Yes 2/ No
86. Have you contributed for "Busa Gonfaa" in last 5 years? 1/ Yes 2/ No
87. Have you received "Busa Koonkii" (collection and distribution of milk for poor households) in the last 5 years? 1/ Yes 2/ No
88. Have you contributed for "Busa Koonkii" in last 5 years? 1/ Yes 2/ No

Annex 3.A Guiding question for In-depth case study discussion

1. How long have been living in the area?
2. What is your major source of livelihood?
3. What other opportunities do you have to support your livelihood?
4. What are the most important resources for your livelihood?
5. Could you rank these resources according to their importance?
6. Who has control over the resources?
7. How do you access the resources?
8. Do all the community members have equal access and rights over the resources? If not why?
9. Identify hazards that threaten your livelihood system?
10. What kind of changes have observed in your environment over the past Ten years? Five years?
    A. Discuss about pattern of precipitation
    B. Discuss about pattern of temperature
    C. Occurrence of extremes (drought, flood)
11. What are the impacts of these changes on your livelihood system?
    A. Impact on factors of production
    B. Impact on source of income
    C. Impact on social system
    D. Impact on human health
12. What are the coping strategies you undertake to overcome these challenges?
13. What action will you take as a community if you had information that states the occurrence of bad climatic condition in your area?
14. In what way do you prepare yourself for the possible future scenario? (For the period of 5years, 10 years)
15. What resources are available to adopt these new scenarios? (Through market , infrastructure, water development, technology, health and veterinary facilities)
16. What are the constraints to adopt these new strategies?

17. Do you think your way of life style (Pastoralism or Agropastoralism) has made you more vulnerable to effects of climate change? How?
18. What are your opinions about development interventions undertaken in your area by government bodies? What about the work of NGO's?

Annex 3.B Guideline questions for key informants

1. What are the most important resources for livelihood system in the area?
2. How is access and control to these resources determined?
3. What changes have observed in the climatic condition of the area?
4. Specify the most frequent impacts of the change.
5. What changes have been seen in the area in terms of social behavior that correlates with effects of climate change?
6. What activities have been done in the following areas
    - Infrastructure development
    - Institutional set up and introduction of new technologies
    - Environmental protection activities
7. What options/ resources does the community have to reduce its vulnerability to the effects of climate change?
8. From your past experience which group of society is more vulnerable to climate change in your area? (Pastoral or agropastoral) and why?
9. Explain the common challenges the two social groups face during bad climatic conditions.
10. Explain the factors that made one of the groups advantageous or disadvantageous over the other one during such periods.
11. Explain the factors that aggravate the vulnerability of the area.
12. What prospects are available to reduce the vulnerability of the area?

Annex 4. Tables for Finding a Base Sample Size

+/- 5% Margin of Error

	Sample Size				
	Variability				
Population	50%	40%	30%	20%	10%
100	81	79	63	50	37
125	96	93	72	56	40
150	110	107	80	60	42
175	122	119	87	64	44
200	134	130	93	67	45
225	144	140	98	70	46
250	154	149	102	72	47
275	163	158	106	74	48
300	172	165	109	76	49
325	180	173	113	77	50
350	187	180	115	79	50
375	194	186	118	80	51
400	201	192	120	81	51
425	207	197	122	82	51
450	212	203	124	83	52
500	222	212	128	84	52
600	240	228	134	87	53
700	255	242	138	88	54
800	267	252	142	90	54
900	277	262	144	91	55
1,000	286	269	147	92	55
2,000	333	311	158	96	57
3,000	353	328	163	98	57
4,000	364	338	165	99	58
5,000	370	343	166	99	58
6,000	375	347	167	100	58
7,000	378	350	168	100	58
8,000	381	353	168	100	58
9,000	383	354	169	100	58
10,000	385	356	169	100	58
15,000	390	360	170	101	58
20,000	392	362	171	101	58
25,000	394	363	171	101	58
50,000	397	366	172	101	58
100,000	398	367	172	101	58

Source: Available at: http://www.extension.psu.edu/evaluation/pdf/TS60.pdf

Declaration

I, the undersigned, declare that the thesis is my original work, has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged.

Declared by:

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