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ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
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WATER & DEVELOPMENT PROGRAM

ASSESSMENT OF FARMERS' VULNERABILITY TO IMPACTS OF CLIMATE CHANGE/VARIABILITY AND THEIR WATER RELATED ADAPTATION STRATEGIES

THE CASE OF LODE HETOSA WOREDA ARSI ZONE, OROMIA REGIONAL STATE ETHIOPIA

BY: MESFIN ZENEBE

ADVISOR: BELAY SIMANE (PhD)

JUNE, 2014
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A Thesis Submitted to the School of Graduate Studies of Addis Ababa Universality In Partial Fulfillment of the Requirements for the degree of Masters of Art in Water and Development

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Abstract

Assessment of Farmers` Vulnerability to Climate Change and Variability and their Water Related Adaptation Strategies.
The Case of Lode Hetosa, Arsi Zone, Ethiopia

Climate change and variability causes long term effects on human systems. However, not all individuals and groups exposed to a certain climate change-related hazard are equally vulnerable. Vulnerability of human systems, therefore, depends on exposure to climate change the sensitivity and adaptive capacity of the system. .It is with this basic notion that this paper tried to assess the vulnerability of farmers in Lode Hetosa woreda to impacts of climate change and variability and their water related adaptation strategies by taking flood and drought in to account. The research was done based on household survey conducted in the study wereda on 135 selected farmers from three agro ecologies, namely kolla, woinadega and dega. Beside the household survey, inputs from local and federal government officials, experts, community leaders and development partners in the target area were also participated as key informants, FGD and community mapping participants. The study revealed that the three agro ecologies in the woreda are not equally affected by the selected hazards-flood and drought. Flood is found to be the most serious hazard in dega/highland agro ecology while drought is a major threat in kolla/lowland and woinadega/midland agro ecology. The result of the study also showed that farmers in dega agro ecology have less adaptive capacity and depend on highly sensitive livelihood sources than their kolla and woinadega counterpart in the study area.. An intra-community comparison of the study showed that households headed by women, elderly, children and illiterate household heads were foud to be more vulnerable to climate related impacts., Besides, the farmers in the study area were also found to be generally vulnerable as the degree of dependence on natural resource based livelihoods is higher and the share of non farm income and livelihood diversification is generally lower in all the three agro ecologies. Added to these, application of planned water--related adaptation strategies in the study area is found to be low and is influenced by the status of farmers' vulnerability to climate change. Generally, the study suggests that the status of farmers' vulnerability and application of water related adaptation strategies is low and hence much effort is needed in the future to improve the adaptive capacity of the communities so as to reduce their vulnerability. .

Key words: Vulnerability, Adaptive Capacity, Climate change, Adaptation

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Iv .Acronyms

ARDO	Agriculture and Development Office
AR4	IPCC 4th Assessment Report
AR5	IPCC 5th Assessment Report
CRGE	Climate Resilient Green Economy
CDS	College of Development Studies
DAs	Development Agents
EPA	Environmental Protection Authority
EPACC	Ethiopian Program of Action to Climate Change
FGD	Focus Group Discussions
GHGs:	Green House Gases
GTP	Growth and Transformation Plan
GTZ	Gesellschaft fur Technische Zusammenarbeit
HH	Households
IPCC	Intergovernmental Panel on Climate Change
KII	Key Informant Interview
NAPA	National Adaptation Program of Action
NGOs	Non Governmental Organizations
NMA	National Meteorological Agency
SLF	Sustainable Livelihood Framework
SPSS	Statistical Package for Social Scientists
TAR	Third Assessment Report
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCC	United Nations Framework Convention on climate change

`INTRODUCTION

1.1. Background

Climate change and variability have become the primary environmental concern of the 21st century. It is one of the biggest environmental challenges (Adugna et al, 2013).There is increasing evidence that the climate of the world is changing already; it is probable that it will continue to change and that humans contribute to these changes (Mohan and Robert, 2004). It is considered the biggest environmental threat in human history and the defining human challenge for the twenty-first century (IPCC, 2007; UNDP, 2010). What turns this in to a problem is that these changes affect the functioning of the ecosystem and societies. Globally, there are already increasing concerns regarding changes in climate that are threatening the livelihoods of vulnerable population segments (Watson, 2010). According to Slingo et al (2005), climate change and variability is posing the greatest challenges to mankind at global as well as local level.

Natural climate variability has always been a challenge to human livelihoods. Human-induced climate change has lent a complex new dimension to this challenge. Evidences show that the natural climatic variability, compounded with climate change will adversely affect millions of livelihoods around the world (IPCC, 2007). Climate change impacts affects social and ecological systems in complex and broad-ranging ways as technological, economic, social and ecological changes take place across regions, groups and sectors. Many of these impacts, such as impacts on ecological systems, have cascading effects on social, economic and health outcomes. In order to respond to climate change, more vigorous actions are required to mitigate emissions of greenhouse gases (GHGs) and to adapt to unavoidable consequences that are increasing vulnerability

around the world Impacts of climate change pose very serious risks for countries, vital ecosystems, and sectors including agriculture, forestry, health, local economic activities and biodiversity. In conjunction with other pressures, they could also exacerbate other serious local and regional challenges, such as poverty, poor healthcare, inequitable distribution of resources, diminishing ecological resiliency and energy insecurity (UNEP, 2009).

Vulnerability to the impacts of climate change remains a critical issue in the interaction of society with global environmental change. While adaptation to evolving climate patterns can and does occur, sections of society already vulnerable to present climate variability could find this vulnerability exacerbated by the changing incidence of extreme climate events such as droughts and floods (Adger, 2008). Present approaches to vulnerability to climate change focus on the physical aspects of such vulnerability, such as land areas lost or threats to agricultural production. This study, by contrast, focuses on social vulnerability by giving special attention to households as a unit of analyses. This is mainly because, from the social science perspective, it is people who are vulnerable to climate change, and it is institutions, economies and societies which adapt and respond to present day risks from climate variability and to future changes in climate.

It is a well established fact that both natural and human systems are vulnerable to climate change and variability. This vulnerability depends on the type of change (eg. Temperature, rainfall, variability, occurrence of extremes), magnitude and rate of the change, exposure and adaptive capacity.(Moham & Robert 2005). According to these authors, the most vulnerable are those with:

- The greatest exposure to climate related hazards like drought, flood, extreme temperature etc
- The greatest sensitivity (the degree to which the system respond to a given change in climate) to climate change.
- The least ability to adapt. Hence,
- societies and economies tend to be more vulnerable in developing countries where there are weaker institutions and economies.

.On the political side, the United Nations Framework Convention on Climate Change (UNFCCC) was agreed upon in 1992 and the subsequent Kyoto Protocol with legally binding commitments was signed in 1997. According to the UNFCCC, the prominent climate change response strategies are mitigation and adaptation. The former aims ate stabilizing the concentration of greenhouse gases and hence delaying impacts and reducing severity while the later involves actions that will reduce the impact of climate change without necessarily altering the likelihood that it will occur (Moham and Robert 2005). Mitigation and adaptation are clearly linked. This is because, the more successful mitigation would be, the easier it would be to adapt to the residual climatic change.

Ethiopia is heavily dependent on rain-fed agriculture. Its geographical location and topography—in combination with low adaptive capacity—entail a high vulnerability to the impacts of climate change (World Bank, 2010, Gebreegiziaber et al, 2011). Historically the country has been prone to extreme weather variability. Rainfall is highly erratic, most rain falls with high intensity, and there is a high degree of variability in both time and space.

According to the World Bank (2010), droughts[2] and floods are the most frequent climate related hazards facing Ethiopia. Ethiopia is known to be highly vulnerable to drought, which is the single most important climate-related natural hazard impacting the country from time to time. Major droughts in Ethiopia in recent times were in the late 1950s (in northern parts), in 1972/73 (northeastern in Tigray and Wollo),in 1984/85 (in major parts of the country), 1994 (in the low land pastoral areas), in 2000 (in the southern lowland pastoral areas), in 2002/3 (in major parts of the country), and in 2007/8 (in many areas in the highland and lowlands). The other climate-related hazard that affects Ethiopia is flood. Major floods also occurred in different parts of the country in 1988, 1993, 1994, 1995, 1996, and 2006 (Diao and Pratt 2007). Survey data show that between 1999 and 2004more than half of all households in the country experienced at least one major drought shock (UNDP 2007). Major floods occurred in different parts of the country in 1988, 1993, 1994, 1995,1996, and 2006 (ICPAC, 2007) These climatic changes and extremes has been a serious developmental challenge to the country. For instance, rain failures have contributed to crop failures, deaths of livestock, hunger and famines in the past. Even relatively small events during the growing season, like too much or too little rain at the wrong times, can spell disasters. Small farmers and cattle herders, who are already struggling to cope with the impacts of current climate variability and poverty, will face daunting tasks to adapt to future climate change (Alebachew & Weldamlak, 2011).

Causes for vulnerability of Ethiopia to climate variability and change include very high dependence on rain fed agriculture which is very sensitive to climate variability and change, under-development of water resources, low health service coverage, high

population growth rate, low economic development level, low adaptive capacity, inadequate road infrastructure in drought prone areas, weak institutions and lack of awareness, etc (NMA, 2007).

In order to minimize the risk of climate change and accelerate its economic development, Ethiopia has taken some significant steps in recent years. These efforts include the formulation and implementation of five year growth and transformation plan (GTP), initiation of Climate Resilient Green Economy (CRGE), preparation of National Adaptation Plan of Action (NAPA), formulation of Ethiopian Program of Adaptation (EPAC).

Lode Hetosa Woreda, which is one of the 24 woredas in Arsi Zone is predominantly inhabited by farming communities. Out of the total population of the woreda, 91,835 (84%) live in rural areas while the urban population is only 15,298 (14%). Like most part of Ethiopia, the population in this woreda is highly dependent on rain-fed agriculture which is considered as a very sensitive form of livelihood to climatic changes ((Lode Hetosa woreda Agriculture and Rural Development Office, 2013). According to the same source, the woreda is one of the relatively densely populated areas of the country with an average family size of eight. The woreda is highly dominated by midlands and highlands which cover more than 90 per cent of the total area of the wereda. Mixed agriculture is the dominant form where farmers cultivate crops and rear animals in a very traditional way. With the exception of cultivating some cash crops like onion in some parts of the woreda, application of commercial form of agriculture is not widely practiced in the area.

1.2. Statement of the Problem

Although Climate change is a global phenomenon; its manifestations and impacts vary locally, so do the adaptation capacities, preferences, and strategies. Effective planning for climate change adaptation programming requires an assessment of local vulnerabilities so as to bridge the gap between community needs and priorities at the local level, and policy processes at the higher level (Piya et al, 2013). Developing countries in general and least developed countries like Ethiopia in particular, are more vulnerable to the adverse impacts of climate variability and change. Rural communities in the developing countries are expected to be affected more due to their extensive dependence on climate sensitive livelihood options, and limited adaptive capacity to adapt to the changes (UNFCCC, 2009). Ethiopia is one of the developing countries, which are more vulnerable to climate variability and change. Low level of socio-economic development, inadequate infrastructure, lack of institutional capacity and a higher dependency on natural resources base make the country more vulnerable to climatic factors including climate variability and extreme climate events. Besides, because of endemic poverty and the reliance of the rapidly growing population on natural resources and agriculture for the provision of basic needs and economic production, people in most parts of Ethiopia are highly vulnerable to various climate related impacts like water stress, food insecurity, public health problem, and poverty and so on. Currently, climate change and variability is already imposing a significant challenge to Ethiopia by affecting food security, water and energy supply, poverty reduction and sustainable development efforts, as well as by causing natural resource degradation and natural disasters (NMA, 2007).

Agriculture, mainly rain-fed agriculture, is the mainstay of the economy of many Ethiopian communities. The situation in Lode Hetosa woreda is not an exception to this fact. By its very nature, this form of livelihood is very sensitive to different climate change related hazards like draught, flood, extreme temperature and so on. Particularly the agriculture sector in Arsi Zone in general and Lode Hetosa Woreda in particular is facing multifarious problems such as lack of adequate supply of quality inputs, inadequate farming knowledge, rudimentary farming practices, lack of farm machinery and tools, marketing, poor local capacity to provide necessary services to improve farmers efficiency and growth (FAO, 2010) Hence, assessing the real situation of vulnerability of communities to climatic hazards is a prerequisite for any current and future development planning and designing and implementing adaptation strategies prior to occurrence of a wide range of impact on people and their resource base, the environment.

One of the reasons the researcher selected Lode Hetosa Woreda to conduct this research on assessment of vulnerability of farmers to climate change and their water related adaptation strategies is that Lode Hetosa Woreda in particular and Arsi Zone in general, is considered by many as an area of surplus production, 'good' climatic condition and prosperous natural environment. As a result of these and other perceptions, researches on socio economic vulnerability of the farmers to climatic stimuli have been neglected. Besides, the implementation of development interventions that are related to reduction of people's vulnerability and enhancing adaptive capacities are not given emphasis by both state and non state actors.

1.3. Research Objectives

The general objective of this study is to assess the extent of farmers' vulnerability to impacts of climate change/variability and their water related adaptation strategies in Lode Hetosa Woreda.

The study will also have the following specific objectives.

- To assess the state of exposure of farmers in Lode Hetosa Woreda to climate change/ variability impacts.
- To examine the degree of sensitivity of communities to impacts of climate change/variability.
- To assess the existing adaptive capacity of farmers in the woreda to minimize climatic hazards.
- To investigate water related adaptation strategies employed by farmers in the target area

1.4. Research Questions

This research will try to address the following research questions.

- How is the status of climate change in the study area?
- Which community groups and agro ecologies are more exposed to climate related impacts like flood and drought?
- Which agro ecologies and community groups depend on sensitive livelihood sources?
- How is the distribution of assets among communities and agro ecologies that enhances adaptive capacity to climate change related impacts?

- What are the most significant factors that determine the status of farmers vulnerability to impacts of climate change and variability?
- What are are the factors that influence farmers' application of water related adaptation strategies?

1.5. Significance of the Study

Now days, climate change has been highly affecting the livelihoods of people in almost all corners of the world. Most notably, the impact of climate change is high particularly in the developing countries like Ethiopia where there is limited or no adaptation capacities and the extent of vulnerability is high. Therefore, the result of this research will be highly valuable for the following bodies.

- It will help for decision makers particularly at local level so as to determine where, when and how to intervene in order to reduce impacts of climate change/variability through enhancing adaptive capacity of vulnerable communities
- The research will also be beneficial for academicians to advance the studies in other areas.
- The local communities will also be benefitted from the result of the study since they will be given summarized form of the research paper after the findings will be finalized.

- Project and program planners in different government and non-governmental offices will also be expected to benefit out of it for different development planning purposes.

1.6. Limitation of the Study

The objective of this research is to conduct an assessment on farmers' vulnerability to impacts of climate change and variability and their water related adaptation strategies. The aspects like environmental and physical vulnerability were not given emphasis while doing this research. Besides, due to cost and time constraint, the study gives particular focus to only water related adaptation strategies farmers in the target study area are using. As a result, other adaptation strategies which are related to agriculture and the biophysical environment were not directly assessed by this research. Moreover, while assessing farmers' vulnerability to climate change impacts, only selected climatic hazards i.e flood & draught were considered. Due to the above mentioned limitations, other climate hazards were not covered by this study.

1.7. Organization of the Thesis

This thesis is organized under five major chapters. The first chapter is an introductory part where the back ground, justification, research objectives and questions, scope and limitation and some operational definitions are included. The second chapter is a part where presentations and discussions of the relevant conceptual and theoretical literatures to this research is made. The third chapter is devoted to description of the study area and the detailed methodologies used for conducting the study and analyzing the study results are incorporated. This chapter presents the methods of gathering both primary and

secondary data for the research.. Besides, it also elaborates the methods of both qualitative and quantitative data analysis use throughout the study process. The fifth chapter is the part of the thesis where the result of this study is discussed in detail. Under this main body part, both the qualitative and quantitative data collected from the primary sources and secondary sources are analyzed and discussed based on the objectives outlined in the first chapter. The final chapter, on the other hand, is given to the major conclusions made based on the findings of the study. It also incorporates some crucial recommendations made for future considerations.

1.8. Definition of Operational Terms

Adaptation: The process of adjustment to actual or expected climate and its effects.

Adaptive capacity is a measure of the potential, ability, or opportunities available to decrease exposure or sensitivity of a system to a climate induced stress (i.e., adapt).

Coping Ability:-the degree to which a household can grapple successfully with a stimuli- it is an element of adaptive capacity.

Drought: for this particular study, draught refers to a meteorological draught which is a period with an abnormal precipitation deficit or dry weather long enough to cause a serious .hydrological imbalance.

Exposure:: The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.(IPCC fifth Assessment Report)

Hazard: A potentially damaging climate related physical event, phenomenon that may cause loss of life or injury, property damage, social and economic disruption, or environmental degradation

Physical vulnerability to climate change: Refers to people who live in areas of the World that are prone to more than one type of the physical manifestations of climate change: floods, storms, droughts, sea level rise etc.

Sensitivity is a measure how a system is likely to respond when exposed to a climate-induced stress.

Socio-economic vulnerability to climate change: Incorporates the capacity of individuals, communities, economies and societies to adapt to climate change impacts and avoid suffering from long-term, potentially irreversible losses in wellbeing and stability.

Vulnerability:-is the degree to which a household is susceptible to or unable to cope with adverse effects of climate change including climate variability and extremes. It is the function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and adaptive capacity

Vulnerability Analysis – this identifies who and what is exposed and sensitive to external impacts. A vulnerability analysis starts by considering the factors that make the people of an environment susceptible to harm, i.e., access to natural and financial resources; ability to self-protect; support networks and so on.

Vulnerability Assessment (VA)-is a process for assessing, measuring, and/or characterizing the exposure, sensitivity, and adaptive capacity of a human system to disturbances.

II. THEORETICAL AND EMPRICAL LITERATURE REVIEW

2.1. Theoretical Literature Review

2.1.1. The Concept of Climate Change and Variability

The term climate change as defined by the Intergovernmental Panel on Climate Change, (2014) is 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. According to this IPCCs fifth assessment report of the Working Group II (WGII) climate change has been further explained as any change in climate over time, whether due to natural variability or as a result of human activity On the other hand, the United Nations Framework Convention on Climate Change (UNFCCC), defines the term as a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods (IPCC, 2007). Climate variability, on the other hand, refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate at all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing or external variability (IPCC, 2012).

2.1.2. Causes of Climate Change/Variability

In early 2007 the United Nations' Intergovernmental Panel on Climate Change (IPCC) concluded that human activity is causing the earth's climate to change (IPCC, 2007). The single most important cause is the rapid increase in the quantity of greenhouse gases (GHGs) in the atmosphere. This increase is driven mainly by three kinds of activity: the burning of fossil fuels, agriculture and livestock production, and changes in land use like clearing forests. According to this IPCC report, the principal greenhouse gases that initiate the world climatic change and variability include the following.

- Carbon dioxide, CO2 (fossil fuel combustion and land use changes).
- Methane, CH4 (arable farming and livestock production).
- Nitrous oxide, N2O (arable farming and livestock production).

According to the IPCC's 5th Assessment Report (AR5), it is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century. Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes. The report also confirms that the evidence for human influence has grown since the release of the 4th Assessment report (AR4) in 2007.

2.1.3. The Human Impacts of Climate Change and Variability

Climate change impacts affect social and ecological systems in complex and broad-ranging ways as technological, economic, social and ecological changes take place across regions, groups and sectors, (IPCC, 2014). Many of these impacts, such as impacts on

ecological systems, have cascading effects on social, economic and health outcomes. In order to respond to climate change, more vigorous actions are required to mitigate emissions of greenhouse gases (GHGs) and to adapt to unavoidable consequences that are increasing vulnerability around the world (UNEP, 2009).

It is challenging to isolate the human impact of climate change definitively from other factors such as natural variability, population growth, land use and governance. In several areas, the base of scientific evidence is still not sufficient to make definitive estimates with great precision on the human impacts of climate change. However, data and models do exist which form a robust starting point for making estimates and projections that can inform public debate, policy-making and future research. Climate change affects human health, livelihoods, safety, and society

The IPCC fifth Assessment Report (2014) and Global Humanitarian Forum Report, (2009) categorized the major human impacts of events that are directly attributed to climate change and variability as follows.

i. **Food security:**

According to the AR5 of Working Group II (2014), throughout the 21st century, climate-change impacts are projected to slow down economic growth, make poverty reduction more difficult, further erode food security, and prolong existing and create new poverty traps and emerging hotspots of hunger. In this report, it is also argued that climate-change impacts are expected to exacerbate poverty in most developing countries and create new poverty pockets in countries with increasing inequality, in both developed and developing countries. In urban and rural areas, wage-labor-dependent poor households that are net

buyers of food are expected to be particularly affected due to food price increases, including in regions with high food insecurity and high inequality (particularly in Africa),

ii. **Public Health:**

The Global Humanitarian Report (2009) mentioned that many diseases are directly or indirectly associated with climatic changes. The fifth assessment report of the Working Group II of the IPCC also confirm that vector-borne diseases are sensitive to changes in meteorological parameters such rainfall, temperature, wind and humidity. The health status of millions of people is projected to be affected through, for example, increases in malnutrition; increased deaths, diseases and injury due to extreme weather events; increased burden of diarrheal diseases; increased frequency of cardio-respiratory diseases due to higher concentrations of ground-level ozone in urban areas related to climate change; and the altered spatial distribution of some infectious diseases Health threats like diarrhea, malaria, asthma and stroke affect more people when temperatures rise (IPCC, 2014).

In Ethiopia, as seasonal rains stop falling, drought sets in and severe food shortages prevail across many parts of Ethiopia (Oxfam, 2009). Over the past two decades, five major droughts have occurred in this country, leaving many families unable to recover and pushed to the brink of survival. Agriculture accounts for over half of GDP and employs more than 80 percent of the labor force, but less than 1 percent of farming land is irrigated and drought quickly brings food shortages (Red Cross, 2009). Weakened by food shortages, people are more susceptible to diseases like diarrhea. Dehydration caused by diarrhea kills approximately 20,000 children every year in Ethiopia, and 40 percent of

the population does not have access to improved water sources such as piped water, protected springs or hand-pumps.

iii. **Poverty**:

Climate change drives poverty through a vicious circle of reduced crop yield and resulting lower income, which leaves fewer resources for the following year's planting season (Global Humanitarian Report, 2009). Because the poor tend to live in geographical and climatic regions that are naturally most vulnerable to climate change, their capacity to adapt is easily overwhelmed by the impact of the changing conditions. They have the least assets to rely on in the event of a shock. Climate change compounds existing poverty by destroying livelihoods. Specifically, rising temperatures, changing rainfall patterns, floods, droughts and other weather-related disasters destroy crops and weaken or kill livestock.

iv. **Water Scarcity** :

Climate change exacerbates already shrinking fresh water availability. This change makes water scarce and unfit for human consumption today and exacerbates unsustainable water use by farming sector in many water scarce regions. As the climate warms, it changes the nature of global rainfall, evaporation, snow, stream flow and other factors that affect water supply and quality. Freshwater resources are highly sensitive to variations in weather and climate (Miller, 2009). Chronic shortages of freshwater are likely to threaten food production, reduce sanitation, hinder economic development and damage ecosystems. Because of these, water scarcity and reduced quality pose problems that threaten the very survival of those affected (Kundzewicz, et al, 2007).

v. **Displacement:**

Climate change over the 21st century is projected to increase displacement of people (IPCC, 2014). Displacement risk increases when populations that lack the resources for planned migration experience higher exposure to extreme weather events, in both rural and urban areas, particularly in developing countries with low income. Climate change causes displacement of people in several ways, the most obvious—and dramatic—being through the increased number and severity of weather-related disasters which destroy homes and habitats forcing people to seek shelter or livelihoods elsewhere. In the long term, such environmental effects of climate change as desertification and rising sea levels gradually doom livelihoods and force communities to abandon traditional homelands for more accommodating environments. This is currently happening in areas of Africa's Sahel, the semi-arid belt that spans the continent just below its northern deserts. Deteriorating environments triggered by climate change can also lead to increased conflict over resources which in turn can displace people (Renner, 2008):

vi. **Security**:

Climate change can indirectly increase risks of violent conflicts in the form of civil war and inter-group violence by amplifying well-documented drivers of these conflicts such as poverty and economic shocks (IPCC, 2014). . More people live under the continuous threat of potential conflict and institutional break down due to migration, climate-related disaster and water scarcity. Hence, Climate change has the potential to exacerbate existing tensions or create new ones — serving as a threat multiplier. It can be a catalyst for violent conflict and a threat to international security (Smith and Vivekananda,. 2007).

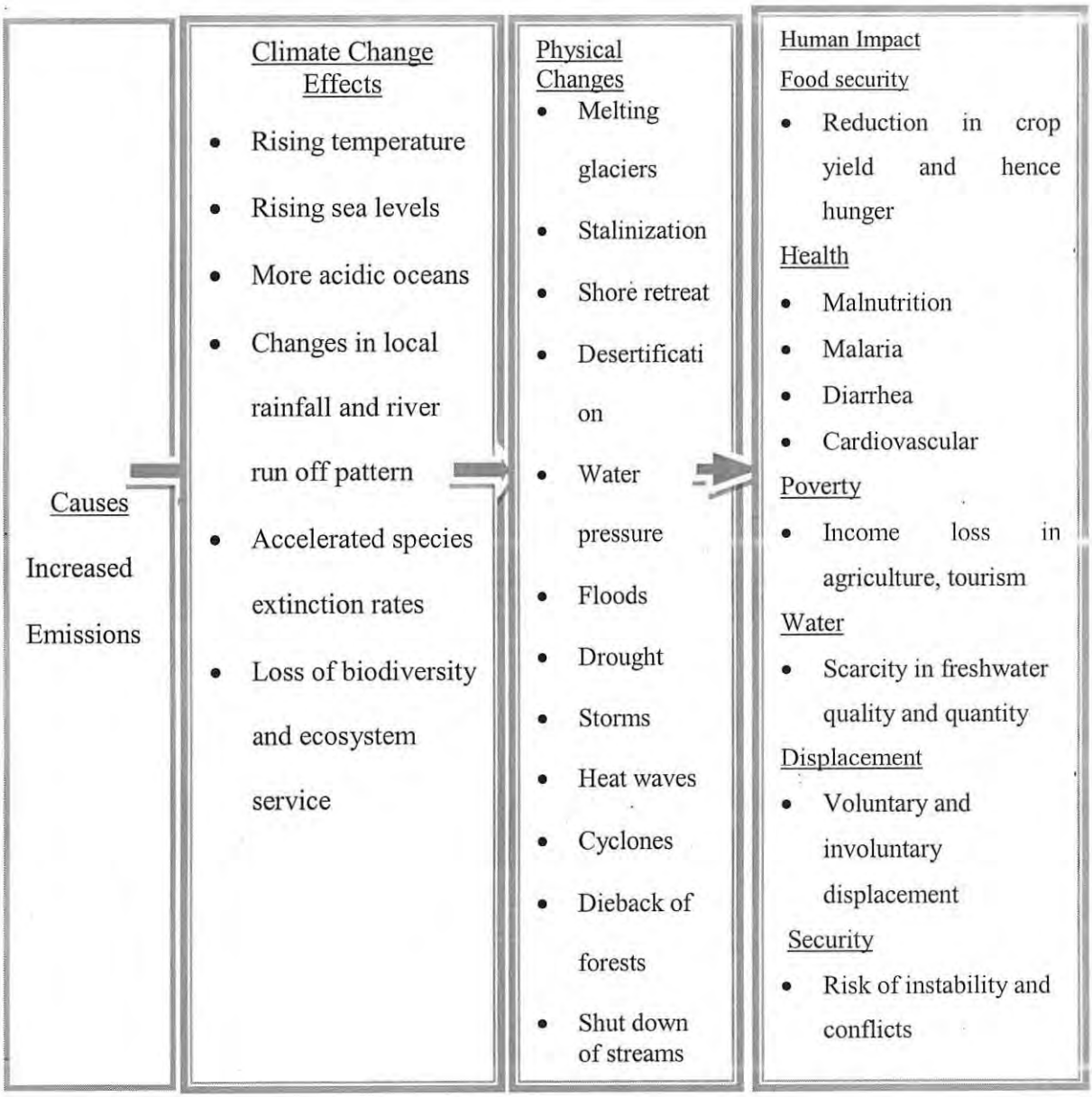


Figure 1. : The Link between Climate Related Effects and Human Impact
Source: Adapted from Global Humanitarian Report, 2009

2.1.4. Climate Change Response Strategies

Since global climate change was put on the international political agenda in 1992, developments in both climate science and climate policies have been shifted taking in to account the complexities of the issues at stake. On the political side, the United Nations

Framework Convention on Climate Change (UNFCCC) was agreed upon in 1992 and the subsequent Kyoto Protocol[1] with legally binding commitments was signed in 1997.

Efforts to address climate change have so far focused on two response strategies: mitigation and adaptation. Mitigation seeks to reduce greenhouse gas (GHG) emissions to avoid further warming of the globe. Adaptation, on the other hand, aims to cope with the problem of climate impacts when they materialize (IPPC, 2001; Huq and Reid, 2004). However, climate discussions in the early years of the Convention were overwhelmingly dominated by mitigation while little consideration was given to adaptation. This was, to a great extent, due to the early perception of climate change as something that was going to occur in a gradual fashion in the medium- to long-term (i.e. in the next 50 to 100 years). According to Munaisinghe and Swart, (2005), this two climate change response strategies can be made more effective if they are integrated with broader sustainable development efforts. These authors also argue that climate change responses should be guided by broader objectives of development, equity and sustainability.

2.1.4.1. Climate Change Mitigation

According to IPCC, (2007), mitigation refers to the actions taken to lower greenhouse gas emissions targeted at reducing the extent of global warming. These mitigation actions are aimed at reducing the likelihood of occurrence of climate change and variability.. Mitigation actions which stabilize GHG concentration would help to delay climate impacts and reduce their severity but can never substitute for adaptation (Swart, 2005). [1]

[1] A protocol that requires countries to reduce their GHG emissions using the assigned quotas.

2.1.4.2. Climate Change Adaptation

Adaptation to climate change refers to the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects to moderate harm or exploit beneficial opportunities (IPCC, 2001). The term adaptation means any adjustment, whether passive, reactive or anticipatory, that is proposed as a means for ameliorating the anticipated adverse consequences associated with climate change (Smit et al., 2000). It is the degree to which adjustments are possible in practices, processes or structures of systems to projected or actual changes of climate. It was further indicated that adaptation can be spontaneous or planned, and can be carried out in response to change in conditions.

Adaptation to climate is not a new phenomenon. Throughout human history, societies have adapted to natural climate variability by altering settlement and agricultural patterns and other facets of the economies and lifestyles.(Burton, 2006). There is increasing recognition that the world's current progress in reducing emissions of GHGs is not occurring rapidly enough to avoid impacts from climate change in the coming century. Because of this, the world is "committed" to a certain level of global warming, and therefore a degree of impacts that will require adaptive responses by nations, communities and individuals (Robinson, et al .2009). Climate change related adaptation strategies can be designed and implemented at global, national, regional, local and household level. Besides, adaptation strategies can also be designed based on sectors like agriculture, water resource, ecosystem etc However, ,the concern of this study is to assess the status of farmers application of only water related adaptation strategies using the household as a unit of analysis.

2.1.5. Household Level Water Related Adaptation Strategies

Water scarcity is becoming a real problem in many parts of the world. Climate change is one of the causes for water scarcity though not the only one. Different scholars pointed out different strategies aimed to assist in reducing the impact of climate change on water resources. The Intergovernmental Panel on Climate Change, (IPCC), in its Fourth Assessment Report mentioned strategies like expanded rainwater harvesting, application of water storage and conservation technologies, water reuse, desalinization, water use and irrigation efficiency as possible water related adaptation options. On the other hand, GTZ (2008) mentioned the following water related adaptation strategies that can be applied at household level. These are:

i. **Multiple use of water** Multiple use strategies are concerned with systems that can support a variety of productive activities, (e.g. as related to irrigated crops, livestock, poultry, and aquiculture), as well as domestic water supply and environmental needs, rather than with just a single use.

ii. **Adoption of Water Saving Technologies** Adoption of water-saving technology by farmers for different purposes is a key adaptive response to scarcity of water. These technologies assist farmers in increasing efficiency of water and reducing wastage. The technologies include drip irrigation appliances, low volume toilets and showerheads etc.

Additional water related adaptation strategy that can be applied at household level is conjunctive use of surface and ground water (FAO, 2007). The different water related adaptation strategies mentioned by various scholars can generally be categorized in to

two major categories (David and Fayyaz, 2006). These are demand side and supply side strategies. Generally, this research used the above mentioned strategies to assess the household level water related adaptation strategies of farmers in the study area.

2.1.6. Vulnerability to Climate Change Impacts

The term vulnerability has been defined in many different ways by various scholarly communities. The term is conceptualized in very different ways by scholars from different knowledge domains, and even within the same domain. For instance, natural scientists and engineers tend to apply the term in a descriptive manner whereas social scientists tend to use it in the context of a specific explanatory model. Nelson et al, (2010), defined vulnerability as the susceptibility of a system to disturbances determined by exposure. Likewise, Cutter et al. (2009) defined vulnerability as the susceptibility of a given population, system, or place to harm from exposure to the hazard and directly affects the ability to prepare for, respond to, and recover from hazards and disasters. Both these definitions agree that vulnerability refers to the susceptibility to harm, rather than the measure of harm itself, which may be due to exposure to threats or drivers of change, to perturbations, sensitivity to perturbations, and the capacity to adapt. The IPCC's third assessment report, to which this research is based on, defines vulnerability as the degree to which a system is susceptible to, 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' (IPCC, 2007). IPCCs Fifth Assessment Report (AR5) is also consistent with the earlier definition of vulnerability given by FAR.

Different scholars give due attention to the different aspects of vulnerability while making assessments. Some of the different types of vulnerability as mentioned by Adger et al (2010) include the following.

i. ***Physical Vulnerability***: meaning the potential for physical impact on the built environment and population. The degree of loss to a given element at risk or set of elements at risk resulting from the occurrence of a natural phenomenon of a given magnitude and expressed on a scale from 0 (no damage) to 1 (total damage)". o Vulnerability is analyzed per group of constructions (i.e. structural types) having similar damage performance; It is an intrinsic quality of a structure and it does not depend on location.

ii. **Economic vulnerability**: the potential impacts of hazards on economic assets and processes (i.e. business interruption, secondary effects such as increased poverty and job loss) Vulnerability of different economic sectors,

iii. ***Social vulnerability*** : the potential impacts of events on groups such as the poor, single parent households, pregnant or lactating women, the handicapped, children, and elderly; consider public awareness of risk, ability of groups to self-cope with catastrophes, and status of institutional structures designed to help them cope.

iv. ***Environmental vulnerability***: the potential impacts of events on the environment.

Although various types of vulnerability exist, this study focuses on the social and economic aspect of vulnerability of households to selected climatic stimuli like flood, draught and extreme temperature. With regard to the components, the IPCC indentifies

three major components of vulnerability. These components of vulnerability in the context of climate change and variability are explained below.

A. Exposure to Climate Change Impacts

Climate change exposure refers to the nature and degree to which a system is exposed to climatic variations (Füssel, 2006).. This exposure depends on global trends of climate change and - due to spatial variations - on the system's location On the other hand, the IPCC, (2012), defines the term exposure as the presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets in places that could be adversely affected. Exposure could include geographical location, especially related to high exposure to risks (i.e., people living in the areas of natural disasters such as drought or coastal areas and river basins affected by floods). Currently over 2.8 billion people live in areas of the world prone to more than one type of the physical manifestations of climate change: floods, storms, droughts and sea level rise. Physical vulnerability to climate change is used to mean that an individual is vulnerable if they face a medium to high risk of experiencing at least two of these events (Global Humanitarian Forum Report, 2009). For this particular study, only floods and droughts were considered. To assess community's exposure to climate change, different researchers used different variables. Piya, et al, (2012) for instance used the following variables for assessing exposure. These are occurrence of the hazard like flood and drought in a specified time period, frequency of the hazards within a specified time period, .magnitude of the hazards in terms of the damage caused by the hazard, trend of change of average annual precipitation, trend of change of annual temperature, observed changes in pattern of precipitation in the area..

B. Sensitivity to Climate Change Impacts

According to the IPCC, sensitivity is defined as "the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. The effect may be direct (e.g. a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g. damages caused by an increase in the frequency of coastal flooding due to sea-level rise)." (IPCC, 2007). Sensitivity is context-specific and varies from country to country, from community to community, among social groups and individuals, and over time in terms of its value, but also according to its nature. According to Wongbusarakum and Loper, (2011), a population could be considered sensitive based on their overall level of social development (i.e., a population containing people sick with malaria, HIV/AIDS, areas with rain-fed agriculture, limited access to resources for migrants, widows, disabled people with higher level of poverty and food insecurity). Farmers sensitivity can be assessed using different indicators. Some of these indicators as measured by different scholars include income structure of the target communities,, the share of irrigation based farming and rain-fed agricultural practices to total agricultural practices, farmers awareness and use of drought and flood resistant crops (Piya, et al, 2012; Wongbusarakum and Loper,2011).

C. Adaptive Capacity to Climate Change Impacts

The Inter -governmental Panel on Climate Change (2007) states that adaptive capacity is the degree to which individuals or groups can adapt to risk at any given time. Adaptive capacity is intimately connected to social and economic development, but it is not evenly distributed across and within societies (IPCC, 2007). According to this IPCC

report, the capacity to adapt is dynamic and is influenced by a society's productive base, including natural and man-made capital assets, social networks and entitlements, human capital and institutions, governance, national income, health and technology. Smit and Wandel (2006) identified that at the local level, adaptive capacity is determined by factors such as managerial ability, access to financial, technological and information resources, infrastructure, the institutional environment, political influence and kinship networks. UNEP, (2009), also argues that adaptive capacity depends on access to resources that could help in responding to threats and exposures (i.e., functioning community networks, access to low-rate loans, accessible services such as health care and sanitation, irrigation systems and water storage, etc).This includes the ability of individuals to cooperate within households, but also with neighbors and with the community leaders and their involvement in decision-making. Similarly, (Piya et al, 2012) categorized the major indicators of adaptive capacity as assets of physical human, financial, natural and social nature. This categorization is based on the sustainable rural livelihood framework developed by Elis, (2000) and DFID, (1999) (Jacobsen et al, 2011). This research also used the DFID's Sustainable Livelihood Framework (SLF) in order to assess the adaptive capacity of communities. According to DFIDs Sustainable Livelihood Framework, the five livelihood assets are the following.

i. Human capital/Asset

Human capital represents the skills, knowledge, ability to labor and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives. At a household level human capital is a factor of the amount and

quality of labor available; this varies according to household size, skill levels, leadership potential, health status, etc.

ii. Physical Capital/Asset

Physical capital comprises the basic infrastructure and producer goods needed to support livelihoods, such as affordable transport, secure shelter and buildings, adequate water supply and sanitation, clean, affordable energy and access to information. Its influence on the sustainability of a livelihood system is best fit for representation through the notion of opportunity costs or 'trade-offs', as a poor infrastructure can preclude education, access to health services and income generation.

iii. Natural Capital/Asset

Natural capital is the term used for the natural resource stocks from which resource flows and services (such as land, water, forests, air quality, erosion protection, biodiversity degree and rate of change, etc.) useful for livelihoods are derived.

iv. Social Capital/Asset

In the context of the sustainable livelihoods framework social capital is taken to mean the social resources upon which people draw in pursuit of their livelihood objectives seeking for their livelihood outcomes, such as networks and connectedness, that increase people's trust and ability to cooperate or membership in more formalized groups and their systems of rules, norms and sanctions (DFID, 2001)

v. Financial Capital /Asset

Financial capital denotes the financial resources that people use to achieve their livelihood objectives and it comprises the important availability of cash or equivalent,

that enables people to adopt different livelihood strategies. According to DFID (2001), two main sources of financial capital can be identified:

- **Available stocks** comprising cash, bank deposits or liquid assets such as livestock and jewelers, not having liabilities attached and usually independent on third parties.

- **Regular inflows of money** comprising labor income, pensions, or other transfers from the state, and remittances, which are mostly dependent on others and need to be reliable.

In terms of the above described social vulnerability components, those most vulnerable to the human impact of climate change are exposed to both the physical changes and the socio-economic implications. Socio-economic vulnerability to climate change is a measure of how well individuals and communities are able to respond and adapt to the human impacts of climate change.(Cruiz, 2007). According to this author, the global poor, with incomes of less than $2 per day (40 percent of global population), have very limited resources to respond and adapt to climate change without assistance. This author further argues that people with incomes between $2 and $10 have some capacity to respond but they are still likely to be vulnerable if confronted with the impacts of climate change. Those relying on natural resources for their livelihoods such as farmers, fishermen and low-wage earners in tourism will be particularly vulnerable to income losses due to climate change. The level of social development and local infrastructure also significantly determines the vulnerability of communities and their capacity to adapt. People living without access to affordable health care, water, electricity and paved roads are more likely suffer severe human impact than those who have access to these basic

services (Friedman, 2008). This author further argues that broad lack of access to insurance in developing countries further magnifies vulnerabilities. Insurance is a mean for people to help them find their own way out of a crisis and this cover against risks can help people escape poverty.

Climate change has varied effects on different social groups. Some social groups are more vulnerable than others. Individual and social factors such as gender, age, education, ethnicity, geography and language lead to differential vulnerability and capacity to adapt to the effects of climate change. Climate change effects such as hunger, poverty and diseases like diarrhea and malaria, disproportionately impact children, i.e. about 90 percent of malaria and diarrhea deaths are among young children (Diouf, 2009) Furthermore, in times of hardship young girls are particularly likely to be taken out of school to care for sick relatives or earn extra income. The elderly have weakened immune systems making them more susceptible to diseases and changing climatic conditions, especially heat waves, along with being highly vulnerable to weather-related disasters due to reduced mobility. According to CARE International, (2011), people who are most vulnerable to climate change are often the poorest, and in particular people who face social exclusion, marginalization in their communities and countries, and inequality in terms of rights, power and access to resources and services. Without due attention to identifying and engaging these vulnerable groups, there is a risk that they will also be excluded from adaptation processes, further exacerbating their existing vulnerability.

Climate change also exacerbates gender inequalities. Women account for two-thirds of the world's poor (Irish Aid. 2009). Seventy to eighty percent of agricultural workers are women. They are also largely responsible for water collection and often serve as the

primary caretaker in a household (IUCN, 2004). As a result, climate change impacts like decreased farm yields and water supply disproportionately impact women by reducing their livelihoods, impairing food provision and increasing their household workload.

Generally, the following social groups are relatively more vulnerable to climate-related hazards in Ethiopia than other groups (World Bank, 2010).

- Resource poor households which have no or very limited alternative means of coping with the effects of climate-related hazards;
- Women and children who have limited ability to leave their places of residence during times of drought and production failures, thus forcing male adults to migrate and search for jobs;
- The elderly and sick, who have little capacity to support themselves;
- Communities who live in already precarious situations of land and natural resources degradation and where agricultural production is poor.

There are various approaches to climate change related vulnerability assessments used by different scholars. The most commonly used ones include biophysical and social methods (Nelson et al. 2010). The biophysical method emphasizes on the physical aspects of exposure and sensitivity while the social method gives due attention to adaptive capacity of people to hazards (Piya et al, 2012). Fussel and Klein (2006) described about impact assessment that focuses on understanding biophysical changes in terms of the exposure to future change in climate and sensitivity of the environment to that change.

2.1.7. Climate Change Vulnerability in Ethiopia

Climate change is a major development challenge to Ethiopia. Ethiopia has historically been suffered from climatic variability and extremes. Rain failures have contributed to crop failures, deaths of livestock, hunger and famines in the past. Even relatively small events during the growing season, like too much or too little rain at the wrong times, can spell disasters. Small farmers and cattle herders, who are already struggling to cope with the impacts of current climate variability and poverty, will face daunting tasks to adapt to future climate change (Alebachew & Woldeamlak, 2011). Over the years, repeated famines and chronic food crisis resulting from frequent droughts, environmental degradation and decline in food production havocked the country many times and still remain major challenges to the country (Aklilu & Alebachew, 2009).

Droughts and floods are very common phenomena in Ethiopia with significant events occurring every three to five years (World Bank, 2006). According to World Bank (2006), the country has experienced at least five major national droughts since the 1980s, along with dozens of local droughts (World Bank, 2009). Over the years, the frequency of droughts and floods has increased in many areas resulting in loss of lives and livelihoods (Mesfin, 2001). Climate change is expected to exacerbate the problem of rainfall variability and associated drought and flood disasters in Ethiopia (NMA, 2006).

Since climate change has strong linkages to poverty and social inequality, its impacts will be felt in different ways and severities by different communities and social groups in Ethiopia. It is well recognized that the most vulnerable and marginalized

communities and groups are those who will experience the greatest impacts (IPCC, 2007), and are in the greatest need of support and adaptation strategies. At the same time, it is the vulnerable and marginalized who lack or have the least access to information, technology or opportunity to adapt to current climate variability and sufficiently prepare for future changes in the climate system. Particularly, climate change poses a significant challenge to the reduction of poverty and social inequality for the rural poor, especially women, the marginalized, the disabled and those living with HIV/AIDS, who will suffer disproportionately from its multifaceted and growing impacts (Alebachew & Woldeamlak, 2011).

Causes for vulnerability of Ethiopia to climate variability and change include very high dependence on rain fed agriculture which is very sensitive to climate variability and change, under-development of water resources, low health service coverage, high population growth rate, low economic development level, low adaptive capacity, inadequate road infrastructure in drought prone areas, weak institutions, lack of awareness, etc (NMA, 2007).

2.1.8. Recent Climate Change Related Plans in Ethiopia

i. Ethiopia's Growth and Transformation Plan (GTP)

This is a five-year plan that covers the period between 2010/11-2014/15. This strategic document recognizes climate change both as threat and an opportunity for Ethiopia and hence considered adaptation and mitigation issues. In its subsection about environment and climate change (subsection 8.9), the plan recognizes the role that environmental management plays in sustainable development and clearly declares

the government's commitment to building green economy and ongoing implementation of environmental policies and laws of the country (Alebachew & Woldeamllak, 2011).

ii. Climate Resilient Green Economy(CRGE)

The Climate Resilient Green Economy Strategy which addresses both climate change adaptation and mitigation was embarked by the government of Ethiopia in 2010. The CRGE also states that the strategy is based on the following four pillars (EPA, 2011).

a. Improving crop and livestock production practices to increase food yields, hence food security and farmer income, while reducing emissions

b. Protecting and re-establishing forests for their economic and ecosystem services, including as carbon stocks

c. Expanding electric power generation from renewable sources of energy fivefold over the next five years for markets at home and in neighboring countries

d. Leapfrogging to modern and energy-efficient technologies in transport, industry, and buildings.

iii. National Adaptation Plan of Action (NAPA)

The National Adaptation Program of Action (NAPA) is a mechanism within the UNFCCC, designed to help the Least Developed Countries (LDCs) including Ethiopia to identify their priority adaptation needs to climate change and to communicate these needs to the Conference of Parties (COP) of the UNFCCC and other concerned

bodies.(NMA,2010). Ethiopia prepared the National Adaptation Plan of Action (NAPA) in 2007. The National Adaptation Program of Action for Ethiopia was initiated and coordinated by the National Meteorological Agency (NMA). A project Steering Committee with representatives from different stakeholder institutions was established. The role of the steering committee was to provide overall guidance and oversight for the project. The NAPA represented the first step in coordinating adaptation activities across government sectors, The Rationale for NAPA rests on the low adaptive capacity of LDCs including Ethiopia, which renders them in need of immediate and urgent support to start adapting to current and projected adverse effects of climate change (NMA, 2007). The Ethiopian NAPA strategies include: drought/crop insurance; drought and flood early warning systems; rangelands resource management; wetlands management; natural resources research and development; malaria control program; and agro-forestry (World Bank, 2010).

iv. Ethiopia Program of Adaptation (EPAC)

This is a program of action to build a climate resilient economy through adaptation at sectoral, regional and local community levels. The main objective of EPACC is to create the foundation for a carbon-neutral and climate-resilient path towards sustainable development in the country The EPACC updates and replaces Ethiopia's National Adaptation Program of Action (NAPA) which was formulated in 2007 and submitted to the UNFCCC Secretariat (EPA, 2010). The program clearly states the urgency of taking practical adaptation and mitigation actions in the various social and economic sectors. It also identifies adaptation strategies and options in the various socioeconomic sectors including cloud seeding, crop and livestock insurance

mechanisms, grain storage, societal reorganization, renewable energy, gender equality, factoring disability, climate change adaptation education, capacity building, research and development, and enhancing institutional capacity and the political momentum.

2.2. Empirical Literature and Conceptual Framework

2.2.1. Empirical Literature

There is a long history of vulnerability studies concerned with identifying those population groups most likely to experience the adverse effects of drought and other natural hazards or stresses induced by conflict or other social, economic or political forces in order to target effectively preventative measures and disaster relief (Adger et al, 2004). Some attempts have been made by different researchers to study the vulnerability of farmers in Ethiopia to impacts of climate related shocks. However, most of these researches conducted so far were in different biophysical and socio economic settings which cannot be generalized for the farmers in the study area of this research. For instance, Temesgen et al, (2009) studied farmers' vulnerability to climate change impacts in the Nile Basin of Ethiopia. Nevertheless, this study employed a different econometric method of vulnerability assessment. Another research made by Rediet, (2011) tried to assess the vulnerability of communities in South Gondor Zone where there is a different environmental and socio economic setting to the present study area.

Although there are few researches done on the study area, none of this attempt to assess the climate related vulnerabilities of farmers and their water related adaptation strategies. Hence, there is a wide gap of knowledge that this research intends to fill. To conduct this

study, the researcher used the conceptual framework presented below. As it is clearly indicated in the framework, a vulnerability of households is assessed in relation to their exposure and sensitivity (which are considered to be biophysical) to a particular climatic hazard and their adaptive capacity which is a socio economic aspect of household.

2.2.2. Conceptual Framework

The study used a conceptual framework which is constructed by combining the components from Climate Change vulnerability framework used by Lankao and Tribia (2009) and Sustainable Livelihood Framework developed by DFID (1999). As it is indicated below, this framework clearly shows that a climatic hazard imposes a negative impact on exposure and sensitivity and hence results potential impact on households.. Besides, a household with higher degree of exposure and sensitivity to a particular hazard will have a higher vulnerability status. That means, communities with a higher exposure to floods, drought etc and whose income structure is predominantly based on natural resources suffer from the potential impacts of climatic hazards than communities with less exposure to hazards and less climate change sensitive livelihood sources. On the other hand, adaptive capacity which is a manifestation of the five livelihood assets/capitals has a positive effect on household vulnerability

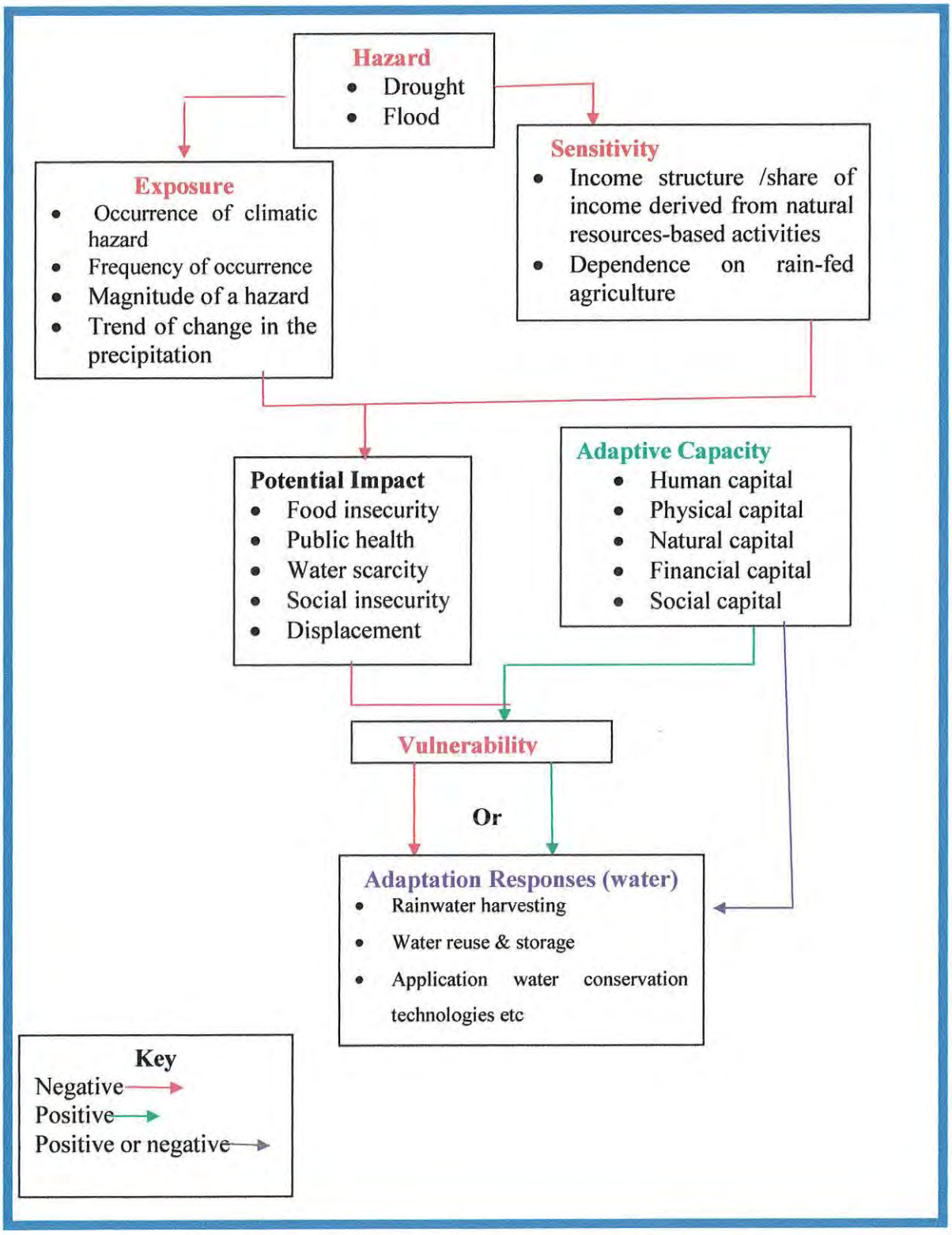


Figure 2. Climate change Vulnerability and Adaptation Framework
Source: Adopted from Lankao and Tribia (2009) and DFID (1999).

That means, communities with better access to human, social, natural, physical and financial assets, will have a relatively better capacity to cope up with the changes and adapt easily than those section of communities who lack the assets. The framework also shows that application of adaptation responses is either negatively or positively affected by the status of vulnerability and adaptation capacity. This is to say that if the better the adaptive capacity people have the better likelihood of implementing adaptation mechanisms. Likewise, communities with less vulnerability status (i.e. less exposure, less sensitivity and high adaptive capacity) can most likely implement adaptation mechanisms.

III. RESEARCH METHODS

3.1. Description of the Study Area

3.1.1. Location and Demography of Lode Hetosa Woreda

Lode Hetosa woreda is one of the 24 woredas in Arsi Zone. It is about 175 km faraway from Addis Ababa in the Southeast direction and 50km from the zonal capital Assela. The woreda is bordered by Sire Woreda to the northeast, Dodota Woreda to the Nirthwest, Hetosa to the southwest and Robe to the south.. The administrative capital of the woreda is Huruta which is composed of two urban based kebeles. The woreda is divided in to 22 kebeles of which 3 (2 kebels in Huruta Town and 1 kebele in Lode Jimata Town) are urban and the remaining 19 are rural based kebeles/peasant associations (Lode Hetosa Woreda Administration Office, 2013). The woreda has a total area of 537.62km^2 where the population density is about 224.7 persons per km^2 Based on the 2011 Central Statistics Agency Report; the total population of Lode Hetosa is 120,782. Out of the total population, 60,329 are male while 60,453 are female. The total number of urban population is only 18,104 while the great majority, 102,678 persons live in rural areas. There are a total of 23,207 (3479 urban and 19728 rural) households in the woreda.

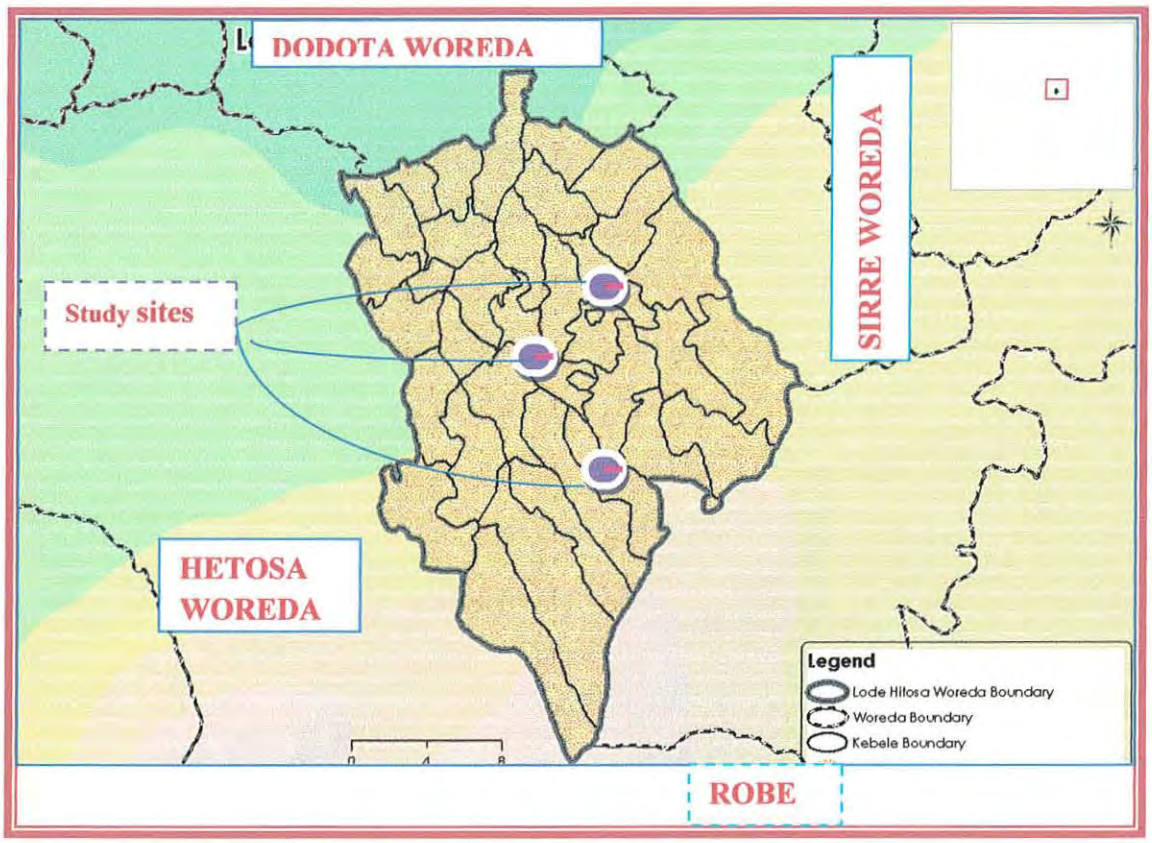


Figure 3. Geographical map of Lode Hetosa Woreda

3.1.2. Soil and Major Crops of The Woreda

The dominant soil types of the wereda are Nitosols found on flat to sloppy terrain in high rainfall areas, vertisols found on flat waterlogged areas, and cambisols on some sloppy areas of rhe woreda. The color of the soil in the study area is light brown with loamy-clay texture. .It is fertile and highly suitable for cereal and vegetable production such as onion. However, as the area is highly populated there is severe erosion in the area. Since the landscape has lost its natural vegetation the soil of the surrounding hills are degraded with frequent rock outcrops (ARDO, 2013).

Different varieties of crops are grown in woreda. These include but not limited to wheat, barley, teff, maize and bean and peas. According to the Lode Hetosa Woreda Agricultural and Rural Development Office, wheat covers the largest part of the cultivated land in the woreda. The distribution of crops grown is not uniform across the woreda. The lowland and midland sections of the woreda is mainly dominated by wheat while barley is the dominant crops in the highland part. Beside cereal crops, the woreda is also known for cash crops like onion, potato and others. A large number of people in the woreda obtain income from production and sale of these vegetables mainly onion.

3.1.3. Agro ecology and Land Use/land cover of the Woreda

Lode Hetosa woreda is divided in to three agro ecological zones. According to the Woreda's Agriculture and Rural Development Office, (2013), the climatic classification is based altitude and rainfall as major criteria. Accordingly, the three agro ecologies are the following.

a. The warm semiarid Lowland (Kola) which lies between 500m to 1500m above sea level. These agro ecology accounts for about 5% of the total geographical area of the woreda.

b. The cool sub-humid temperate zone of midland (Woina Dega) lies between altitudes of 1500m and 2300m asl. The total area of the wereda which lies within this agro-ecological category is about 44%.

c. The cool and humid Highland (Dega) which mostly lies between altitudes of 2300m and 3200m above sea level. About 51% of the total area of Lode Hetosa woreda lies within this agro ecology.

Although there is no recent study conducted on the land use/land cover of the woreda, earlier studies indicate that about 3675 hectare of land in the study woreda is covered by forests (ARDO, 2013). The area of cultivated land in the woreda is close to 23552 hectare.

3.1.4. Climate of the Woreda

The Woreda has four seasons, named as Ganna Birra, Bona and Arfassa. Ganna and Birra are high rainfall seasons; whereas, Bona and Arfassa are dry seasons (Lode Hetosa Woreda Environment and Land administration Office, 2013). The rainfall in the study area is bimodal. The longer rainy season extends from June to September, which supports the major crop production. The shorter rainy season (birra) comes in March and April and allows minor crop production. The longer rainy season (Ganna), on the other hand is from June to September The mean annual rainfall ranges from 800mm to 1400mm and the average rainy days are about 120 days in the year. (Lode Hetosa Woreda ARDO, 2013) The temperature of the woreda varies between 10°C-27°C with the mean minimum and maximum temperatures are 10^0c and 27^0c respectively. The average temperature of the woreda, however, is around 19^0c (ARDO, 2013).

3.2. Research Design

Since the objective of this study is to assess the current status of farmers' vulnerability to climate related impacts and their water related adaptation strategies, time-series design

was not considered. Instead, a cross-sectional study design which gives a one shot approach was employed.

3.3. Sampling Design and Techniques

In order to get the desired accuracy, different types and stages of sample selection and sampling techniques were employed. To start with the sample selection, first, all the 19 rural kebeles of Lode Hetosa Woreda were stratified in to the three agro ecological zones, i.e Kola/lowland, Woina dega/Midland and Dega/Highland. Then, from each agro ecological zone, one kebele was selected randomly hence stratified random sampling. In this woreda, each Kebele/peasant Association has 3 sub divisions called *zones or villages* subdivided for administrative purposes. Hence, from each sampled kebele selected, 1 zone from each kebele was taken and used for the survey. Accordingly, Lode Zone/village of Gerde Busa Kebele from kolla, Zone/village 3 of Fursa Kebele from Woina Dega and Achaba Zone of Gudelcha Kebele from Dega agro ecologies were used for the survey. The total household size for the above mentioned sampled zones/villages of the target kebeles is 540 with Lode zone of Gerde Busa 180, Zone/village 3 of Fursa 160 and Achaba of Gudelcha having 200 households. Out of the total sample frame, about 25% (135 households) were included in this survey. Hence, based on quota sampling method, 40 from lode Zone (Kolla), 45 from Fursa (Woinadega) and 50 from Achaba Zone (Dega) were included in the survey.

Table 1. Number of Samples taken from each Agro Ecologies for the survey

Type of Agro ecology	Name of the Sample kebele selected	Name of the village	Number of Households in the village/zones	No of Samples selected for the study
Lowland/ kolla	Gerde Busa	Adele	180	45
Midland/ Woinadega	Fursa	Zone 3	160	40
Highland/Dega	Gudelcha	Achaba	200	50
Total			540	135

3.4. Sources of Data

To undertake this research, qualitative and quantitative data from both primary and secondary sources were used. These sources are thoroughly elaborated below.

i. Primary sources of data

Primary data for this research was obtained from different bodies. These include sample households in the target kebeles, key informant interviewees representing government and community, development agents, personal observations, photographs and participants of focus group discussions and community mapping processes.. With regard to the key informant interview, the researcher interviewed officials and experts from Environment and Land Administration Office, Agricultural and Rural development Office, Irrigation Office, Water & Energy Office, and Woreda Administration of Lode Hetosa Woreda. Beside the local level participants, interviews were also made with National Meteorological Agency at the Federal level. The agricultural development agents of the respective target kebeles were also interviewed to

triangulate the data collected from Woreda level Government Offices and from sampled households.

ii. Secondary sources of data

To supplement the primary data collected from study area, different relevant literatures have also been consulted. These secondary data sources were collected from concerned government offices like National Meteorological Agency, Central Statistical Authority, local government Agriculture and Rural Development Office of the woreda; Non Governmental Organizations (NGOs), libraries, websites and other sources were exhaustively examined. The secondary sources collected from the above mentioned source include, periodic and special report, publications, research works conducted earlier, local and international journals, books, newspapers and magazines.

3.5. Methods of Data Collection & Instruments

i. **In depth Household Survey** the major unit of analyses for this study is a household. Therefore, to generate information at household level the researcher used both closed and open ended questionnaires and interviews, to collect primary data concerning all relevant variables that enabled him meet the objectives of the research. To conduct the household survey, 6 rural based primary school teachers and Agricultural Development Agents (DAs) who are based in the target kebeles were trained and used as enumerators.

ii. **Key Informant Interviews:** some key personnel representing different bodies like local government officials who work in offices such as Water and Energy Office, Agriculture and Rural Development Offices, Environment and Land Administration Office elders living in the target area, development agents, community leaders, NGO workers and others were interviewed. To get the relevant information about both background information and variables of study, semi-structured interviews were made with the informants.

iii. **Focus Group Discussions (FGD):** to get an in-depth information about the study objective, 6 FGDs were conducted. These FGD sessions incorporated target households that are relatively socially excluded from participation due to various socio cultural reasons and community leaders. This part of community groups were identified by the help of community elders and development agents during community mapping and key informant interviews.

iv. **Personal Observation:** the researcher made personal observation in order to get some relevant data regarding some key variables like locations of residential areas of the target households, drought and flood affected resources and infrastructures, status of residential houses, land use and land cover of the target area.

v. **Community Mapping:** this method of data gathering was done in a such a way that group communities in a certain geographical area come

together and indentify the different resources of their community, threats and opportunities, locations of vulnerable community groups and areas etc. Accordingly, three community mapping sessions were held for this study (1 in each sampled kebele). The participants of these community participants were elders, development agents, teachers and other community leaders. The participants of these CM sessions identified some service providing institutions like credit, education, training, agricultural input etc. They have also figured out the existing gap related to their livelihood situation.

3.6. Methods of Data Analyses and Presentation

The data collected from primary and secondary sources was analyzed both by quantitative and qualitative methods of analyses. This study mainly employs descriptive method of analyses. The primary data collected from household respondents through structured questionnaires was first checked for accuracy then; tabulated and analyzed by using statistical package for social science (SPSS version 20 software.

For analyzing and comparing the status of vulnerability among households in the three agro ecological zones, descriptive statistics such as frequency, percentage, and means were used.. As this paper employs an integrated approach of vulnerability assessment, it combines the socio economic aspect and the biophysical component of vulnerability. Therefore, for the purpose of making comparisons within vulnerability status of households among the three agro ecologies, separate assessment of the components of exposure, sensitivity and adaptive capacity was made. In order to analyze the status of farmers' exposure to climate change related hazards, percentages of households that were

exposed to flood and drought hazard, the frequency of occurrence of these hazards and damages caused were used for comparison among dega, woinadega and kolla villages. For sensitivity analyses, the carefully selected indicators like income structure of farmers, access and use of drought and flood resistant crop varieties, application of irrigation practices, share of chronically ill and disabled and dependant household members have been computed and used for comparison both among agro ecologies and with in households of the same agro ecologies. To assess the status of adaptive capacity households and villages in terms of the five capitals/assets, percentages, indices, means and ratios etc are used. besides, to calculate the farmers diversification of livelihood, the livelihood diversification index was derived using the formula provided by Kimenju & Tschirley, (2009),

$$D_k = 1 - \sum_{i=1}^{N} (Sik)^2$$

Where $\mathbf{D_k}$ is the livelihood diversification index, i is the specific livelihood activity like farming, trading, carpentry etc, N is the total number of activities being considered, k is the particular household, and $S_{i,k}$ is the share of i^{th} activity to the total household income for k^{th} household. Using this formula, figures close to 1 indicate better livelihood diversification while zero valued indicated no diversification at all.

. Once the descriptive statistics like mean, percentages ratios, frequencies and indices of each village have been computed, ranking system has been used to make comparison of villages regarding the three major components of vulnerability. This has been done by

assuming that there is equal weight among the individual indicators of each component, i.e, exposure, sensitivity and adaptive capacity.(Cutter, et al, 2000).

To assess the degree of farmers' application of water related adaptation strategies, the indicators selected were broadly categorized in to demand side and supply side strategies. Hence, the percentages of farmers who apply any of the strategies were assessed. Besides, the existence of relationship between status of farmers vulnerability and application of water related adaptation strategies was also evaluated.

The qualitative data which was gathered through focus group discussions, key informant interviews, personal observations, community mapping and secondary data (document review) were also analyzed qualitatively. The results of the quantitative data analysis are presented in tables, charts and figures.

IV. RESULTS AND DISCUSSIONS

4.1. Socio-Economic Characteristics of Respondents of the Study

Proper description of socio economic situation of the respondent households like sex, age, religion, ethnicity, marital status, educational background, role in the household etc is very crucial for properly analyzing the vulnerability of the target community and decision making so as to mitigate the impacts of climate change/variability.

Out of the total 135 samples taken for this study, 45 of them were taken from kolla while Woindega and Dega agro ecologies represented by 40 and 50 respondents respectively. This number was taken using quota sampling based on the total household number of the respective villages/zones in the sampled kebeles. Among the total 135 respondents, 113 of them are male heads of households while the rest 22 are female heads of households. However, the distribution of sex is not uniform across the three agro ecologies. The largest share of male respondents was in Dega (Achaba) with 88% while the share of male heads of households in Kolla (Lode Zone) and Woinadega (Zone 3) is roughly the same with 82% of their total. With regard the age of respondents, Zone 3 from Woinadega constituted about 82.5% of working force of 18-60 years while the share of working force in Lode zone and Achaba is 80%. While the share of under 18 years is relatively higher at Zone 3, which is 5%, Lode zone takes the lion's share in terms of percentage of old ages of above 60 years with a 5% record. Concerning marital status, the largest percentage of married respondents is at Achaba with 88% while the share of married respondents at zone 3 and Lode zone is only 80%. Besides, there is also a wide gap in the percent of divorced respondents with Achaba a low record of only 2% as compared to Zone 3 and Lode whose share is 11% and 10% respectively. Education is the

other most important factor that contributes to a differential vulnerability to climate change impacts. Among the three agro ecologies, Zone 3 (woinadega) constituted the smallest percent of people who cannot read and write with only 15% as compared to Achaba of Dega and Lode of kolla which have 22% and 24% percent of their total. Besides, the highest record of people who attended tertiary level of education is also seen in Lode of Kolla with 11.1% of the total respondents of that village contrary to only 3.5% and 0% at Zone 3 and Achaba villages respectively. Different scholars argue that people's perception and hence practice is shaped partly by their religion. Hence, knowing the religion of members of a given community is vital for developmental decision making. Orthodox Christian takes the largest share at Zone 3 of Woinadega with 90% while the share of this religion at Lode and Achaba zones is lower with a record of 77.8% and 48% respectively. The religion of Islam is high among the respondents of Achaba (Dega) with 38% followers as compared to 2.5% and 6.7% at zone 3 and Lode villages. Ethnic background can also have contribution in shaping people's perception and practice. Of all the three agro ecologies included in this survey, oromos constituted the largest share at Achaba with 64% while the share of oromo at zone 3 and Lode is 32.5% and 57.8%. Zone 3 of Woindegaand Lode of Kolla villages comprised a relatively large number of Amhara with 50% and 31.1% respectively while the share at Achaba is only 22%.

Table 2. Number of Respondents by Different Categories

Category	Sub Category	Number	Percent
Agro-ecology	Kola /Lowland	45	33.3
	Woina Dega/Midland	40	29.7
	Dega /Highland	50	37.0
	Total	135	100
Sex	Male	113	83.7
	Female	22	16.3
	Total	135	100
Age	Under 18	4	3
	18-60	109	80.7
	Above 60 years	18	13.3
	I don't know	4	3
	Total	135	100
Educational status	Unable to read and write	28	21
	Attended non-formal education	57	42
	Completed primary education	32	24
	Completed secondary education	12	9
	Certificate and above	6	4
	Total	135	100
Marital Status	Single	6	4.4
	Married	112	83
	Divorced	10	7.4
	Widowed	7	5.2
	Total	135	100
Religion	Orthodox	95	70.4
	Muslim	23	17.0
	Protestant	15	11.1
	Catholic	2	1.5
	Other	-	-
	Total	135	100
Ethnic Group	Oromo	71	52.6
	Amhara	45	33.3
	Tigre	7	5.2
	Others	12	8.9
	Total	135	100

***Source*: Own Survey 2014**

Table 3. Chi Square Values of Socio demographic characteristics of the sample

category	Sub category	Observed value (O)	Expected Value (E*)	(O-E)	$X^2=\sum\frac{(O-E)^2}{E}$
Agro-ecology	Kolla (Lowland)	45	**45**	**0**	**1.11**
	Woinadega (midland)	40	**45**	**5**	
	Dega (Highland)	50	**45**	**5**	
	total	**135**	**135**	**0**	
Sex	Female	**22**	**25**	**3**	**0.44**
	Male	**113**	**110**	**3**	
	Total	**135**	**135**	**0**	
Age	Under 18	4	**5**	**-1**	**0.41**
	18-60	109	**110**	**-1**	
	>60	18	**20**	**-2**	
	Total	135	**135**	**0**	
Educational status	Illiterate +informal	85	**80**	**5**	**2.56**
	Primary level	32	**35**	**3**	
	Secondary educ.	12	**16**	**-4**	
	Tertiary educ	6	**4**	**2**	
	Total	135	**135**	**0**	
Religion	Orthodox	**95**	**73**	**18**	**24.93**
	Protestant	**15**	**9**	**6**	
	Islam	**23**	**46**	**23**	
	Catholic	**2**	**2**	**0**	
	Other	**-**	**5**	**-5**	
	Total	**135**	**135**	**0**	
Ethnic group	Oromo	71	**79**	**-8**	**3.19**
	Amhara	45	**42**	**3**	
	Tigre	7	**6**	**1**	
	Other	12	**8**	**4**	
	Total	135	**135**	**0**	

Source: Own Field Survey

**The values of expected frequency is obtained from the percentages of each sub category for the woreda.*

Calculation chi square is done for the purpose of checking the goodness of fit of the sample. As it is shown in the table above, the values of the chi square test are close to 0 for most of the socio demographic characteristics of the sample. This means that there is no significant difference between the samples taken and the population to which an inference is made.

4.2. Pattern of Rainfall and Temperature Change in Lode Hetosa Woreda

Climate change/variability results change in either in the amount or pattern of temporal and spatial variation in the occurrence of precipitation and temperature. To analyse the trend of change of rainfall and temperature in the woreda, the participants of the focus group discussions held in the selected villages were asked. Questions were raised to both survey respondents and FGD participants regarding the change in mount and trend of occurrence of rainfall in the woreda. Accordingly, out of the total number of survey participants 50% at Achaba, 68% at Zone 3 and 67% at Lode Zone mentioned that it is very difficult to make generalization about the amount of annual rainfall they get in the last 10 years. This is mainly due to the frequent temporal change of both the amount and occurrence of rainfall. With regard to the occurrence of rainfall, over 70% in all the three villages mentioned that there is no regular pattern of rainfall occurrence in the area. The participants of the FGD in all villages also mentioned that the beginning and end of rainfall is becoming unpredictable. It comes too early and ends late in one year and comes late and ends early in the other. With regard to the impact of climate change on rainfall amount, however, all participants of FGD reported that there is a reduction in the

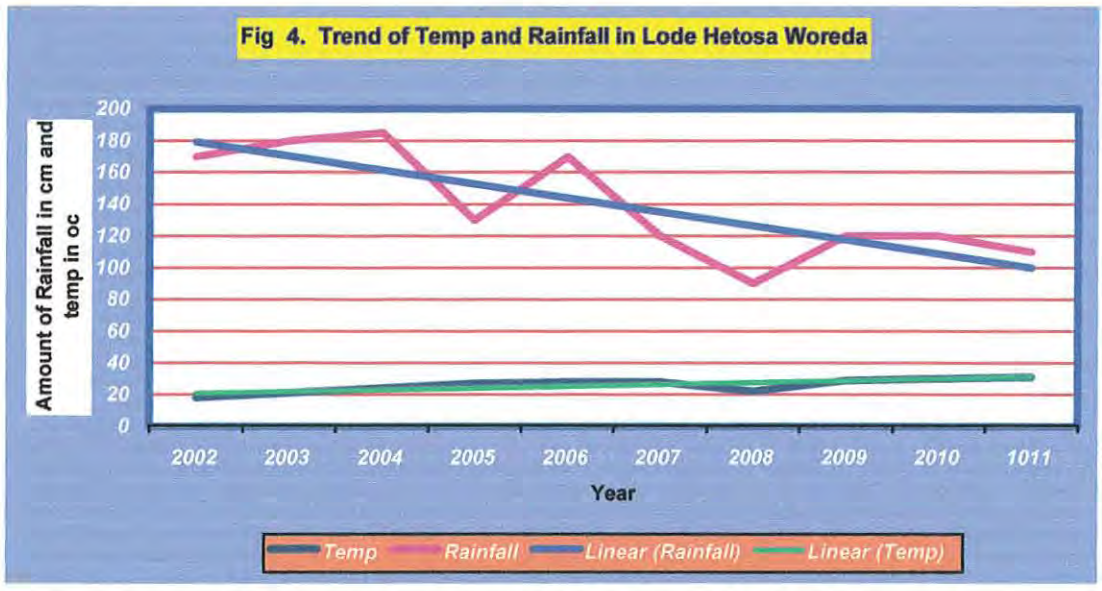
amount of yearly rainfall. Besides, the participants also mentioned that it is becoming a common phenomena to face a very torrential rain with high intensity can rain at any period of the year and damages their properties. Concerning pattern of temperature change in the last 10 years, the FGD participants mentioned that daily temperatures are usually higher while nights mostly cooler than before. Distribution of temperature across seasons has also been varying from year to year. They mentioned that it is very familiar to have a very high temperature in October and very cold temperature in May contrary to what they used to experience long years ago. The responses of farmers on the impacts of climate change on rainfall are presented in the table below.

Table 4. Responses of Survey Participants on Impacts of Climate change on Rainfall

Impacts of Climate Change on rainfall	Achaba (Dega)		Zone3 (Woinadega)		Lode zone (Kolla0		Total	
	Freq	%	Freq	%	Freq	%	Freq	%
1. Amount of annual rainfall in the last 10 years								
1.1. Increased in amount	9	18	4	10	4	9	17	12
1.2. Decreased in amount	12	24	5	12	6	13	23	17
1.3. No change at all	4	8	4	10	5	10	13	10
1.4. Difficult to generalize	25	50	27	68	30	67	82	61
1.5. Total	50	100	40	100	45	100	135	100
Impact of climate change on pattern of rainfall in the last 10 years								
1.1 Begins early and ends early	0	0	0	0	0	0	0	0
1.2 Begins early and ends late	0	0	2	5	1	2	3	2
1.3 Begins late and ends late	7	14	5	12	5	11	17	12
1.4 Begins late and ends early	6	12	4	10	3	7	13	10
1.5 No regular pattern	37	74	29	73	36	80	102	76
1.6 Total	50	100	40	100	45	100	135	100

Source: Own Survey, 2014

As clearly indicated in the table above, over 61% of the respondents mentioned that it is difficult to generalize on the amount of annual rainfall since the amount varies from year to year. The majority of the respondents (90%) believe that there is a change in amount of annual rainfall than the previous decade. However, the share of respondents who believe that rainfall amount has decreased over the last 10 years is higher than those who believe that amount has increased. With regard to the pattern of rainfall in the last 10 years, the great majority (76%) of the respondents mentioned that there is no regular pattern of rainfall. According to both the FGD and survey respondents, rainfall pattern is unpredictable as its beginning and end is not uniform across spatial and temporal scale. However, from the responses given from both survey respondents and FGD participants, one can conclude that most of the time rainfall comes late and hence causes delay of growing season. As a result, farmers are forced to grow early maturing crops even if they are not as productive as the normal crop varieties.



Source: National Meteorological Agency of Ethiopia (NMA), 2013

The above graph indicates that the trend of mean annual rainfall in the woreda is not uniform. The trend shows a decrease in the amount of rainfall. Besides, there is a significant variation of rainfall amount from year to year. This fact confirms the responses of the majority of the survey and FGD participants that mentioned it is difficult to generalize on the amount of rainfall.. Besides, the trend of temperature of the study area also shows a slight increase from 2003 to 2011. Generally, the majority of participants of this study and the recorded meteorological data indicated that there is a frequent variation in the amount of rainfall. Besides, the amount of rainfall of the study area shows a slight decrease from year to year. Likewise, the temperature recorded in the last 10 years also indicated a slight increase from year to year which confirms the perceptions of the FGD participants and key informant interviews.

4.2. Exposure of Farmers to Climate Related Drought and Flood

4.2.1. Exposure of Farmers to the Risk of Flood

In order to assess the degree of vulnerability of farmers in relation to their exposure to flood risk, indicators like exposure to flood, frequency of exposure, impact of the flood risk on farmers have been used. With respect to farmers' exposure to the risk of flood, there is a variation among the three agro ecologies. More than 90% of farmers at Achaba (Dega) were exposed to the risk of flood at least once in the last 10 years. On the other hand, the percentage of farmers who were exposed to flood risk in the past 10 years at least once was 17.8% and 62.5% at Lode (Kolla) and Zone 3 (Woinadega) respectively. From the above survey result, it can be concluded that farmers in dega agro ecology are more exposed to the risk of flood than those in woinadega and kolla. The participants of

the FGD conducted in the three villages also confirmed that the climate change related hazard to which they mostly experience is different. The participants at Achaba mentioned flooding as a major hazard that causes serious erosion most of the time. The participants at Lode village on the other hand pointed out that they face drought more frequently than that of flood. The participants at Zone 3, however, responded that both flood and drought occur but very rarely in their area.

The frequency of flood occurrence is not uniform among the three agro ecologies. More than 52% of the respondents at Achaba mentioned that they have faced with flood risk more than 5 times in the last 10 years as opposed to the respondents at Zone 3 and Lode whose percentage is only 12% and 4.5% respectively. On the other hand, the percentage of farmers who faced flood hazard in the mentioned period only once was 60, 45 and 4 at Lode, Zone 3 and Achaba respectively. From the above statistics, we can conclude that farmers at Dega face flood hazard more frequently than their Woinadega and Kolla counterparts. All the respondents who said that they are exposed to flood risk at least once have also been affected by the risk regardless of their agro ecologies. This indicates that as a result of the sensitiveness of their livelihood source and limited adaptive capacity, most of the farmers suffer from the risk of the hazards whenever they face them. However, the type of flood effect varies among the three villages and even within the communities of the same village. With regard to the type of damage caused by flood, the great majority of respondents at Achaba (76.6%) mentioned that their property had been lost due to flood while those who lost both property and livestock and property and human life are 15% and 8.4%. At Zone 3 and Lode, on the other hand, there is no respondent who reported loss of human life due to flood. More than 92% and 80%

respondents at Zone 3 and Lode said that flood resulted in loss of property damage in the last 10 years. Besides, about 7.7% and 20% at Zone 3 and Lode said that they lost both property and livestock due to flood hazard. But there is no loss of human life in both villages. With regard to the measures they take to prevent the hazard, 65% at Achaba, 56% at Zone 3 and 51% at Lode village mentioned construction of terraces as a possible strategy. On the other hand, 23% at Achaba, 18% at Zone 3 and 16% at Lode villages mentioned planting trees as a prevention method. The head of Lode Hetosa Woreda Agriculture and Rural development Office and other experts mentioned that Gudelcha kebele, in which Achaba is found, is one of the few kebels where flood causes a serious property damage. According to these officials, the woreda loses about 100 to 300hectares of cultivated land annually Mosley in the highland agro ecologies.

4.2.2. Exposure of Farmers to the Risk of Draught

Drought which is a prolonged absence of rainfall in a given area affects the livelihood of farmers to a great extent. Contrary to exposure of flood hazard, the great majority of respondents at Achaba (84%) mentioned that they have not been encountered with drought in the last 10 years. However, the percentage of farmers who faced drought in the last 10 years at Zone 3 and Lode at least once is 78% and 82% respectively. About 6% at Achaba, 5% at Zone 3 and 4.4% at Lode do not exactly remember whether they faced drought in the last 10 years or not. The frequency of occurrence of drought is not uniform across the villages. All respondents of Achaba who said yes to exposure of drought reported that they faced drought only once in the last 10 years. The percentage of farmers who mentioned that they faced drought only once at Zone 3 and Lode is 78 and 55 respectively. The rest (22% at Zone 3 and 45% at Lode) reported that they encountered

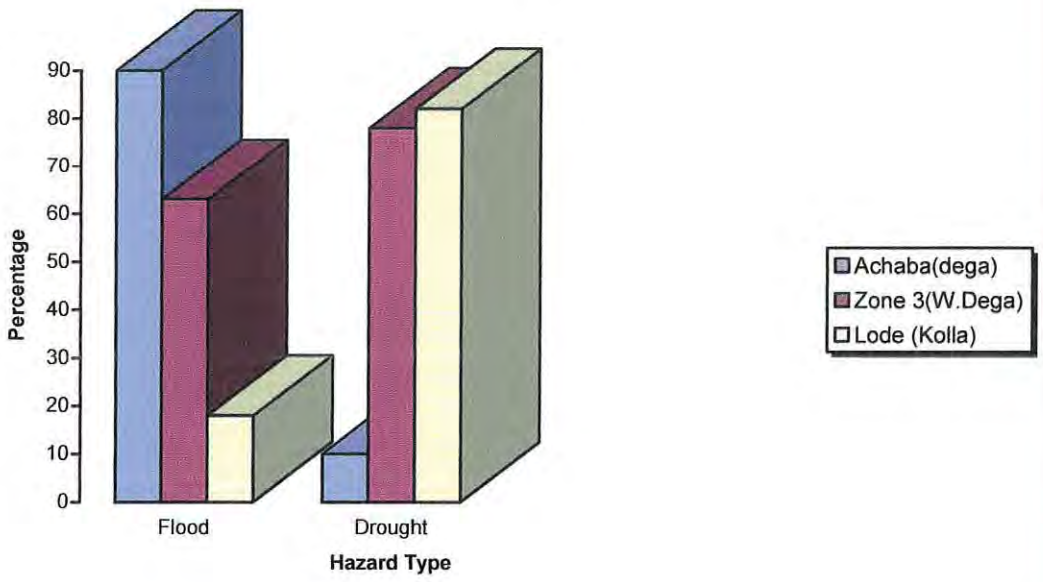
drought more than one time in the last 10 years. The above figures indicate that farmers at kolla and woinadega are more exposed to the risk of drought than those in dega agro ecologies. With regard to the frequency of occurance of drought in the target areas, the highest is 5 times reported in Lode zone while the lowest is 0 in Achaba village.

Regardless of difference in agro ecologies, all respondents in all the three villages who reported that they faced drought at least once in the last 10 years confirmed that their livelihood have been affected by the hazard. However, the degree of damage caused by the drought hazard varies from one village to the other. For instance, the farmers who reported that drought affected only their properties is 80%, 64% and 60% at Achaba, Zone 3 and Lode respectively. Those farmers whom drought affected both their livestock and other properties is 20%, 36% and 40% at Achaba, Zone 3 and Lode respectively. Although there is no clear variation in terms of drought related damage across the three agro ecologies, it can be said that all farmers in the three agro ecologies have been affected by the drought hazard though the effect varies on the basis of their degree of sensitivity and adaptive capacity.

The results of focus group discussions and community mapping sessions made with the target communities attest that climate change and variability has brought various human impacts on the target population. FGD participants at Lode and Zone 3 mentioned that malaria incidences are becoming very common since few years which was not the case in earlier days. They have also confirmed that some disease out breaks like diarrhea also occur following the incidence of flood hazard. Occurrence of flood and drought in these two villages is also threatening the food security effort of the communities as mentioned by the participants of the FGD. Likewise, FGD participants at Achaba mentioned that

displacement of households is becoming a common phenomenon due to flood hazards since their residential area mainly on a hilly topography very vulnerable to flood hazard. The problem of food shortage is also mentioned by the participants at this village mainly due to crop damage due to flood. At Lode village on the other hand, participants of FGD mentioned that sometimes, there are clashes between community groups regarding use of some communal resources like a pond while using for their animals and irrigating their farmland.

Figure 5. Exposure of Farmers to Flood and Drought Hazard by Agro Ecology



From the above figure, it can be understood that farmers at Achaba (dega) are more affected by climate change related flood than zone 3 and Lode villages. On the other hand, drought is the most frequent climate change related hazard as compared to occurrence of flood hazard. However, this does not mean that flood is not an issue of

concern in the Kolla and woinadega agro ecologies. The farmers at Lode and Zone 3 mentioned during FGD and community mapping sessions that they had encountered many occasions of a rainfall of very high intensity that usually results in flooding. However, the frequency is not as high as that of the Dega agro ecology. .

4.3. Analyses of Farmers' Sensitivity to Climate Change/Variability

As it is clearly mentioned in the literature review and methodology section, there are different indicators that can be used to measure the status of farmers' sensitivity to climate change impacts. This paper, however, focuses on the level of dependence of farmers on natural resource based income, demographic structure and health status of households, farmers' access to flood and drought resistant crop varieties and application of irrigation practices for crop production

Higher share of natural resource based income (composed of agriculture, livestock, forest, honey and handicrafts) increases the sensitivity of the household as these sources are more dependent on climate; while higher share of non-natural resource based remunerative income sources (composed of salaried jobs, non-farm skilled jobs, and remittances from abroad or local source) reduces the sensitivity (Piya, et al, 2012). With regard to the major source of livelihood of farmers, more than 90% (96% at Achaba, 91% at Lode and 90% at Zone 3) of all farmers in all the three villages depend on natural resource based income like farming, livestock rearing, handicrafts, forestry etc. However, while there is no household in Achaba village with non agriculture related source of income as a major livelihood source, while about 7% and 7.5% of farmers at Lode and Zone 3 villages depend heavily on non agricultural related income sources like trading, renting houses in towns carpentry, electric installation and brokerage. Besides, only 4% at Achaba, 2% at Lode

and 2.5% at Zone 3 have remittances from abroad and domestic source and pension as a major source of livelihood.

Table 5. Survey Result on Indicators of Sensitivity

N S	Indicators of Sensitivity	Frequency and percentages of respondents by agro ecology					
		Achaba (Dega)		Zone 3(W.Dega)		Lode (Kolla)	
		Frequency	%	Frequency	%	Frequency	%
1	Agriculture as major source of livelihood	48	96	36	90	41	91
2	Presence of dependant population (under 18 and above 60 years) in the household	37	74	29	72.5	33	73
3	Presence of chronically ill and disabled family member in household	2	4%	1	2.5%	2	4.4.%
4	Access and Use of drought resistant crops	0	0	5	12.5%	8	17%
5	Access and use of flood resistant crop varieties	0	0	0	0	0	0
6	Application of irrigation practices	2	4%	4	10%	6	13%

Source: Survey Conducted for this study (2014)

The presence of relatively large proportion of dependant population of old ages and children enhances the sensitivity of households to climate change related hazards. This is partly due to the fact that these groups of people cannot easily withstand the impact of the hazard. Besides, children and old people reduce productivity as they are not actively engage in production activities that support the livelihood of the household. As it is indicated in the above table, there is no significant difference of dependant population among the three villages. However, over 70% of respondents in all the three villages mentioned that there is at least 2 dependant household member in their household. This

means that the sensitivity of farmers in the woreda with regard to dependency ratio is higher. in the context of the woreda, and even in many parts of rural Ethiopia, however, children above the age 5 or 6 can perform various activities even can do agricultural works like weeding and plowing. Therefore, presence of such children may not clearly indicate dependency.

Access and use of drought and flood resistant crops minimizes farmers' vulnerability to climate change related hazards by reducing their sensitivity. This is mainly because, the drought and flood resistant crops can resist the hazard that is caused by the climate change related impact and hence assists the farmers to cope up with the hazard. At Achaba village, there is no one who uses drought resistant crops while 12.5% and 17% of the farmers at Zone 3 and Lode villages respectively use drought resistant crop varieties. The drought resistant crop varieties mentioned by the farmers wheat likc durum and different types of potato. .All farmers in the three villages who do not use drought resistant crops mentioned lack of knowledge and inability to afford the crops as a reason for not using the crops. With regard to use of flood resistant crops, no farmer in the three villages uses as a result of lack of knowledge about such type of crop varieties. Besides, the agricultural development agents in the three villages also mentioned that although there are certain crop varieties like wheat and potatoes that are drought resistant their price is expensive to farmers and they are not easily accessible to the poor.

Application of irrigation practices for farming enhances farmers' productivity by reducing their dependence on rain-fed agriculture. In the study area however, application of irrigation practices is very minimal. According to the Lode Hetosa woreda Irrigation Office, there is no large scale irrigation scheme functional at this time. The only irrigation

practices in the woreda are small scale irrigation schemes practiced by individual farmers using pipe water, hand-pumps and motor pumps to a very limited degree. The farmers that practice irrigation are mostly those who are educated and better off. Of all the respondent farmers of the woreda, only 4% at Achaba, 10% at Zone 3 and 13% at Lode villages practice irrigation agriculture. The total area of farming land they are irrigating is less than $1/3^{rd}$ of their total agricultural land in all the three villages. Besides, there is no non-governmental organization that supports farmers in this regard in the entire woreda. However, the woreda irrigation office mentioned that there are plans to practice irrigation in the future by diverting major rivers found in the woreda.

When a comparison is made using the above mentioned six sensitivity indicators, Achaba village, which represents highland/dega agro ecology ranks last in terms all the indicators assessed. Hence, it is the most sensitive village of all the three villages., Zone 3 is best in terms of having population of relatively less dependent on agriculture related livelihood sources, less proportion of dependant population and less proportion of chronically ill and disabled household members. . The other village, Lode, on the other hand, is best in terms of application of drought resistant crops, and using irrigation as an alternative means to rain-fed agriculture. The ADAs in that kebele mentioned that application of relatively better irrigation in this village is due to a recurrent drought problem in the area. With regard to access and use of flood resistant crop varieties, all the three villages do not have access and hence no variation. Although farmers in all the three villages grow some leguminous plants like beans, peas, chickpeas etc that resist erosion, they do not grow them for their erosion tolerance but for their domestic consumption purpose. In general,

Zone 3 ranks first in terms of aggregate sensitivity followed by Lode village. On the contrary, Achaba is last with regard to all the six indicators.

In addition to inter-village comparison, effort has also been made to make comparison of sensitivity among the different socio economic groups of people in each agro ecologic based village. To do so, age, gender and status of education were used. The results of the survey on the selected sensitivity indicators based on the above mentioned social groups are presented in the table below.

Table 6. Values of Sensitivity Indicators by Socio-demographic Characteristics

Indicators of sensitivity	Percentage by socio economic characteristics						
	Sex		Age			education	
	Male (n=113)	Female n=(22)	<18 (n=4)	18-60 (n=109)	>60 (n=18)	Literate (n=50)	Illiterate (n-=85)
1. Agriculture as major source of livelihood	103 (91%)	22 (100%)	0 0%	109 (100%)	0 0%	42 (84%)	83 (98%)
2. Presence of dependant population (under 18 and above 60 years) in the household	82 (73%)	17 (77%)	4 (100%)	77 (71%)	18 (100%)	40 (80%)	59 (69%)
3. Presence of chronically ill and disabled family member in household	4 (4%)	1 (5%)	0 0%	2 (2%)	3 (17%)	1 (2%)	4 (5%)
4. Access and Use of drought resistant crops	12 (11%)	1 (9%)	0 (0%)	8 (7%)	5 (28%)	10 (20%)	3 (3%)
4. Access and use of flood resistant crop varieties	0	0	0	0	0	0	0
5. Application of irrigation practices	9 (8%)	1 (4.5%)	1 (25%)	8 (7%)	1 (6%)	7 (14%)	3 (3.5%)

Source: Own Survey, 2014

As shown in the table above, farmers' sensitivity to climate change related hazards varies dues to various socio economic and demographic factors. With regard to sensitivity of farmers based on sex, female farmers are found to be more sensitive to climate change in

almost all indicators assessed. Out of the 22 female household heads included in this study, all of them practice agriculture as a major source of livelihood. Besides, access to drought resistant crops and application of irrigated agriculture is also lower in the case of female than male household heads. Age is also the other factor that influences the sensitivity of a household to climate change and variability. According to this survey, household heads who are between the ages of 18-60 years are less sensitive to climate change as compared to those sections of the community who do not actively engage in the productive activities. Likewise, level of education of the household also influences sensitivity of the household. As it was hypothesized, rate of literacy has a positive contribution in reducing sensitivity of farmers to climate change. This fact is attested by the fact that the percentage of farmers who use drought resistant crop varieties and apply irrigation agriculture is higher in the case of literate farmers than those of illiterate ones. Generally, female-headed households, households who are headed by illiterate and those who are not in the active productive work force are more sensitive to climate change and variability. According to the participants of the FGD in all the three villages, there is no social groups that are vulnerable due to their social exclusion as a result of their social background.

4.4. Analyses of Farmers' Adaptive Capacity to Respond to Climatic Impacts

As it has been mentioned in the previous sections, the DFIDs Sustainable Livelihood Framework was used to analyze the adaptive capacity of farmers to climate change related impacts. The five types of assets/capitals of physical, natural, social, human and financial are used. The different types of indicators used to assess the farmers adaptive

capacity in relation to the five assets and farmers responses is presented in the table below.

Table 7. Survey Results on Adaptive Capacity Indictors (Human, Natural and Physical Assets)

Asset Category	Description of indicators	Achaba	Zone 3	Lode	Total
Human Asset	1. Dependency ratio	0.75	0.55	0.54	0.58
	2. Literacy rate excluding informal education	18 36%	31 77%	28 62%	77 57%
	3. Highest educational qualification in the household (grade 12 and above)	3, 6%	11, 27%	10, 22%	23, 17%
	4. Ratio of households with chronically sick and disabled	2,4%	1,2.5%	2,4.4%	5,3.7%
	5. Access to vocational training in the household	2, 4%	5, 12.5%	4, 8.8%	11, 8%
Natural Asset	1. Access to farming land	45,90%	37,93	41,91%	123,91%
	2. Average farming land per household in hectares	1.6ha	2.1ha	2.15ha	1.95ha
	3. Access to common natural resources like forest, water, fruits etc	50 100%	40 100%	45 100%	135 100%
Physical Asset	1. Type of better residential house (wooden/block wall with tile roof)	34 68%	35 87%	40 88%	109 81%
	2. Access to information communication equipments of hh heads 2.1. Mobile phone 2.2. Radio 2.3. Television 2.4. Radio and TV 2.5. Mobile Radio TV	 12,24% 39, 78% 0, 0% 0, 0% 0,0%	 26,,65% 37,93% 6, 15% 6, 15% 6, 15%	 32,71% 42,93% 4, 9% 4. 9% 4, 9%	 70 ,52% 118,87% 10, 7% 10. 7% 10, , 7%
	3. Access to irrigated land	2, 4%	4, 10%	6, 13%	12, 8.9%
	4. Walking distance to the nearest motor road	1hour	30min	35min	42min

Table 8. Survey result on Adaptive Capacity (Financial and Social asset)

Financial Asset	1. Annual average income	13000.00	21000.00	19000.00	17667.00
	2. Average number of livestock owned	9	7	8	8
	3. Ownership of saving account	4 8%	10 25%	9 20%	23 17%
	4. Annual average saving in birr	1200br	1500br	1500br	1400br
	5. Livelihood diversification	0.19	0.49	0.46	0.38
	6. Access to credit sources	5, 10%	10, 25%	9, 20%	24, 18%
Social asset	1. Membership to CBOs	46, 92%	36, 90%	40, 89%	122, 90%

Source: Own Household Survey, 2014

To assess the human capital of households of the target villages, rate of literacy, dependency ratio (ratio of under 18 and above 60 years to total household members), access to vocational training courses, ratio of chronically ill and disabled household members to total family members and highest educational qualification attained has been taken as indicators. The survey result on human capital of the villages shows that Achaba village is the least in terms of adaptive capacity. Average dependency ratio of the respective villages of Achaba, Zone 3 and Lode was 0.75, 0.55 and 0.54 respectively. This shows that the number of productive labor force at Achaba village is lower than the other two which indicates that this village has lesser capacity to cope up with shocks due to its higher number of dependant population. Regarding the rate literacy, the aggregate rate of the three villages is 57% with Zone 3 having the highest (77%) followed by Lode (62%) and Achaba only 36%. Besides, Achaba is also the least in terms of the total

number of people with higher educational qualification (grade 12 and above). Achaba is also the least in terms of the percentage of populations who attained a higher educational status of grade 12 and above. Zone 3 and Lode villages have better proportion of educated people even higher than the aggregate of the three villages. Moreover, the percentage of population who obtained any vocational training courses by government or other institution is relatively higher at Zone 3 (12.5% of the total household members) as compared to Achaba which has only 4% of population with vocational training skill. In terms of proportion of chronically sick and persons with disabilities, Zone 3 has a lower proportion while Lode and Achaba has equal proportion of 4% of their respective total population. In general, when comparison is made among the three villages, Zone 3 (woinadega) has a relatively better human asset in almost all the five indicators followed by Lode while Achaba village has the least human capital.

In order to assess farmers adaptive capacity in terms of natural capital, ownership of farming land, size of farming land and access to common natural resources like forests, water resources etc have been used. Ownership of these natural resources has been hypothesized to maximize adaptive capacity of households and hence lower vulnerability to climate change impacts. With regard to ownership of farming land, there is no significant variation among the three villages. Almost over 90% of the respondent households have access to farming land. The difference, however, lies in the size of the farming land owned by the households. The average farm size at Zone 3 and Lode is slightly higher than the aggregate figure which is 1.95ha per household while that of Achaba is lower than the aggregate by about 0.35hectare. This is partly attributed to the higher fertility rate and rugged topography which is difficult for cultivating at Achaba as

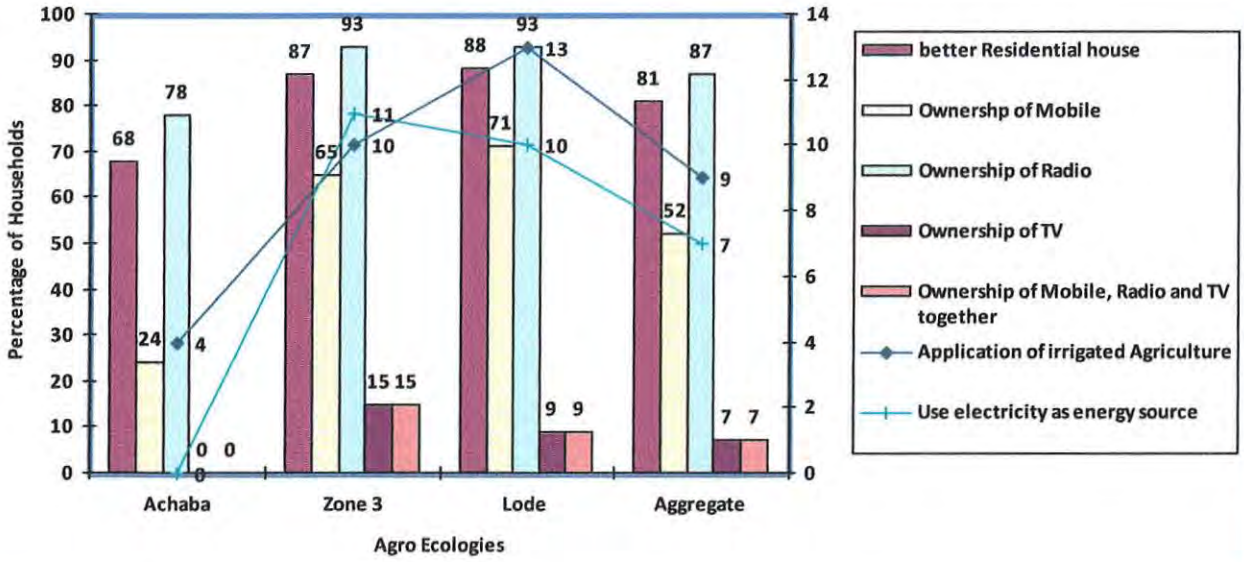
compared to the other two villages. In terms of access to some common natural resources like water points, forest resources etc, all the respondents in the three villages reported that they have access but with the exception of water for their animals and themselves, they do not get any benefit from other natural resources. Here again, Achaba has a lower adaptive capacity as a result of its lower farm size as compared to the three villages.

Farmers' ownership of physical capital/assets is an indicator of adaptive capacity that reduces vulnerability to climate related impacts. To assess the adaptive capacity of farmers in the study area, four indicators related to ownership of physical assets, namely, percentage of farmers who own a better residential house type of stone/wooden wall with steel wall, percentage of households who have information communication materials like mobile phone, radio and television, percentage of households who have irrigated land, source of energy in rhe household, and average walking distance to the nearest motor road are used.

The results of the survey show that about 81% of the household in the entire villages own a house constructed from wooden/stone wall with steel roof which is an indicator of a relatively better economic status. The percentage of households having the above mentioned house type at Zone 3 and Lode is roughly the same and above the aggregate while that of Achaba is lower than the aggregate figure. With regard to application of irrigation practices, Lode village has a relatively good percentage of irrigated land followed by Zone 3 village. However, only 4% of the households at Achaba practice small scale irrigation. In general, application of irrigation is very limited in entire woreda. Only 9% of the sampled households practice less than a quarter of their farm land using traditional irrigation methods like hand pumps. According to Lode Hetosa Woreda

Irrigation Office, modern irrigation practices are inexistent in the entire woreda. Access to information communication equipments like mobile, radio and TV helps farmers to get climate related information to be used for planning and decision making. Of all the above mentioned information communication materials, radio is available in a large number of households in the three villages. Nearly 87% of households own radio in the three villages although the percentage of households that own radio at Achaba is lower than the average of the three villages with about 78%. Mobile phone is the 2nd most available equipment next to radio owned by about 52% of the entire villages with the lowest figure of only 24% at Achaba. Those households who own mobile, radio and TV together is the highest at Zone 3 followed by Lode while there is no household that owns all the three equipments at Achaba. Proximity to motor roads is also considered as one good indicator of adaptive capacity since it gives farmers the chance of transporting their produce and farm related inputs to and from market. From the three target villages, households at Achaba spend about an hour to reach the nearest Robe-Hurata road while the walking distance of farmers from Zone 3 and Lode to the nearest motor road is 30 and 35minutes respectively. Besides, these two villages are also relatively closer to the woreda capital Huruta which provides access to market to their products. As it is elaborated above, Achaba is the least in terms of owning all the physical assets and the farthest from the nearest motor road and hence the least in terms of adaptive capacity. Although there is a relatively better adaptive capacity at Zone 3 and Lode villages, the overall status of adaptive capacity particularly in terms of application of irrigated agriculture, is very low. Only less than 10% of the entire woreda practice small scale irrigation mainly at garden level using traditional methods.

Figure 6. Farmers Ownership of Physical Capital



Source: Own Survey, 2014

According to the information obtained from the Lode Hetosa Woreda Energy Office, the available energy sources in the woreda include biomass (wood and animal excreta), kerosene, electric, solar, and biogas. However, with the exception of biomass, most of the other sources are not well developed and used. Thus, firewood is the most important source of domestic energy supply. Likewise, the survey respondents also confirmed that over 93 percent of the population in the woreda use biomass as energy source for their household. This fact is also supported by the following table which shows the major sources of energy for households in the rural part of the woreda.

Table 9. Source of Energy used by Households for Cooking in Rural Part of the woreda

Sn	Sources of Energy	Frequency of households	Percent of total
1	Electricity	87	0.44
2	Gas	16	0.03
3	Kerosene	2864	16.5
4	Charcoal	3787	21.7
5	Firewood	15778	90.6
6	Animal Dung	16077	92.3
Total housing units		17417	100

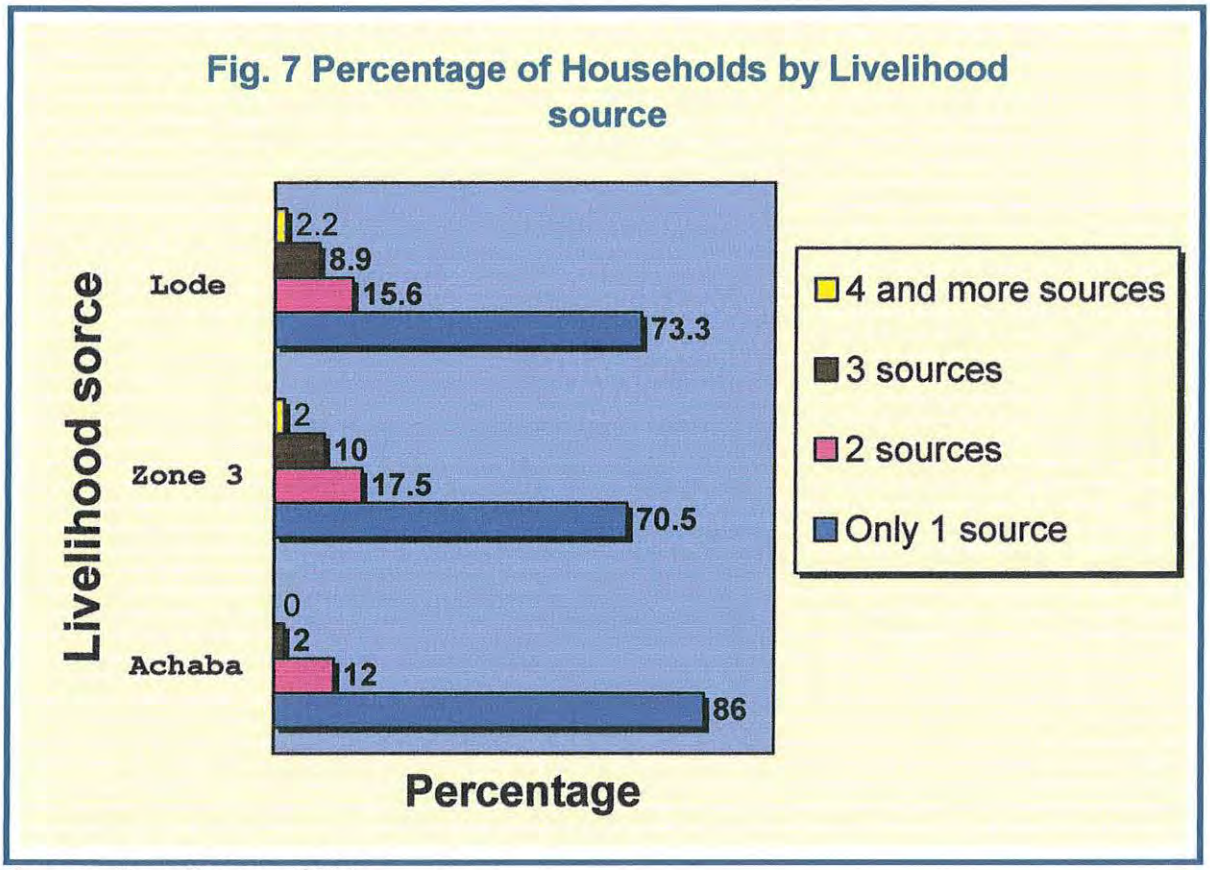
Source, Central Statistics Authority, 2010

As it is clearly indicated in the table above, more than 90 percent of the rural population in Lode Hetosa Woreda use animal dung and firewood for as source of energy. Besides, the survey result and CSA data confirms that the percentage of households that use electricity as an energy source is extremely rare. From this analysis, we can understand that the households adaptive capacity is very small.

Access to financial capital is the other most important factor that influences the adaptive capacity of farmers to climate related impacts. To assess the status of households in terms of their financial assets, five indicators have been used. These are annual average income of the household, access to credit sources, average livelihood diversification index of the villages, ownership of saving account and annual average saving and number of livestock

owned. The average annual income of households varies both among the villages and from household to household. The highest annual income is reported at Zone 3 while the lowest at Achaba. The respective average annual income of Achaba, Zone 3 and Lode zones is 13000, 21000 and 15000 birr. At household level, the minimum annual income is 900 birr at Achaba and the highest is 80,000 birr at Zone 3. Of all the respondent households, only 8%, 25% and 20% at Achaba, Zone 3 and Lode villages have a saving account either from commercial or micro credit institutions. The average annual saving of farmers that own a saving account is 1200 birr in all the three villages. Regarding farmers access to credit sources, the highest percentage is reported at Zone 3 and the lowest at Achaba. The farmers mentioned that the credit is usually obtained from micro credit institutions and nearby individual with a higher interest rate from 10% to some times 100 percent. Possession of livestock animals has also been taken to indicate better status of adaptive capacity as farmers use the livestock as an alternative source of livelihood. An inter household analyses of livestock ownership indicated variation from a minimum of 0 at Lode and Zone 3 to a maximum of 50 animals. At Achaba. The average ownership is the highest at Achaba of 9 animals while that of Zone 3 and Lode villages posses an average of 8 animals per household. The other indicator of financial asset related adaptive capacity is livelihood diversification index. Respondents were asked to mention the types of livelihood activities they practice together with the respective average annual income from the specific activity. Using the livelihood diversification formula mentioned in the methodology section, values ranging from 0 to 0.78 have been found. Zero values indicate no livelihood diversification at all. That means, many of the farmers in the study area practice a single activity of farming as the only source of livelihood. On the other

hand, an index nearer to 1 indicates a better livelihood diversification. From the three agro ecologies, the highest average livelihood diversification index was at Zone 3 followed by Lode village. The index of Achaba is very close to 0 which indicates that livelihood diversification is very low in the area. The average index of diversification for the three villages is found to be 0.38 which is lower than that of Zone 3 and Lode villages. The survey also indicated that of all the farmers interviewed, about 77% of households earn income only from a single activity. The percentage of households who earn income from two sources account for about 15% while those earning income from three sources and four and above income sources respectively account for about 7% and 1% of the total. Besides, the share of non-farm related income is very minimal in all the three villages. The percentage of households who earn income from non-farm related income sources like remittances, trading, pensions, non-farm related salaries, carpentry, brokerage etc is 7% at Achaba and Zone 3 and 9% at Lode village. In addition, there is also a significant variation among the three villages with regard to the number of livelihood sources from which the farmers derive income. The result of the survey regarding the number of livelihood sources in the three villages is presented in the graph below.



Source: Own Survey, 2014

As it is indicated in the above graph, the lion's share of the households in all the three villages earns income from a single activity. However, the percentage of households who depend on a single source is the highest at Achaba and the lowest at Zone 3 Lode zone being somewhere between the two. Besides, at Achaba, there is no household that earn income from 4 and above sources while the about 2% of households earn income from 4 and above livelihood sources at Lode and Zone 3 villages. These show that farmers' vulnerability is relatively higher at Achaba village due to higher dependence on a single livelihood source while there is a relatively less status of vulnerability at the other two villages.

To evaluate the status of adaptive capacity among the different demographic groups of the community like women, dependant population and illiterate people, one indicator was selected from each of the five capitals. Hence, rate of literacy from human capital, access to farming land from natural capital, ownership of better house type from physical capital, annual average income from financial capital and membership to CBOs from social capital are used for comparison. The result of the survey for the selected indicators is presented below.

Table 8. Status of Adaptive capacity by Socio demographic Characteristics

Indicators of adaptive Capacity	Percentage by socio-demographic characteristics						
	Sex		Age			Education	
	Male (n=113)	Female n=(22)	<18 (n=4)	18-60 (n=109)	>60 (n=18)	Literate (n=50)	Illiterate (n-=85)
Literacy rate	45, 40%	5, 23%	4, 100%	41, 38%	5, 28%	-	-
Access to farming land	108, 96%	15, 68%	1, 25%	103, 94%	15, 83%	48, 96%	75, 88%
Ownership of better housing	94, 83%	15, 68%	2, 50%	100,92%	7, 39%	41, 82%	68,80%
Annual average income	18,300	10,800	12,600	18,900	17,600	19,600	16,400
Membership to CBOs	102, 90%	20, 91%	0, 0%	101, 93%	17, 94%	45, 90%	77, 91%

Source: Own Survey conducted for this study, 2014

The above table clearly shows that in all the selected indicators of adaptive capacity, female have less access to resources than their male counterparts. Besides, the distribution of assets is also varies among the different age categories. Households headed by persons in the working age of 18-60 years have a relatively better adaptive capacity than those households headed by people who are under the age of 18 and over 60 years

In order to evaluate the status of farmers' adaptive capacity on the bases of their agro ecology, the average rank of each village for each indicator under the five capitals of adaptive capacity has been used. This rank has been given using percentages, ratios, indices, means etc of the three villages for the purpose of making comparisons. The rank of the three villages on the basis of indicators of adaptive capacity is presented in the table below.

Table 11a.Rank of Villages by Adaptive Capacity Indicators (human & natural asset)

Components of adaptive capacity	Specific indicators used	Relationship to adaptive capacity	Rank of villages by adaptive capacity*		
			Achaba	Zone 3	Lode
Human capital	1. Dependency ratio	Negative	3	2	1
	2. Literacy rate excluding informal education	Positive	3	1	2
	3. Highest educational qualification in the household (grade 12 and above)	Positive	3	1	2
	4. Ratio of households with chronically sick and disabled hh members	Negative	2	1	3
	5. Access to vocational training in the household	Positive	3	1	2
	Average of human capital	Positive	3rd	1st	2nd
Natural capital	1. Access to farming land	Positive	3	1	2
	2. Average farming land per household in hectares	Positive	3	2	1
	3. Access to common natural resources like forest, water, fruits etc	Positive	1	1	1
	Average of natural capital		3rd	1st	1st

Table 11b. Rank of Villages by Physical, Financial and Social Capital

Physical capital	1. Possession of better residential house (wooden/block wall with tile/tin roof)	Positive	3	2	1
	2. Access to information communication materials (mobile, radio and TV)	Positive	3	1	2
	3. Possession of irrigated land	Positive	3	2	1
	4. Average walking distance to nearest motor road	Positive	3	1	2
	Average of physical capital		3rd	2nd	1st
Financial capital	1. Annual average income	Positive	3	1	2
	2. Possession of saving account	Positive	3	1	2
	3. Average annual saving	Positive	3	1	2
	4. Possession of livestock	Positive	1	3	2
	5. Average livelihood diversification index	Positive	3	1	2
	Average rank of financial capital		3rd	1st	2nd
Social capital	1. Membership to CBOs (eddirs, mahber, equbs etc)	Positive	1	2	3
Average rank of villages by all the five components		Positive	3rd	1st	2nd

Source: Own Survey Conducted for this study, 2014

**The rank of villages has been given on the basis of cumulative percentages, indices, ratios, means of each indicator in each village.*

As it has been shown in the table above, the relative rank of adaptive capacities of the three agro ecology-based villages is not the same. Out of the five capital of adaptive capacity, Achaba is better only in terms of social capital of having a good proportion of households being a member of community based institutions like edir, mahber, equb etc. this village ranks last in all other capitals. Zone three and Lode on the other hand, have an approximately closer values used for comparison. While Zone 3 from Woinadega agro ecology ranks 1st in human and financial capitals, Lode exceeds in terms of possession of physical capital.. With regard to possession of natural capital, on the other hand, the two villages have the same rank. In general, Zone 3 has the best relative adaptive capacity followed by Lode zone while Achaba is the least adaptive capacity that will enable to with stand climate change related impacts.

4.5. Differential Vulnerability

4.5.1. Vulnerability Status by Agro Ecology

This study tried to assess the status of vulnerability of farming households in the three agro ecologies. To do so, the data obtained regarding the selected indicators of exposure, sensitivity and adaptive capacity have been evaluated using different techniques like qui-square test for independence using SPSS. . To arrive at a conclusion, all the survey results, responses of FGD and community mapping and key informant interviewees were integrated. Based on the above mentioned methods, therefore, comparisons have been made between the three agro ecologies. Accordingly, therefore, among the three agro ecologies, Zone 3 (Midland agro ecology) was found to be the least vulnerable followed by Lode (lowland) with a minor difference. On the other hand, Achaba (Highland) was

found to be the most vulnerable of all the three agro ecologies. Zone 3 and Lode villages are less vulnerable to climate change due to various reasons. The most important ones include their less exposure to flooding, relatively gentler topography, proximity to the capital of the Woreda as market source, access to some physical infrastructure like electricity and motor roads, better application of irrigation and non- farm related jobs, practicing cash crop production like onion. When comparison is made between the two villages, however, Lode is more vulnerable due to its high exposure to drought, inability to caltivate diversified crop varieties and unbalanced rainfall. Achaba village (Highland/dega agro ecology), on the other hand, is the most vulnerable because of its steeper topography hence highly exposed to flooding, its higher number of household size, less productive land, less irrigation agriculture, its distant location from market centre and motor roads, its degraded farm land and higher rate of illiteracy.

4.5.2. Vulnerability Status by Socio Economic Characteristics

The status of vulnerability of households has also been evaluated on the basis of selected socio economic characteristics like sex, education and age of the household heads. On the basis of these characteristics, it was found that there is a variation of vulnerability status among the different community groups. Regarding sex, it was found from the survey result that female headed households are found to be more exposed to hazards, highly dependent on very sensitive livelihood sources and have less access to the five types of assets. Age of the household heads was also found to be a significant contributor to the status of vulnerability of households. Of all the age categories participated in the survey, those household heads found in the age range of 18-60 are less exposed to effects of hazards, have better access to socio economic resources and less dependent on climate

change sensitive livelihood sources like rain fed agriculture. Likewise, education has also shown a positive impact to vulnerability of households. From the survey result, it was found that majority of the households headed by educated household heads have better access to physical, natural, financial and human assets and hence practice less sensitive income sources. They were also found to practice relatively diversified activities than those illiterate households.

4.6. Application of Water Related Adaptation Strategies

Prior to the evaluation of farmers' application of water related adaptation strategies, they are asked whether climate change and variability has brought impact on the water resources of the area during the last 10 years. Accordingly, therefore, 129 out of 135 (96%) respondents said climate change has resulted in reduction of both the volume and quality of water resources in their respective villages. They also cited numerous examples of dried up rivers due to climatic impact. They mentioned that many rivers which used to flow year to year now days flow only for half or a quarter of a year. Even the reaming 4% of the farmers believe that the volume and quality of water resources of their villages has been reduced. However, they believe that it is not climate change that is to blame but due to supper natural reasons. The interview made with the head of Lode Hetosa woreda Water Resource Office and ADAs also confirms the above mentioned argument given by the respondent farmers. The head and ADAs mentioned that many perennial rivers like Wodecha, Guna, Kutle many other rivers flow well only during the rainy season.

The responses given by the target respondents regarding application of water related adaptation strategies is presented in the table below.

Table 12. Framers Application of Water Related Adaptation Strategies

Category of the strategy	Types of the strategy	Number of farmers applying adaptation strategy by agro ecology						Aggregate	
		Achaba (Dega(		Zone 3 (Woina Dega)		Lode (Kolla)		Freq	%
		Freq	%	Freq	%	Freq	%		
No application of water related adaptation strategy at all		32	64	18	45	14	32	64	47
Apply at least one adaptation strategy of any of the category		18	36	22	55	31	68	71	53
Demand side adaptation strategies	1. Using water saving efficient technologies and methods like drip irrigation	0	0	0	0	0		0	0
	2. Using water for multiple purposes	0	0	0	0	0	0	0	0
	3. Reduction in water demand for irrigation by changing the cropping calendar, crop mix, irrigation method, and area planted	0	0	5	23	12	39	17	32
	4. Recycling of water	0	0	0	0	0	0	0	0
	5. Removal of invasive non native vegetation types from riparian areas	0	0	3	14	9	29	12	17
Supply-side adaptation strategies	1. Construction of flood protection infrastructure and water conservation practices	18	100	22	100	31	100	71	100
	2. Directing roof runoff to lawns to enhance infiltration	0	0	0	0	0	0	0	0
	3. Expanding the capacity of water harvesting infrastructures like wells	0	0	7	32	9	29	16	23
	4. Extraction of groundwater	6	33	2	9	8	26	16	23
	5. Rainwater harvesting	7	39	15	68	26	84	48	68

Source: Own Survey conducted for this study, 2014

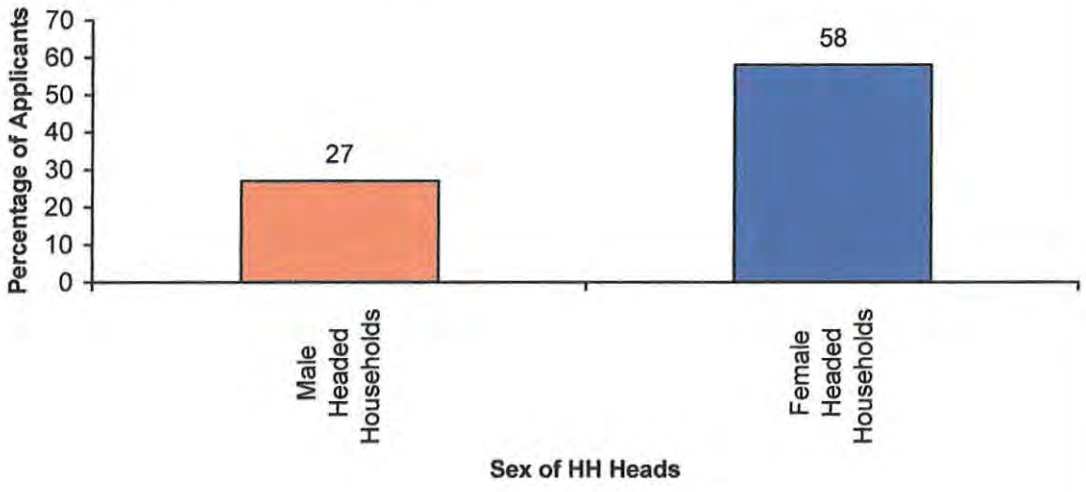
As it is clearly indicated in the conceptual literature part, status vulnerability of households has a direct influence on application of adaptation strategies. The vulnerability assessment of the households in the study area indicated that Achaba (Dega) agro ecology has the highest vulnerability than the other two villages. Likewise, this villages is also the least in terms of number of households who practice any one of he water related adaptation strategies. The highest percentage of applying water related adaptation strategies is reported at Lode village (Kolla Agro ecology) where there is a relatively better adaptive capacity and higher exposure o drought. Out of the total 135 respondents, 71 of them (53%) practice at least one water related adaptation strategy. The remaining 47% of the total respondents do not practice any of the water related adaptation strategies. The farmers were also asked to reason out why they are not applying any water related adaptation strategy. Of those who reported they do not practice any of the water related adaptation strategies, 19% mentioned lack of awareness on what have to be done, 15% not certain about the trend of climatic impact on water resources 19%, lack of material and financial resources to be used for implementing the strategies and 17% mentioned absence of initiation and coordination by the local administration government as a major reasons for not implementing water related adaptation strategies. Besides, about 19% of non applicants also mentioned all the above reasons for not implementing the strategies. Application of the adaptation strategies varies among the three agro ecological zones. The highest application of water related adaptation strategies is reported at Lode village where about 68% of the total respondents practice at least one strategy followed by Zone 3 where the percentage is only 55% of the total. The lowest percentage of application of adaptation strategies is reported at Achaba.

In this village the percentage of households who practice any one of the water related adaptation strategy is 36% which is lower than the other two villages. With regard to the type of strategies applied by most farmers, supply-side strategies take the lion's share. Particularly at Achaba village, there is no household that practices demand side adaptation strategies. In terms of applying demand side adaptation strategies, reducing water demand by changing cropping calendar was the type of strategy applied by a large percentage of farmers followed by removal of some invasive crop varieties from riparian areas. The above mentioned demand side strategies are practiced by most farmers at Lode zone followed by Zone 3 villages.

Out of the supply-side water related adaptation strategies, all farmers in all the three villages practice construction of flood protection infrastructures and water conservation methods like dikes, terraces etc on their farmlands.. Besides, rainwater harvesting is also highly practiced by a large proportion of farmers. This strategy is highly applied at Lode zone followed by Zone 3 and Achaba villages. About 32% of the total adaptation strategy applicants at Zone 3 village practice expanding the capacity of water holding infrastructures like wells etc. The next higher percentage of applying this strategy is reported at Lode village. Unlike the above mentioned strategies, extraction of ground water is practiced by a good proportion of farmers at Achaba followed by Lode and Zone 3 villages.

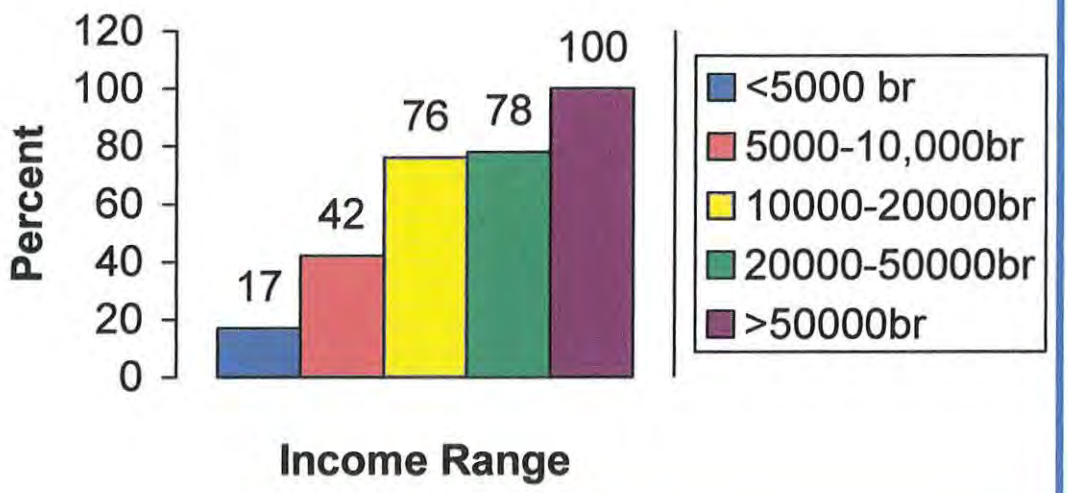
The study also revealed that there is a variation among the different socio geographic groups in applying any one of the water related adaptation strategies.

Figure 8 Application of Water Related Adaptation Strategy by Sex



As shown in the figure above, the proportion of Female household heads that practice water related adaptation strategies is less than that of male household heads. Out of the 22 female headed households, only 6 of them (about 27%) practice at least one water related adaptation strategy. This figure is by far lower than the percentage of male headed households which is about 58%. In terms of age of household heads, the highest percentage of applicants of adaptation strategies is found to be in ages of 18-60 years which confirms the hypothesis made in the literature section. . Education of household heads has also exhibited a difference concerning application of adaptation strategies in the study area. The share of literate farmers who practice at least one water related adaptation strategy is higher than that of illiterate household heads. Besides, annual income, which is an indicator of economic status, has also an impact to the application of adaptation strategies as shown in the figure below.

Figure 9. Application of Addaptation strategies by ecocomic status



As it is indicated in the conceptual framework of this study, households or villages with less exposure, less sensitivity and higher adaptive capacity tend to apply better water related adaptation strategies. In terms s of the three components of vulnerability of exposure, sensitivity and adaptive capacity, Zone 3 is found to be better followed by Lode village. In a similar manner, application of the water related adaptation strategies was also found to be higher at Zone 3 and lower at Achaba. This shows that households with higher adaptive capacity are most likely to practice adaptation strategies as it is mentioned in the framework.

V. CONCLUSION AND RECOMMONDATION

5.1. Conclusion

This paper has examined the vulnerability of farmers in Lode Hetosa Woreda to climate change and variability and their water related adaptation strategies. In doing so, it employs a method of comparison among agro ecology based villages using different descriptive values of selected indicators

Both the responses of the participant community members and the meteorological record of the study area attest that climate change and variability has brought a change in variation of amount and pattern of rainfall and temperature. Owing to this fact, therefore, the impacts of climate related hazards like flood and drought on both communities and the biophysical environment is very severe. With regard to vulnerability of the target communities, adaptive capacity is found to be the most crucial component in determining the overall vulnerability of the households in the woreda. Farmers in midland and lowland villages have a relative better access to almost all sorts of assets like physical, financial, natural and human. As a result, they are able to be less sensitive and less exposed to impacts of climate related hazards like drought and flood. For instance, application of non-farm activities, which is a more climate change resistant form livelihood source, is found in villages where there is a physical asset of electric power. The study revealed that Achaba (Dega) agro ecology is vulnerable mainly due to its high exposure to frequent flooding, its low adaptive capacity and high dependence on very sensitive livelihood sources. Zone 3 (Woinadega) and Lode (Kolla) are less vulnerable in their order is mainly due to less exposure to climate related hazards like flood, relatively

better access to the different types of assets and hence relatively less dependent on climate change sensitive livelihood sources.

Among the three components of vulnerability, adaptive capacity of households is playing a very significant role in the lives of the community. The study shows that those households who have access to human capital like education and training opportunities, active working force have also better chance of expanding their access to other assets like physical, financial, and natural and hence reducing their sensitivity to climate change related impacts.

Expansion of some infrastructures like electricity and water supply facilities was found to be a crucial factor in creating new opportunities for enhancing adaptive capacity and reducing sensitivity. This was clearly seen in the villages of Zone 3 (Woinadega) and Lode (Kolla) where the percentage of households who practice non-farm related livelihood sources and livelihood diversification index is higher as a result of presence of electricity and water supply facilities. The study result reveals that all the farmers, agricultural development agents and even some of the local government officials do not give much attention to demand side water related adaptation strategies. The focus is mainly to expansion of supply which is considered as half effort.

As a result of limited capacity, absence of initiation effort by government and other stakeholders, application of irrigated agriculture is very minimal. Only about 13% of the interviewed households practice mostly traditional form of small scale irrigation. This study has revealed that household vulnerability to climate change is influenced by sex, education level, age and economic status of the household members.

The study also indicated that there is a relationship between the status of farmers' vulnerability to climate change and their application of water related adaptation strategies. Although more than 50 percent of the interviewed households practice at least one water related adaptation strategy, the majority of them give emphasis to supply side strategies without giving due attention to demand side strategies. Generally, application of adaptation strategies is influenced by factors like sex, age, education level and economic status of the household heads.

5.2. Recommendations

- A tremendous effort has to be made by the local administrative government and other stakeholders in order to improve the human capital of the households and hence improve opportunities of access to other assets including physical, natural, social and financial.

- Expansion of physical infrastructures like electricity, water supply and irrigation facilities and access roads etc has to be given due attention by the local government administrations so as to enhance the capacity of households for reducing farmers' sensitivity to climate change impacts.

- It is also better if due attention is given to the poor, landless, female headed households etc during provision of services and support so as to reduce intra-village disparity in adaptive capacity that would enable them cope up with climate related hazards.

- The agricultural development agents should be equipped with recent and up to date knowledge related to impacts of climate change on resources and

communities, adaptation strategies etc so as to raise the awareness of farmers and reduce their vulnerability.

- Application of demand side water related adaptation strategies has to be given emphasis by all in order to reduce or adjust the problem of water which results from the existing and future impact of climate in the area.

- As the application of irrigated agriculture is very limited in the study area, the individual farmers, development agents, local government administrators and other stakeholders need no give special emphasis so as to enhance the capacity of the households and reduce their vulnerability o climate change.

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APPENDICES

I. Survey Questionnaire

ADDIS ABABA UNIVERSITY
WATER & DEVELOPMENT PROGRAM
STRUCTURED QUESTIONNAIRE FOR CONDUCTING HOUSEHOLD SURVEY

Dear Respondent;

My Name is _____. I am collecting data on behalf of Mesfin Zenebe who is currently conducting an MA Research in Water & Development in Addis Ababa University entitled "An Assessment of Farmers Vulnerability to Impacts of Climate Change/ Variability and their Water Related Adaptation Strategies in the case of Lode Hetosa Woreda The responses given by you will be used ***ONLY*** for academic purposes and not for any other use. Since your responses are extremely essential to realize the objective of this study, you are kindly requested to cooperate the enumerators.

Thanks for Your Cooperation!!

Name of the Interviewer:-_____ Code:_____

I. General Demographic and Socioeconomic Related Questions

1. Name of the Respondent_____
2. Address of the Respondent: Kebele (PA)_____Village_____
3. Sex: 1. Male ◇ 2. Female ◇
4. Age:_____
5. Marital Status: 1. Single: ◇ 2. Married ◇ 3. Divorced ◇ 4. Widowed ◇
6. What is your religion?
   1. Orthodox Christian◇ 2. Muslim ◇ 3. Protestant ◇ 4. Catholic ◇ 5. Other_____
7. What is our Ethnicity?
   1. Oromo ◇ 2. Amhara ◇ 3. Tigre ◇ 4. Other ◇
8. Are you head of the household? 1. Yes ◇ 2. No◇
9. Educational Status:
   1. Unable to read and write ◇
   2. Able to read and write (informal education) ◇
   3. Attended Primary Education (1-8) ◇
   4. Attended Secondary Education (9-12) ◇
   5. Attended Tertiary Education (Certificate & above) ◇

II. Questions Related to Objective One

(To assess the state of exposure of farmers in Lode Hetosa Woreda to climate change/ variability impacts.)

10. Have you ever exposed to the risk of flood in the last 10 years?

    1. Yes ◇ 2. No ◇ 3. I don't know ◇

11. If your answer to Q8 is yes, how many times did the event happen in the period mentioned?

    1. Only once ◇ 2. 2-3 times ◇ 3. 4-5 times ◇ 4. 6-7 times ◇ 5. every year ◇

    6. I don't know ◇

12. Have your household been affected by the flood occurred in the last 10 years?

    1. Yes ◇ 2. No ◇ 3. I don't know ◇

13. If your answer to Q10 is yes, what was the damage on your household?

    1. Loss of property ◇ 2. Death of livestock ◇ 3. Loss of life of family member ◇

14. Have you ever exposed to the risk of drought in the last 10 years?

    1. Yes ◇ 2. No ◇ 3. I don't know ◇

15. If your answer to Q13 is yes, how many times did the event happen in the period mentioned?

    1. Only once ◇ 2. 2-3 times ◇ 3. 4-5 times ◇ 4. 6-7 times ◇ 5. every year ◇

    6. I don't know ◇

16. Have your household been affected by the drought occurred in the last 10 years?

    1. Yes ◇ 2. No ◇ 3. I don't know ◇

17. If your answer to Q15 is yes, what was the damage on your household?

    1. Loss of property ◇ 2. Death of livestock ◇ 3. Loss of life of family member ◇

18. How do you perceive the overall trend of amount of precipitation in the last 10 years?

    1. Reduced in amount ◇ 2. Increased in amount ◇ 3. No change in amount ◇

    4. Difficult to guess ◇

19. What is your observation on the overall occurrence of precipitation in the last 10 years?

1. It begins early and ends early ◇
2. It begins early and ends late ◇
3. It begins late and ends early ◇
4. It begins late and ends late
5. It is difficult to predict

III.. **Questions Related to Objective Two**

(To examine the degree of sensitivity of communities to impacts of climate change and variability).

20. What is the major source of livelihood for your household?
    1. Natural resource based activities (farming, animal rearing, forestry, handicrafts etc) ◇
    2. Non agriculture related profit, salaries and wages ◇
    3. Pension or remittance ◇
    4. Other, specify _____

21. What is the total number of household members who are below 14 and above 60 years of age?
    1. Not at all ◇ 2. Only one ◇ 3. 2-3 members ◇ 4. 4-5 members ◇
    5. more than 5 members

22. Do you use drought resistant crops for your farmland?
    1. Yes ◇ 2. No ◇

23. If your answer for Q20 is No. what is the reason for not using?
    1. Lack knowledge ◇ 2. Lack of access ◇ 3. Unable to afford them ◇
    other reason, Specify_____

24. Do you use Flood resistant crops for your farmland?
    1. Yes ◇ 2. No ◇

25. If your answer for Q23 is No. what is the reason for not using?
    1. Lack knowledge ◇ 2. Lack of access ◇ 3. Unable to afford them ◇
    4.. other reasons, Specify_____

IV. Objective Three: To assess the existing adaptive capacity of farmers in the woreda to minimize climatic hazards.

Human Capital related questions

26. Do you have other family members in the household? 1. Yes ◇ 2. No ◇

27. If your answer for question #25 is yes, please, mention the number of household members according to age category listed below. Otherwise go to Q28

SN	Name of Household member	Sex	Age	Kinship (son, daughter, mother etc)	Health status (please mention if there is chronically ill or a person with disability in the HH)
1					
2					
3					
4					
5					
6					
7					

28. What is the educational status of each household member? Please indicate in the table below.

Educational level	Number of Household member including the head of the HH
1. Unable to read and write	
2. Able to read and write (Informal Education)	
3. Primary level C1 (1-4)	
4. Primary level C2 (5-8)	
5. Secondary education C1 (9-10)	
6. Secondary education C2 (11-12)	
7. Tertiary Education (above diploma)	

29. Is there any family member in the household who has attended any vocational skill training?

1. Yes ◇ 2. No ◇

30. If your answer for Q28 is yes, how many family members got the training?

1. Only one ◇ 2. 2 members ◇ 3. More than 2 members ◇ 4. All of them ◇

Physical Capital Related Questions

31. What is the type of your house?
    1. Mud house with Thatch roof ◇
    2. Wooden wall with Thatch roof ◇
    3. Stone wall with tile roof ◇
    4. Mud house with tile roof ◇
    5. . Thatch wall with tile roof ◇
32. Do you have the following information communication devices? If yes, Please indicate the number of the devices in the household.
    1. Mobile phone ◇ 2. Landline phone ◇ 3. Radio ◇ 4. TV ◇
33. Do you have access to clean water source? 1. Yes ◇ 2. No ◇
34. If your answer to Q33 is yes, what is the source of the water for your family?
    1. River Water ◇ 2. Spring ◇ 3. Tap water of your own ◇ 4. Community Tap water ◇
35. What is the source of energy for your household?
    1. Animal dung and firewood ◇ 2. Charcoal ◇ 3. Kerosene ◇ 4. Solar based electricity ◇ 5. Hydro Power based electricity ◇
36. How long will it take to reach the nearest motor road from your house?_____
37. Do you have farming land? 1. Yes ◇ 2. No ◇
38. If your answer to Q37 is yes, how much is in hectares?_____
39. Do you have irrigated land? 1. Yes ◇ 2. No ◇
40. If your answer to Q33 is yes, how much of it is irrigated?
    1. Approximately less than a quarter of it
    2. Approximately 1/3rd of the total
    3. Approximately half of the total
    4. More than half of the total

Natural Asset Related Questions

41. If your answer to Q37 is yes, in your opinion, what is the proportion of fertile and productive land?
    1. All of it o 2. Nearly half o 3. Nearly 1/3 of it o 4. None of it o 5. I don't know o
42. Do you have access to natural resources like forests, water bodies etc in your area?
    1. Yes I have o 2. No, I don't Have o\

Financial Asset Related Questions

43. Do you have sources of income other than farming? 1. Yes ◇ 2. No ◇

44. From the sources of income listed below, from which sources does your family get income and what is the average annual income from each source?

Sn	Type of the livelihood/income source	Tick (✓) the applicable livelihood sources	Average income per year
1	Farming		
2	Livestock raising		
3	Handicrafts		
4	Trading		
5	Remittance from abroad/within the country		
6	Pension		
7	Non farm-related employment		
8	Other business, please specify_____		
	Total income from all sources		

45. Is there a saving account used for the household? 1. Yes ◇ 2. No ◇
46. If your answer for question #45 is yes, what is the average amount of saving in a year in birr?_____
47. Do you have access to credit for your household? 1. Yes◇ 2. No ◇
48. If your answer to Q47 is yes, what are the sources of credit you are using?
    1. Individuals nearby◇
    2. Micro finance institutions◇
    3. Commercial banks ◇
    4. NGOs ◇
    5. others, specify _____
49. Does your household have the following domestic animals?

Sn	Name of the domestic animal	Number
1	Oxen	
2	Cow	
3	Horse and donkey	
4	Goat and sheep	
5	Other (specify)_____	
6	Total	

Social Capital Related Questions

50. Do you actively engage/participate in community based organizations or networks like iddir, /mahber equb, senbete etc

1. Yes ◇ 2. No ◇

51. If your answer to Q50 is yes, what kind of support do you get from the organizations/networks?

1.. No support at all

1. Only Financial support ◇
2. Only material support ◇
3. Only emotional support ◇
4. All kind of support ◇

VI. Questions Related to Objective Four

(To investigate water related adaptation strategies employed by farmers in the target area)

52. How do you see the impact of climate change/variability on water resources in the last 10 years?

1. Resulted in increase in amount of water resources ◇
2. Resulted in decrease in amount of water resources ◇
3. Resulted in improvement of quality of water resources ◇
4. Resulted in reduction of quality of water resources ◇
5. No impact on water resources ◇

53. In order to cope up with the water scarcity problem resulted from climate change/variability; do you implement water related adaptation strategies?

1. Yes ◇ 2. No ◇ 3. I don't know ◇

54. If your answer to Q47 is Yes, which one of the following water related adaptation strategies does your household implement

Sn	Type of water related adaptation strategies/measures	Mark (✓) if applicable
Demand side Water related adaptation strategies at household level		
1.	Application of efficient technologies like drip irrigation	
2.	Using water for multiple uses	
3.	Reduction in water demand for irrigation by changing the cropping calendar, crop mix, irrigation method, and area planted	
4.	Water conservation practices, reuse of water, water recycling by modification of industrial processes and optimization of water use	
Supply side Water related adaptation strategies at household level		
5.	Construction of flood protection infrastructure	
6.	Directing roof runoff to lawns to encourage infiltration	
7.	Increasing storage capacity by building reservoirs like hand-dug wells	
8.	Removal of invasive non-native vegetation from riparian Areas	
9.	Extraction of groundwater	
10.	Rainwater harvesting and water conservation practices	

55. If your answer to Q48 is No, what is/are the reasons for not implementing adaptation strategies?
    1. No need to implement due to uncertainty about the real impact of climate on water ◇
    2. Lack of awareness on existing available strategies ◇
    3. Lack of knowledge and skill on how to implement ◇
    4. Lack of financial and material resources ◇
    5. Lack of initiation by local governments ◇
    6. Other reason please, specify_____

II. GUIDELINE FOR KEY INFORMANT INTERVIEW

2.1. Woreda Agriculture and Rural Development Office

1. What is the total area of the woreda?
2. What is proportion of cultivated land, forest covered area etc?
3. What is the proportion of the woreda agro ecology?
4. What does the situation of soil in the woreda looks like?
5. What does the climatic situation of the woreda looks like? How is the pattern of temperature and rainfall in the past 10 years?
6. What are the major crops in terms of coverage farmers in the woreda are cultivating?
7. What is the percentage of irrigated land in the woreda?
8. How is the occurrence and impact of flood and drought in the woreda in the last 10 years?
9. What does the overall vulnerability of farmers to climate change looks like?
10. What measures have been taken by your office to reduce the vulnerability of farmers to climate change?

2.2. Agricultural Development Agents of the Sample Kebeles

1. What are the total population and household of the kebele where you are working?
2. What are the human impacts of climate change and variability in the kebele?
3. Which livelihood activities are most vulnerable to climate change and variability?
4. Who do you think are most vulnerable community groups in the kebele and why?
5. How do you describe the impact of climate change on the water resources of the area?
6. What are the demand and supply side water related adaptation strategies farmers are practicing in order to cope up with the impacts of climate change?

2.3. Interview Guide for NGOs

1. Does your organization have intervention in the woreda which are related to reducing the vulnerability of farming communities to climate change? If so, what are these intervention areas?
   - 1.1. Raising the awareness of the farmers about climate change
   - 1.2. Reducing the exposure and sensitivity of the farmers to climate related vulnerability

1.3. Improving the adaptive capacity of the farming communities so that they can adjust themselves to climate related changes

1.4. Improving the household level water related adaptation strategies

III. GUIDELINE FOR FOCUS GROUP DISCUSION

1. How do you generally perceive the overall trend of climatic change of the area in the last 10 years?
2. What are the observed changes in the timing, frequency and intensity of climate related hazards in the area?
3. How sensitive are the livelihood activities of the area to climate change and variability?
4. Which sections of the community groups are more vulnerable to climate related hazards? Why?
5. What do you think is the impact of climate on the water resources of the area?
6. What are some the factors that make some households more vulnerable to effects of climate change than others?
7. How do you respond to mitigate the impact of climate change on the water resources?

IV. Population and Area of the Study Area (Lode Hetosa Woreda)

Sn	Name of the Kebele	Number of Households			Total area in hectares
		Male	Female	Total	
1	Tulu Dego	1578	188	1766	1481
2	Boru wodecha	590	174	764	493
3	Fursa	630	67	697	417
4	Gerde Busa	835	277	1112	594
5	Gonde qurchasa	1098	232	1330	1683
6	Gura haricho	1086	376	1462	1565
7	Gudelcha	710	323	1033	1282
8	Ifa Lode	900	222	1122	1522
9	Mede Bishan	998	167	1165	1161
10	Melka Jebi	1099	157	1256	1080
11	Qiltu Bela	847	222	1069	1145
12	Qersa	734	211	945	1032
13	Tulu Jebi	856	216	1072	1525
14	Tulu Yembo	799	261	1060	1349
15	Ticho	721	221	942	1249
16	Ademere	938	282	1220	1079
17	Aleko	1351	285	1636	1965
18	Gebe	1378	317	1695	1830
19	Shaya	902	102	1004	1096
20	Total	18050	4300	22350	23552

Source: Lode Hetosa Woreda Agriculture & Rural Development Office, 2014