

**ANALYSIS OF SMALLHOLDER FARMERS' PRODUCTIVITY  
WITH CLIMATE VARIABILITY IN SIDAMA ZONE, SNNPRS,  
ETHIOPIA**

**MA THESIS**

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**HAWASSA UNIVERSITY, HAWASSA, ETHIOPIA**

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**A THESIS SUBMITTED TO THE SCHOOL OF GOVERNANCE  
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**HAWASSA UNIVERSITY**

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## DECLARATION

I hereby declare that this MA thesis is my original work and has not been presented for a degree in any other university, and all source of materials used for the thesis have been duly acknowledged.

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## **Abbreviations and Acronyms**

<b>AEZs</b>	Agro Ecological Zones
<b>AGRA</b>	Alliance for a Green Revolution in Africa
<b>AR4</b>	Fourth Assessment Report
<b>AIDS</b>	Acquired Immune Deficiency Syndrome
<b>EFDR</b>	Ethiopian Federal Democratic Republic
<b>CRGE</b>	Climatic Resilient Green Economy
<b>DA</b>	Development Agent
<b>FAO</b>	Food and Aid Organization
<b>FHHHs</b>	Female Household Heads
<b>FGDs</b>	Focus Group Discussions
<b>GDP</b>	Gross Development Plan
<b>HHHs</b>	Household Heads
<b>HIV</b>	Human Immunodeficiency Virus
<b>IPCC</b>	Inter Governmental Panel on Climatic Change
<b>ITCZ</b>	Inter-Tropical Convergence Zone
<b>IFAD</b>	International Fund for Agricultural Development
<b>MHHHs</b>	Male Household Heads
<b>masl</b>	mean above sea level
<b>MoA</b>	Ministry of Agriculture
<b>MoFED</b>	Ministry of Finance and Economic Development
<b>MoWRNMA</b>	Ministry of Water Resource National Meteorological Agency
<b>NMA</b>	National Meteorological Agency

<b>NREPA</b>	Natural Resource and Environment Protection Agency
<b>NAPA</b>	National Adaptation Program of Action
<b>NMSAE</b>	National Meteorological Service Agency of Ethiopia
<b>SNNPR</b>	Southern Nation, Nationalities and Peoples Region
<b>SZFEDD</b>	Sidama Zone Finance and Economic Development Department
<b>SSA</b>	Sub Saharan Africa
<b>UNEP</b>	United Nations Environmental Program
<b>UNDP</b>	United Nations Development Program
<b>UNICEF</b>	United Nations Children's Fund
<b>UNFCCC</b>	United Nations Framework Convention on Climate Change
<b>UNCCD</b>	United Nations Convention to Combat Deforestation
<b>WFP</b>	World Food Program

## **Abstract**

*Climate change and variability is one of the greatest challenges facing the Ethiopian agrarians. Climate variability has a drastic impact on agricultural output, with total crop failure and massive livestock deaths. Furthermore, the capacity of the rural poor to cope with climate related shocks has declined due the increase frequency and intensity of droughts. This study looks on the impact of climate variability on farmers' productivity and their adaptation methods of Sidama Zone, Loka Abaya, Dalle and Wonsho Woredas. The study area is hotspot for the impact of climate variability. Both primary and secondary data were used in the study and analyzed though qualitative and quantitative methods. The data were collected through key informant interview, focus group discussion and direct observation and analyzed by using descriptive statistical tools like percentage, frequencies, mean value, cross tabulation were implemented to investigate information about the intended objective of the study. To determine the sample size for the study, multi stage sampling techniques were employed Three Kebeles were selected by simple random sampling method and 191 respondents were participated in the study. The general findings of the study shows that the climate of the zone has shown variability and in turn, this climate variability has impact on the productivity like crop production, cropping pattern, availability of long cycle crops, and availability of livestock feed and loss of livestock were the major ones. To minimize the impacts of climate variability on elders and child, landless, female-headed household, the farmers of the zone had adopted different coping strategies like; selling labour, food aid and selling livestock. Migration, early maturing crop varieties, water and soil conservation, environmental rehabilitation and area closure were long-term adaptation practices applied by farmers and zone office of agriculture. By considering the above facts, the researcher recommends, there should collaboratively works of farmers and DA experts on rehabilitation of their environment. The zone office of agriculture should encourage farmers to use drought resistant crop seeds with commercial fertilize, compost and soil moisture management practices. In addition to this, the concerned body should train the farmers create consciousness about the impact of climate variability.*

**Key Words: Climate Variability, Vulnerability, Productivity, Smallholder Farmer, and Coping Mechanisms**

# CHAPTER ONE

## INTRODUCTION

### 1.1 Background of the Study

Global temperatures have experienced natural shifts throughout human history. For example, the climate of the Northern Hemisphere varied from a relatively warm period between the eleventh and fifteenth centuries to a period of cooler temperatures between the seventeenth century and the middle of the nineteenth century (IPCC, 2007). However, scientists studying the rapid rise in global temperatures during the late twentieth century say that natural variability cannot account for what is happening now (IPCC, 2001). The main culprit, they say, is emissions of carbon dioxide and other greenhouse gases from human activities, primarily the burning of fossil fuels such as coal and oil. Other human sources of these gases include deforestation, agriculture and industrial processes (Brohan *et al.*, 2006).

The livelihood of more than half of the economically active population in the developing world directly depends on the environment through agriculture, animal husbandry, hunting, fishing, forestry and foraging. This alone underscores the importance of the seventh Millennium Development Goal to “ensure environmental sustainability”. In recent years, economists have increasingly focused on the important implications of environmental issues for the success of development efforts. Rising pressures on environmental resources in developing countries can have several consequences for self-sufficiency, income distribution and future growth potential. Environmental degradation can also detract from the pace of economic development by imposing high costs on developing countries through health-related expenses and the reduced productivity of resources (Todaro and Smith, 2012).

Climate change and variability are expected to compromise agricultural production and food security severely in many African countries. In East and Southern Africa, the region’s high poverty levels, weak infrastructure, poor natural resources management will compound the effects of climate change and dependence on rain fed agriculture. As a result of climate change, the region could see net reductions of more than 10 per cent in the production of

maize and other major crops such as sorghum, millet, sugar cane and wheat. While commercial livestock activities may marginally improve as the result of increased rainfall, traditional communal livestock activities may be disadvantaged because of increased erosion and the incursion of woody weeds in some areas (IFAD, 2011).

Water-related problems are likely to worsen as a result of climate variability. Intense rainfall events will increase the incidence of flooding in many areas. Simultaneously, reduced run-off will intensify water stress and reduce the quality and quantity of water available for domestic and crop and livestock use. Experts forecast that Southern Africa will become drier, and that rainfall will increase in parts of East Africa. Drought-prone areas of Botswana, Ethiopia, the Sudan and Zimbabwe are likely to become more vulnerable to climate change than more humid areas of the United Republic of Tanzania or Zambia (IFAD, 2011).

The agriculture sector is the backbone of the economies of most of the developing world, employing about 60 percent of the workforce and contributing an average of 30% gross domestic product (GDP) in Sub-Saharan Africa (World Bank, 2011). Smallholder farmers are the majority in this sector and form the backbone of agricultural production in Africa (Dixon *et al.* 2004). These smallholder farmers are estimated to be about 36 million across the continent and have an average access to 2 hectares or less of land for their agricultural production (Jaeger, 2010; Nagayets, 2005). Due to their dominance in the sector, they make a huge and important contribution to the domestic food production, while at the same time producing export crops that earn foreign exchange for these economies (Quan, 2011).

According to World Bank (2008), Ethiopia has experienced at least five major national droughts since 1980, along with a large number of localized droughts. These cycles of drought create poverty traps for many households constantly consuming their efforts to build up assets and increase income. About half of all rural households in the country experienced at least one major drought from 1999 to 2004 (World Bank, 2011). With agriculture highly dependent on rainfall variability and amount, weather in general rules the lives and well-being of many rural Ethiopians. The weather determines whether they will have enough to eat, be able to provide necessities and be able to earn a living. Indeed, farmers' dependence on

rainfall and its erratic patterns have largely contributed to the food shortages and crises with which they constantly battle.

According to Senait *et al.* (2010), Ethiopian agriculture makes use of traditional technologies with eighty-seven percent of rural households work less than two hectares (ha) of land, and 64.5 percent of them cultivate less than one. Households with relatively small farm size are generally poor in cash income and have low access to extension services, oxen, fertilizer, improved seeds, animal drugs and vaccines, improved breeds of livestock, water, and credit. Such households have few opportunities to take risks. Climate change is expected to manifest itself in the frequency and intensity of floods and droughts, as well as in variable temperature and rainfall. If rainfall is more intense and frequent, even more soil will be stripped from farmers' fields, resulting in the loss of valuable nutrients, which will affect crop yield.

In the study area smallholder farmers always practice traditional agricultural activities like growing of enset, fruit and vegetables, cereals, coffee and rearing livestock. Just one extreme climate event-drought, flood, unpredictable rain-can devastate a year's crop and impoverish a family, nullifying the hard-won gains of several successful past growing seasons. Even relatively small events during the growing season, like too much or too little rain at the unexpected times, can spell disaster.

## **1.2 Statement of the Problem**

Agriculture in Ethiopia is heavily dependent on rainfall. Its geographical location and topography, plus a low adaptive capacity, make the country highly vulnerable to the adverse impacts of climate variability. The incidence of poverty in Ethiopia declined markedly between 2004/05 and 2010/11. The headcount poverty rate fell from 38.7 % in 2004/05 to 29.6 % in 2010/11. This implies that the country is on the right track to achieving the MDG target of reducing poverty by half in its due time. Over the same period, poverty gap is also reduced, but not the severity of poverty. Despite the substantial declining of poverty over the past five years, poverty remains high at 29.6 percent (MoFED, 2012).

According to Negasa (2013) cited in Dereje Gorfu, geographically, Ethiopia can be subdivided into five agro-ecological zones, based on moisture and land use namely drought-

prone highlands with insufficient rainfall; rainfall-sufficient highlands dominated by enset-based farming; rainfall-sufficient highland areas mainly planted with cereal-based crops; generally dry, pastoral lowland areas; and humid lowland areas further inland that primarily support crop farming. We expect that climate change will lead to adaptive shifts in cultivation patterns in all five regions. Whether input and output markets can change sufficiently in time, so that farmers can cope with these shifts, will be an important challenge for future adaptation policies.

As indicated by FAO (2012), climatic instability negatively affects agricultural productivity leading to substitution through importation or a shift to other sectors. These effects have a direct impact on smallholder farmers, who mostly rely on rain-fed agriculture for their production. This is because smallholder farmers are the main contributors of domestic food mostly rely solely on rain-fed agriculture and have a limited means of coping with this adverse weather variability. Productivity variation attributed to these continual climatic changes is also known to cause changes in agricultural production trends. Despite the uncertainties, the smallholder farming community plays a huge role in addressing world poverty and eradication (FAO *et al.*, 2012). This is through combating the effects of climate change by adoption new approaches to their agricultural systems. Unfortunately, awareness about climate change in developing countries is still rather low compared to the developed world, with African countries rated as the least aware (Pelham, 2009). This lack of farmer awareness influences negatively on their adoption of appropriate adaptive technologies.

Climate factors are changing and varying from time to time in the study area. In the study area, it was observed that land has been degraded considerably; shortages of water especially in dry years are very unbearable; air, water and land were polluted affecting human health; excessive erosion removed tons of productive soil etc. In addition, climate of the area is varying and getting dry with very frequent droughts, which create extra burden for the economy and especially for agriculture among smallholder farmers. As the time goes by, the situation was complicated by an increase in natural disasters and the needs for more water resources for agriculture and human existence. Evidences indicate that climate produces strong impact on agriculture and food supply and demand (Emerta, 2013). However, the least

known fact is how the changing climate will affect food supply and demand in the region and particularly in the study area.

The impact of climate change and variability on smallholder rain-fed farming has been a subject of debate amongst policymakers and agricultural practitioners. Despite these widespread debates, not much is known about the capacity of smallholder farmers to cope with climate variation on their agricultural practices. Research on how to mitigate the impacts of climate variability to agricultural productivity is still very limited in the study area. There is also limited knowledge on whether farmers perceive climate variability and change and how they are responding to the effects of a changing climate. It is also important to note, that models cannot estimate local perceptions and there is need to document how the lives of the local people are affected by the recent changes in climate. This research, therefore, was carried out with the aim of generating location specific information about the climate variability and its impact on smallholder farmer's productivity in the study area.

### **1.3 Objectives of the Study**

#### **1.3.1 General Objective**

The main objective of the study was to analyze the productivity of smallholder farmers' with climate variability in Sidama Zone, SNNPR, Ethiopia.

#### **1.3.2 Specific Objectives**

The specific objectives of the study were:

1. To analyze the current production and productivity of smallholder farmers with climate variability in the study area.
2. To identify the intensity /magnitude of vulnerability with climatic variability in the study area.
3. To asses coping strategies of smallholder farmers to the livelihood changes brought by climate variability and its impacts in the study area,

#### **1.4 Research Questions**

1. What is the current status of productivity related to climate variability on smallholder farmers?
2. Who are more vulnerable to the impacts of climate variability in the study area?
3. What are the mechanisms followed by smallholder farmers to mitigate the livelihood changes brought about by climate variability at the local level?

#### **1.5 Significance of the Study**

The study may primarily help the small holder farmer to undertake measures that could improve their capacity and efficiency with the regard to climate variability. Secondly, the regional government can make use of the results so as to make policy decisions matters pertaining to rural development. Understanding how smallholder farmers cope with climate change could shed light in how productivity at the local level could be enhanced. The mechanism could indicate how farmers manage long-term changes associated with climate change, which can be associated with their adaptive capacity. This will be helpful to researchers and government by enabling them to tap on to existing adjustments farmers are already making order to sustain their productivity. Moreover, the variations in smallholder farmers to cope with climate change amongst different agro ecological zones and across different timelines are yet to be properly documented in the region. Knowing farmers' perceived changes in agricultural practices in smallholder systems will allow researchers to initiate encourage and serve as a springboard for future investigation, extension educators and farmers to develop research agendas and adopt practical practices that meet present and future farming needs in specific agro ecological zones.

#### **1.6 Delimitation of the Study**

The scope of this study is delimited to Dalle, Loka Abaya and Wonsho *Woredas* of Sidama zone to make it manageable within the financial, material and time constraint. Regarding contextual boundary, the study focuses on impact of climate variability in smallholder farmers' productivity. Therefore, the key variables have been assessed from smallholder

farmers who are actively participating in the crop production and animal rearing activities in providing information on the impact of climate variability in their productivity.

### **1.7. Limitation of the Study**

It is obvious that research work cannot be totally free from limitation. To this end, some limitations were observed in this study. One apparent limitation is that, most of households in the study area were busy and not had enough time to respond to interview questions since it was the period of harvesting cereals. Some of them who had enough time were also reluctant to give response to the questions as per the required time. Studies carried out in many developing countries have pointed out that farmers are unwilling to provide accurate information on the variables such as income level, farm size, livestock number, etc. due to the fact that taxes and other development contributions are distributed among them based on these factors. Hence, this study was also not free from these limitations. However, to reduce this problem as much as possible care was taken to convince farmers individually and collectively about the objectives of the study.

### **1.8. Organization of the Study**

This study was organized into five chapters. The first chapter deals with introduction including background, statement of the problem, objectives of the study, research questions to address significance of the study, scope or delimitation of the study, and limitations of the study. The second chapter deals with review of conceptual as well as empirical literatures. While the third chapter presents the research methodology followed in the study. The fourth chapter focuses on major findings and discussion of the study. Finally, the fifth chapter provides summary, conclusion and recommendations of the study.

## CHAPTER TWO

### REVIEW OF RELATED LITERATURE

#### 2.1 Concepts Related to Climate Variability and Smallholder Farmers Productivity

- **Climate:** Refers to prevailing or average weather conditions of a place as determined by temperature and meteorological change over period of time. Climate encompasses the metrological elements such as temperature, humidity, atmospheric pressure, wind, rainfall, in a given region over a long period of time (IPCC, 2007).
- **Weather:** Refers to the state of the atmosphere, to the degree that it is hot or cold, wet or dry, calm or stormy, clear or cloudy.
- **Climate variability:** The way climate fluctuates yearly above or below a long-term average value. ([www.miseagrant.umich.edu/climate](http://www.miseagrant.umich.edu/climate)).
- **Climate Change:** Refers to a long-term change (increase and decrease) in the statistical distribution of weather patterns over periods of time that range from decades to millions of years. It may be a change in the average weather conditions or a change in the distribution of weather events with respect to an average, for example, greater or fewer extreme weather events. Climate change is attributed to directly or indirectly to the human activity that alters the composition of global atmosphere and additionally natural climate variability observed over comparable time period composition (IPCC, 2007).
- **Climate change adaptation:** Refers to practical measures, which reduce vulnerability to the impact of climate change.
- **Global Warming:** Refers to gradual increase in the average temperature on Earth.
- A **Greenhouse Gas** (sometimes abbreviated as GHG) is a gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. The primary greenhouse gases in the Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone. (IPCC, 2007).

- **Smallholder farmers:** refers to an individual or household practicing farming on a small scale. As cited by AGRA, 2014, in Wiggins and Sharada, 2013 described that smallholder farmers as those with 2 hectares or less and they represent 80% of all SSA farms and contribute up to 90% of the production in some SSA countries. Even though, agricultural labor productivity remains low in SSA they provide about 80% of the food supply in Africa. The proportion of the poor in SSA is 53% with the proportion of undernourished<sup>1</sup> at 30% in 2010, making it the highest in any region.

## 2.2 Causes and Impacts of Global Climate Change

Scientists refer to what has been happening in the earth's atmosphere over the past century as the enhanced greenhouse effect. The greenhouse effect keeps the earth warm and habitable; without it, the earth's surface would be about 60 degrees Fahrenheit colder on average. Since the average temperature of the earth is about 45 degrees Fahrenheit, the natural greenhouse effect is clearly a good thing. But the enhanced greenhouse effect means even more of the sun's heat is trapped, causing global temperatures to rise (Christy and Spencer, 2005). Some evidences of the rapid climate change are sea level rise, global temperature rise, shrinking ice sheets, warming oceans, declining Arctic sea ice, glacial retreat, ocean acidification and extreme events.

The Fourth Assessment Report (AR4) from the Intergovernmental Panel on Climate Change has provided the clearest scientific analysis yet available on the potential impacts from changing average global surface temperatures. Such impact will be felt worldwide, and although positive consequences are expected in some cases (e.g. increases in soybean yields in some temperate areas of Latin America), most climate change impacts are likely to be negative, including significant risks of biodiversity loss, changes in precipitation patterns, higher occurrence of extreme weather events, and decreases in yields of other crops (IPCC, 2007). It is believed that poor people in developing countries will be particularly affected by such changes as their vulnerability to climate change impacts will be exacerbated by prevalent stresses, such as population increase, diseases (HIV/AIDS and other), current climate hazards and lack of access to basic services such as sanitation and clean energy (IPCC, 2007). Climate change is thus a direct threat to sustainable development in these countries. To minimize the

consequences of global climate change, the United Nations Framework Convention on Climate Change (UNFCCC) has a long time focused on mitigation of greenhouse gas (GHG) emissions. However, as GHG emissions trends currently follow those of the worst-case scenarios of the IPCC, researchers increasingly point at the urgent need to implement adaptation strategies in order to prevent large-scale adverse impacts in particularly vulnerable regions (IPCC, 2007).

Charles David Keeling (Since 1958) directed a program to measure the concentrations of CO<sub>2</sub> in the Earth's atmosphere over the last half-century. It helps document how humans have transformed the atmosphere and, with it, the Earth's temperature. The Curve is number one evidence that humans have changed the planet's climate. It starts in 1958 and continues uninterrupted for over five decades. The scale of the data is extraordinary, an ideal rarely realized in science. The "hard" data from real-time measurements show the steady accumulation of CO<sub>2</sub> from burning fossil fuels. It serves to warn an energy-hungry culture of its environmental hubris ([http://www.esrl.noaa.gov/gmd/webdata/ccgg/trends/CO2\\_data\\_mlo.png](http://www.esrl.noaa.gov/gmd/webdata/ccgg/trends/CO2_data_mlo.png)).

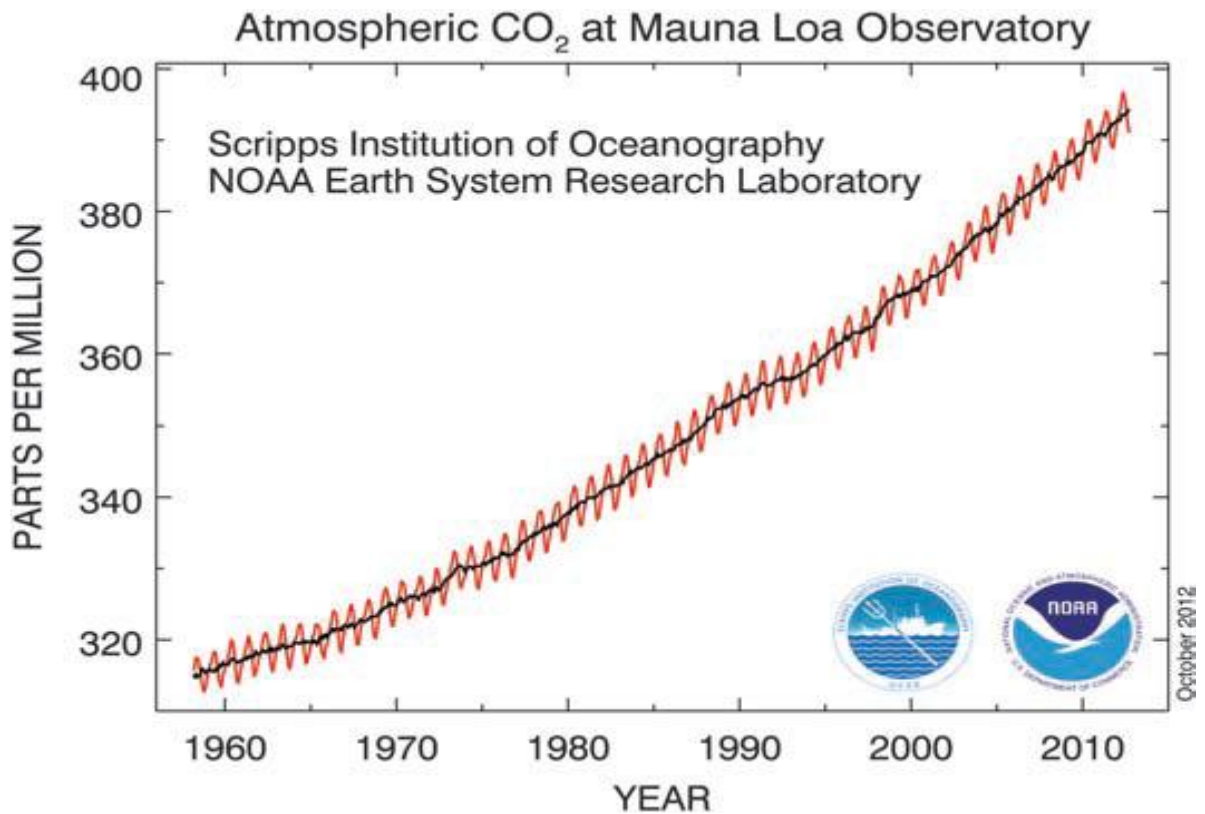


Figure 2.1 Keeling Curve

Source: [http://www.esrl.noaa.gov/gmd/webdata/ccgg/trends/CO2\\_data\\_mlo.png](http://www.esrl.noaa.gov/gmd/webdata/ccgg/trends/CO2_data_mlo.png)

A recent United Nations report blamed climate variability, along with worsening air and water quality and poor disposal of solid waste, for an increase in malaria, cholera and lower respiratory tract infections in African societies. According to U.N. report Africans also are suffering from the effects of reduced crop yields and decreased availability of water (Economic Commission for Africa) on Africa provides an early glimpse of some of the ways in which scientists say climate change will affect people's health in the decades to come, no matter where they live. Climate change can affect human health directly (for example, because of extreme temperatures and heat waves) and indirectly (for example, by contributing to the spread of infectious disease or threatening the availability and quality of food and water). The elderly, the infirm and the poor will be especially at risk (Mark, 2000).

Climate variability also holds the potential of inflicting severe damage on the ecosystems that support all life, from hazards to coral reefs due to warmer and more acidic ocean waters to threats to polar bears because of declines in sea ice. Ecosystems around the world already are

reacting to a warming world. For example, one study found that 130 species, including both plants and animals, have responded to earlier spring warming over the last 30 years. These organisms have changed their timing of flowering, migration and other offspring activities. The changes occurred regardless of regional difference and were linked directly to enhanced greenhouse warming (MacMynowski, 2006).

### **2.3. Climate Variability and Water Resources for Agriculture**

Agriculture and climate variability are inextricably linked. Nelson (2009) stated that, “Agriculture is part of the climate change problem contributing about 13.5 percent of annual greenhouse gas emissions (with forestry contributing an additional 19 percent) compared with 13.1 percent from transportation. Agriculture is however, also part of the solution offering promising opportunities for mitigating emissions through carbon sequestration, soil and land use management, and biomass production. Climate change threatens agricultural production through higher and more variable temperatures, changes in precipitation patterns and increased occurrences of extreme events like droughts and floods”.

The challenges of water resources development in SSA will be aggravated by ensuing climate change, with serious implications on socio-economic development. IPCC (2001) noted that, “these challenges include population pressure, problems associated with land use such as erosion/siltation and possible ecological consequences of land use change on the hydrological cycle. Climate change—especially changes in climate variability through droughts and flooding—will make addressing these problems more complex. The greatest impact will continue to be felt by the poor, who have the most limited access to water resources”. The frequent droughts and floods in most parts of SSA—leading to severe food shortages, food insecurity, water scarcity, hunger/famine and acute shortage of hydropower—signify the region’s vulnerability to climate change. Reduced hydropower also affects energy supply for pumping water.

There is a general consensus that the African continent is particularly susceptible to the onset of climate change (Boko *et al.*, 2007). A variety of factors exacerbate susceptibility to the effects of climate variability but, in focusing on strictly physical elements, the range of

ecosystems present on the continent poses particular challenges in developing mitigation and adaptation mechanisms. FAO (2008) identified distinct ecosystems (agro-ecological zones (AEZs)) in which various farming systems exist, and which would be affected differently by climate change. However, according to Green facts, over the past 40 years, some general climatic trends have emerged on a regional scale.

The IPCC Fourth Assessment Report noted that, since the 1960s, the African continent has experienced a general warming trend with certain regions experiencing more warming than others do (Boko *et al.*, 2007). Since 1900, warming has occurred in Africa at approximately 0.5°C per century (Hulme *et al.*, 2001). Precipitation is also highly variable across the continent, although much of the continent has experienced decreases in annual precipitation. An increase in inter-annual variability has been noted with the indication that extreme precipitation events (floods, droughts) are on the rise (Boko *et al.*, 2007). Notwithstanding the inconsistency of predictions about climate change, the effects of the phenomenon are being experienced throughout SSA, especially in areas typified by variable rainfall shifting growing seasons (IPCC, 2001). Most African farmers, particularly those working in rain fed agriculture, have been affected in one way or another.

It is important to delineate expected regional differences in determining and assessing mitigation strategies for future water stresses resulting from the onset of climate change in Africa. Some African countries are much more economically dependent on agriculture, leaving them more vulnerable than others (Kurukulasuriya *et al.* 2006). The precarious state of water resources in Africa is such that water stress (use exceeds renewable supply) is relatively high for the majority of the continent's population. Yet nearly two thirds of Africans rely on limited water sources prone to high yearly variability (Vörösmarty *et al.* 2000). In total, about a quarter of the continent's entire population lives in water-stressed regions (UNEP, 1999). Because the amount of available fresh water is relatively finite, increases in population result in corresponding decreases in the per capita water supply, while rising temperatures exacerbate an already alarming situation in Africa. In terms of fresh water, annual run-off and water availability are projected to increase by 10-40 percent at high latitudes but to decrease by 10-30 percent over some dry regions at mid-latitudes and in the

dry tropics (Falkenmark, 2007). This means that drought-affected areas will likely increase in extent. Agricultural production is projected to be severely compromised in many regions by these trends (UNFCCC, 2008).

Agriculture accounts for more than 70 percent of global water use (FAO, 2008a, World Bank 2006a). According to projections, there will be increasing challenges in terms of increased water stress and areas suitable for agriculture along the margins of semi-arid and arid areas are expected to decrease significantly (Falkenmark, 2007). Seasonal variability in water availability is also critical for agricultural production. For instance, a comparatively small decrease in rainfall during one season may have more severe consequences than a much larger precipitation decrease in another season.

IPCC, 2007 stated that, “Africa is one of the most vulnerable continents because of multiple stresses and low adaptive capacity. The multiple stresses may arise from current climatic hazards, poverty and unequal access to resources, food insecurity, globalization trends, social and political conflicts and incidences of diseases such as malaria, tuberculosis and HIV/AIDS”. Nevertheless, the overall climate will largely be defined by the change in precipitation corresponding to what appears to be a marked increase in temperature. This will lead to extreme rainfall events with dire consequences to agricultural production, especially for the vulnerable smallholder farmers. The impact of climate change is aggravated by demographic change. In eastern and southern Africa, climate change vulnerability is heightened by the large number of people who depend on the already marginalized natural resource base for their livelihoods (Ziervogel *et al.* 2008). Moreover, within the next 15 to 20 years, the area considered to have relative water security in Africa will fall from 53 percent to 35 percent (Ashton, 2002). Therefore, due to the current population growth, many SSA countries are expected to experience a severe increase in water stress, with or without climate change. Population changes could in fact nullify any increases in precipitation/available water. The situation will be aggravated by over-dependence on natural resources (Raleigh and Urdal, 2007).

## **2.4 Assessment of Vulnerability**

IPCC (2000) defined vulnerability as the extent to which a natural or social system is susceptible to sustaining damage from climate change, and is a function of the magnitude of climate change, the sensitivity of the system to changes in climate and the ability to adapt the system to changes in climate. Hence, a highly vulnerable system is one that is highly sensitive to modest changes in climate and one for which the ability to adapt is severely constrained. In the same manner, IPCC defines vulnerability in 2001, as the degree to which a system is susceptible to, and unable to cope with adverse effects of climate change, including climate variability and extremes.

Looking at vulnerability from food security point of view, FAO publication at the State of Food Insecurity in the World (1999), defines vulnerability as “the presence of factors that place people at risk of becoming food insecure or malnourished.” Clearly, this definition encompasses causes of food insecurity other than climate change (e.g., armed conflict, landlessness, etc.).

Nevertheless, the concept of vulnerability includes hunger vulnerability, which refers to the vulnerability of individuals or households rather than that of regions or economic sectors.

The IPCC report of 2001, *The Regional Impacts of Climate Change: An Assessment of vulnerability* argues that the vulnerability of a region depends largely on its wealth, and that poverty limits adaptive capabilities. According to the Second Assessment Report, vulnerability depends on the level of economic development and institutions. The report argues that socio-economic systems “typically are more vulnerable in developing countries where economic and institutional circumstances are less favourable”. The report continues that vulnerability is highest where there is “the greatest sensitivity to climate change and the least adaptability.”

Though vulnerability differs substantially across regions, it is also recognized that even within economic sectors and social group impacts adaptive capacity and vulnerability will vary. This is partly due to the fact that, changes in temperature and precipitation will occur

unevenly, resources and wealth are distributed unevenly climate change impacts will be unevenly distributed around the globe (IPCC, 2001).

- **Sensitivity**

As Santiago Olmos (2001) defines, sensitivity is the degree to which a system is affected, either adversely or beneficially by climate-related stimuli.

- **Exposure**

IPCC (2001) defined Exposure as the, “degree of climate stress upon a particular unit of analysis; it may be represented as either long-term changes in climate conditions, or by changes in climate variability, including the magnitude and frequency of extreme events”.

- **Adaptive Capacity**

Adaptive capacity is defined as “the potential or capability of a system to adjust to climate change, including climate variability and extremes, to moderate potential damages, to take advantage of opportunities, or to cope with consequences” (Smith, J. *et al*, 1996).

#### **2.4.1 Factors Determining Vulnerability**

Considerable attention has been paid to identifying characteristics that influence a system’s ability to adapt (as part of impact and vulnerability assessment) and/or their priority for adaptation measures (as a basis for policy development) (Todaro and Smith, 2012). A common theme in the climate change impacts and vulnerability literature is the idea that communities social groups, sectors, regions and nations differ in the degree of vulnerability to climate change, i.e. there exists differential vulnerabilities (Bohle *et al.*, 1994).

The significance of climate variation depends on the degree of change and the characteristics of the society exposed to it. These characteristics determine the level of vulnerability of a system. Climate induced changes can have vastly different ramifications on communities, regions and nations because of differential vulnerabilities and coping strategies. Poor developing countries are more vulnerable to and have lesser adaptive capacities to than developed nations, due to;

- Overpopulation (relative to current productivity, income and natural resources),
- Debilitated ecological base (land degradation and fragmentation),
- Over-dependence on climate-sensitive sectors: agriculture, forestry, fisheries
- Low level of economic wealth,
- Unequal in access to resources and wealth among groups,
- Weak socio-cultural (rigidity in land-use practices, social conflicts) infrastructural, financial/market (uncertain pricing, availability of credit, lack of credit), legal and governance structures,
- Technological, skills and human resource bottlenecks,
- Poor pre-existing health conditions.

#### **2.4.2 Approaches to Assess Vulnerability**

There are different conceptual approaches and methodologies in different literatures to assess vulnerability based on the objectives to be achieved and the methodologies employed. The major three conceptual approaches to analyzing vulnerability to climate change are the socio-economic, the biophysical (impact assessment), and the integrated assessment approaches (Temesgen et.al, 2008).

##### **2.4.2.1 Socio-economic Approach**

Socio-economic vulnerability assessment approach mainly focuses on the socioeconomic and Political status of individuals or social groups (Adger, 1999). Individuals in a community often vary in terms of education, gender, wealth, health status, access to credit, access to information and technology, formal and informal (social) capital, political power, and so on. These variations are responsible for the variations in vulnerability levels. In general, the socioeconomic approach focuses on identifying the adaptive capacity of individuals or communities based on their internal characteristics. However, socio-economic approach focuses only on variations within society (i.e., differences among individuals or social groups). In reality, societies vary not only due to socio-political factors but also to environmental factors. Two social groups having similar socio-economic characteristics but

different environmental attributes can have different levels of vulnerability and vice versa (Temesgen et.al, 2008).

#### **2.4.2.2 Biophysical Approach**

The biophysical, or impact assessment, approach is mainly concerned with the physical impact of climate change on different attributes, such as yield and income (Füssel and Klein 2006). Kelly and Adger (2000) referred to the biophysical approach as an *end-point analysis* responding to research Questions such as, “*What is the extent of the climate change problem?*” and “*Do the costs of climate change exceed the costs of greenhouse gas mitigation?*” Although very informative, the biophysical approach has its limitations. The major limitation is that the approach focuses mainly on physical damages, such as yield, income, and so on. For Example, a study on the impact of climate change on yield can show the reduction in yield due to simulated climatic variables, such as increased temperature or reduced precipitation (Temesgen et.al, 2008).

#### **2.4.2.3 The Integrated Assessment Approach**

The integrated assessment approach combines both socioeconomic and biophysical approaches to determine vulnerability. Füssel (2007) and Füssel and Klein (2006) argued that the IPCC (2001) definition which conceptualizes vulnerability to climate as a function of adaptive capacity, sensitivity, and exposure accommodates the integrated approach to vulnerability analysis. According to Füssel and Klein (2006), the risk-hazard framework (biophysical approach) corresponds most closely to sensitivity in the IPCC terminology. Adaptive capacity (broader social development) is largely consistent with the socioeconomic approach (Füssel, 2007). In the IPCC framework, exposure has an external dimension, whereas both sensitivity and adaptive capacity have internal dimension, which is implicitly assumed in the integrated vulnerability assessment framework (Füssel, 2007).

Even though the integrated assessment approach corrects the weaknesses of the other approaches, it has its limitations. The main limitation is that there is no standard method for combining the biophysical and socioeconomic indicators. This approach uses different data sets, ranging from socioeconomic data sets (e.g., race and age structures of households) to

biophysical factors (e.g., frequencies of earthquakes); these data sets certainly have different and yet unknown weights. (Temesgen et.al, 2008) The other weakness of this approach is that it does not account for the dynamism in vulnerability. Coping and adaptation are characterized by a continual change of strategies to take advantage of opportunities (Eriksen and Kelly, 2007); thus, this dynamism is missing under the integrated assessment approach.

## **2.5 Vulnerability of Smallholder Farmers**

According to the IPCC report on the regional impacts of climate change, Africa is the continent most vulnerable to the impacts of projected changes because widespread poverty limits adaptation capabilities. The importance of agricultural activities for the economies of most African countries, combined with the farming sector's reliance on the amount of rain during the rainy season, make countries in the region particularly vulnerable to climate change. Thus, from the point of view of food security, the increasing incidence of drought represents a very serious threat. It has been argued that, in Africa, drought hazard and vulnerability are likely to be the most damaging impacts of climate change (Downing *et al.*, 1997).

Among the many factors contribute and compound the impacts of current climate variability in Africa and will have negative effects on the continent's ability to cope with climate change. These include poverty, illiteracy and lack of skills, weak institutions, limited infrastructure, lack of technology and information, low levels of primary education and health care, poor access to resources, low management capabilities and armed conflicts. The overexploitation of land resources including forests, increases in population, desertification and land degradation pose additional threats (UNDP, 2008). In the Sahara and Sahel, dust and sand storms have negative impacts on agriculture, infrastructure and health.

Smallholder farmers are particularly vulnerable to changes in the climate that reduce productivity and negatively affect their weather-dependent livelihood systems. For instance, in Malawi, frequent droughts and floods have eroded assets and knowledge, leaving people more vulnerable to disasters (Gandure and Alam, 2006) such as water and food insecurity, diseases and land degradation. Evidence strongly suggests that increased droughts and floods may be exacerbating poverty levels, leaving many rural farmers trapped in a cycle of poverty

and vulnerability to diminishing resources (Phiri *et al.*, 2005). Water scarcity is already a major problem in arid and semi-arid areas of SSA (Rijsberman, 2006) areas mainly inhabited by smallholder farmers in both agro-pastoral and pastoral communities. Climate change and increasing population contribute to water scarcity and limit its availability for irrigation and other productive uses (Turner, 2006).

## **2.6 Climate Variability in Ethiopia**

Ethiopia is a country with a very diverse climate. In general, climate patterns are highly variable and unpredictable. The country also has a history of experiencing climate extremes, such as droughts and floods, increasing temperature, and unreliable rainfall (NMA, 2007). The country's geographical location within the tropics and extremes of topography in combination with the low adaptive capacity of the people and their resources result in a high degree of vulnerability to the adverse impacts of climate change. Rain fed agriculture remains the dominant means of production for the national economy. The agricultural sector, which accounts, on the average, for about 45 percent of GDP, is a source of livelihoods for about 80 percent of the country's population (MoFED, 2011). Small-scale farmers engaged in subsistence level production dominated the sector.

According to U.S. Geological Survey of 2012, if recent warming trends continue, most of Ethiopia will experience more than a 1.0°C increase in air temperature, with the warming tendency projected to be greatest in the south-central part of the country. This warming will intensify the impacts of droughts, and could particularly reduce the amount of productive cropland for coffee, since coffee plants typically prefer temperatures cooler than 22°C.

Historically, a strong link has been observed between climate variations and the overall performance of the country's economy, mainly due to the direct impacts of unreliable weather on agriculture and the indirect links to other sectors of the economy. The contribution of agriculture to the country's total GDP clearly explains the relationship among the performance of agriculture, climate and the total economy. According to Hansen (2006), years of drought and famine (1984/1985, 1994/1995, 2000/2001) are associated with very low contributions, whereas years of good climate (1982/83, 1990/91) are associated with better

contributions to GDP. Though agriculture is expected to play a key role in ensuring food security and overall development of the country's economy, its performance is primarily constrained by changing and unreliable weather conditions and the associated disasters such as drought and flooding.

In the North-western parts of the country, rainfall has been relatively constant between the 1960s and the present-after a decline in annual rainfall in the mid-1980s there has been a gradual recovery in recent years. The southwest of the country has experienced an overall decline in rainfall since the 1960s and steep decline since 1996. Of significant concern for food security are the declines in March-September rainfall in the northeast and the southeast. In the North-east, rains have declined since the mid-1990s with 2010-2012 having very low rainfall. Similarly, in the South-east and Eastern parts of Ethiopia, rainfall has been steadily declining since the mid-1980s with the last few years having very low precipitation averages. The northeast and southeast of Ethiopia already have limited water availability, and therefore reduced precipitation patterns would significantly affect livestock production and potentially food security (Funk *et al.*, 2011; NMA, 2012). Trends in Annual precipitation for 1970-1999 mean climate in the recent past and projected future. All values shown are percentage anomalies, relative to the 1970-1999 mean climates.

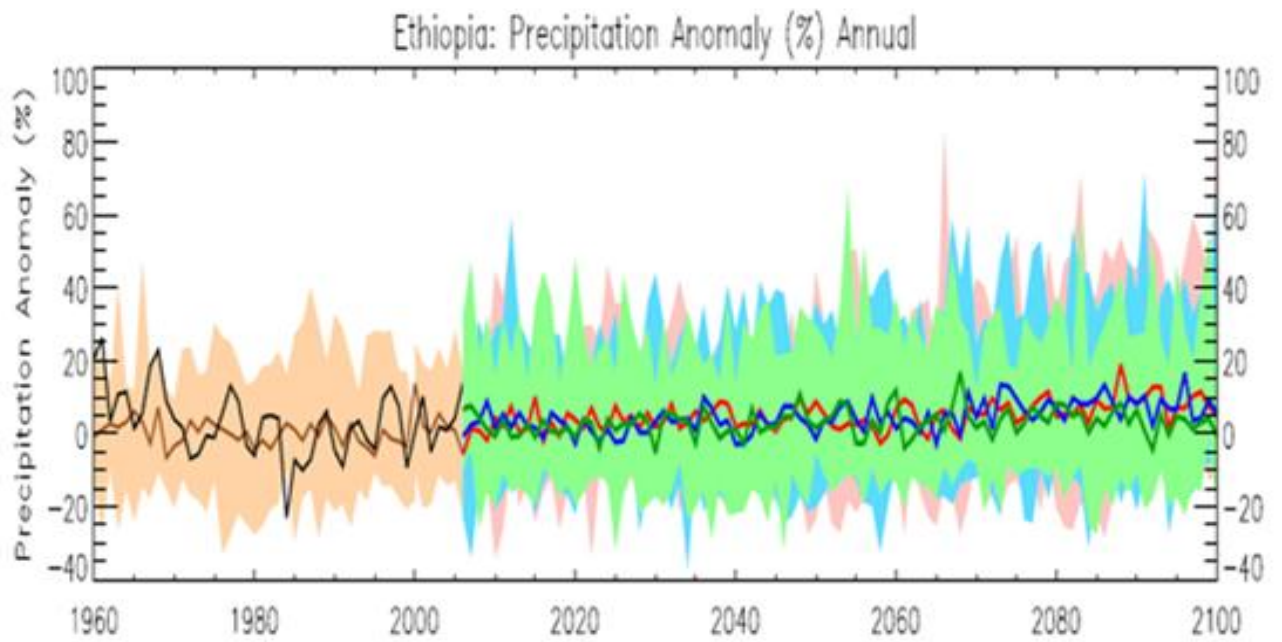


Figure 2.2a: Ethiopian Precipitation Anomaly (%)

Source: Adopted From UNDP (2012)

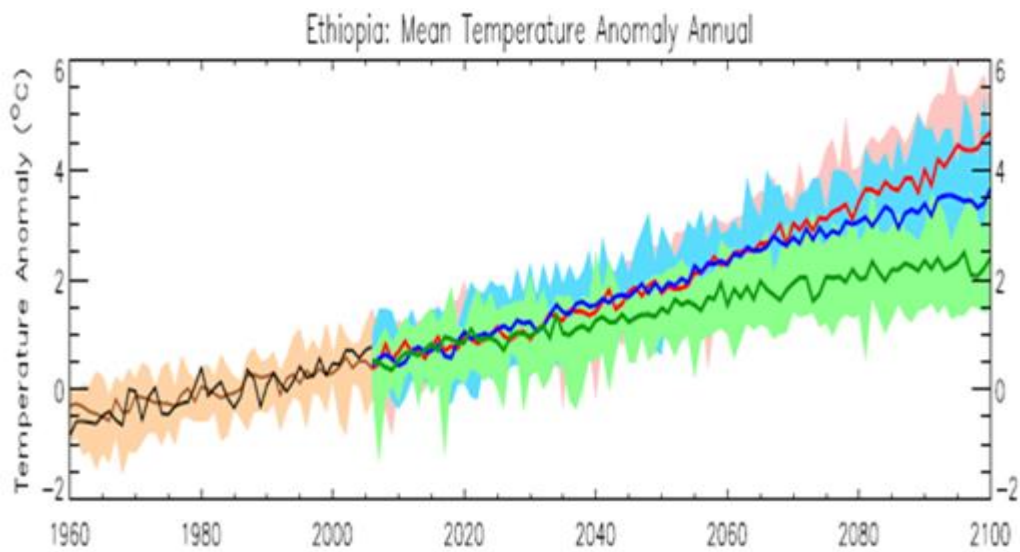


Figure 2.2b Ethiopian Mean Temperature Anomaly.

Source: Adopted From UNDP (2012)

## 2.7 Overview of Ethiopian Agriculture and Climate

Ethiopia is characterized by diverse climatic conditions ranging from humid to semi-arid environments. Its climate system is largely determined by the seasonal migration of the inter-tropical convergence zone (ITCZ) and a complex topography (NMA, 2001). Mean annual rainfall distribution ranges from a maximum of more than 2,000 mm over the South-western highlands to a minimum of less than 300 mm over the South-eastern and North-western lowlands. The south-west and western areas of the country are characterized by a uni-modal pattern whereas the remaining parts exhibit a bi-modal rainfall pattern (World Bank, 2006). The mean annual temperature varies widely, from lower than 15°C in the highlands (>1500 m.a.s.l.) to more than 25°C in the lowlands (< 1500 m.a.s.l.).

Ethiopian agriculture which, is dominant economic sector of the country, is highly determined by climatic variation. Figure 2.2 below shows the correlation between rainfall variability and the overall performance of the country's Gross Domestic Product. As shown by graph, during the years of poor rainfall, the GDP becomes very low which is associated with low rainfall, whereas years with high rainfall were associated with high country's agricultural GDP (World Bank, 2006). Climate variability, particularly rainfall variability and associated droughts have been causes for food insecurity in Ethiopia (Seleshi and Zanke, 2004; Rosell, 2011). Climate change is expected to pose more challenges and to further reduce the performance of the economy (Arndt *et al.*, 2011). A study on mapping poverty and vulnerability in Africa identified Ethiopia as one of the country, most vulnerable to climate variability and change (Thornton *et al.*, 2012).

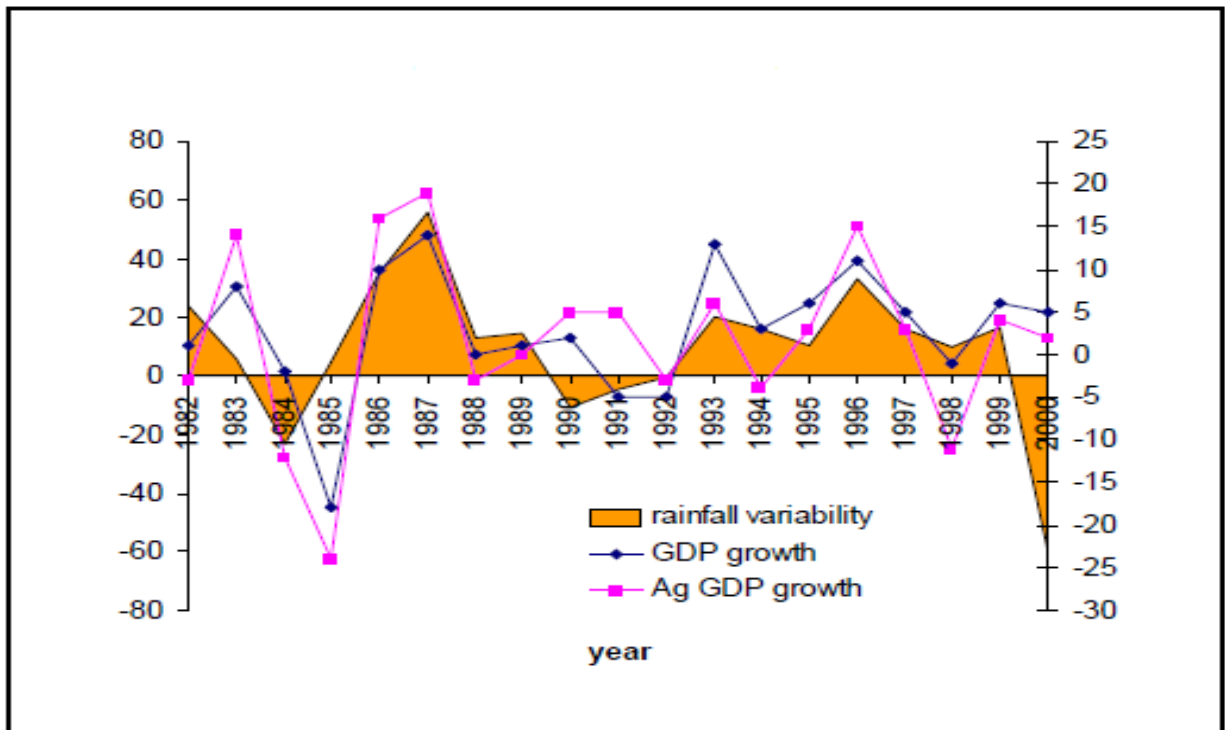


Figure 2.3 Effect of rainfall variability on total and agricultural GDP in Ethiopia  
 Source: Adopted from World Bank, 2006

## 2. 8 Extent of Vulnerability

Ethiopia is directly and disproportionately high dependence on natural resources and climate sensitive livelihoods coupled with the prevalence of poverty places the country in a most vulnerable position. According to the National Meteorological Agency (NMA, 2007), agriculture, water and range resources, biodiversity and human health are vulnerable to climate variability and change, with huge social and economic impacts. According to a recent mapping of vulnerability and poverty in Africa, Ethiopia is identified as one of the countries most vulnerable to climate change because of its low adaptive capacity (Thornton *et al.*, 2012; Conway *et al.*, 2007). The country's smallholder farmers and pastoralists are those with livelihoods most vulnerable to changes in climate.

Rainfall variability and associated droughts have been major causes of the food insecurity and famine with a long history in the country particularly over the past several decades. At least five major droughts have prevailed since 1980, along with dozens of localized ones World

Bank, undated Studies show that the frequency and magnitude of droughts has increased over the past few decades, especially in the lowlands (Lautze *et al.* 2003; Aklilu and Alebachew, 2009a; Eyasu, 2009). Drought cycles create poverty traps for households constantly thwarting efforts to build up assets and increase income to enable them to absorb shocks. With nothing to fall back on, and no cash to buy their way out of danger, drought simply pushes poor communities into dangerously precarious situations by depriving them of their food supplies and assets (Robinson, 2003).

Many places of the country are also vulnerable to the risks of flooding, and floods, unfortunately, often follow droughts and famine. The country was exposed to major floods in 1988, 1993, 1994, 1995, 1996 and 2006 leading to considerable loss of life and property (NMA, 2006). Floods destroy biodiversity, degrade rangelands, remove top soil with its nutrients, and undermine livestock and food production. The destruction of local natural resources can result in resource-based conflicts that drive the vulnerability of local people further. The limited economic, institutional and logistical capacity to deal with these challenges and adapt to climate change exacerbates the vulnerability of many people and their communities.

Temesgen *et al.* (2008) analyzed the vulnerability of Ethiopian farmers (including pastoralists) to climate change by creating vulnerability indices and comparing these indices across regions. They found that the farmers in the Regions of Afar, Somali, Oromia, Amhara and Tigray are relatively more vulnerable to climate change as compared to those in Southern Nations, Nationalities and Peoples (SNNP) and Benshangul Gumuz. While the vulnerability of Afar and Somali is attributed to their low level of regional development, the vulnerability of farmers in Tigray and Oromiya is attributed to the higher frequencies of droughts and floods with low access to appropriate technology, institutions, and infrastructure.

A study of water resources in the Awash and Abay River basins found a high degree of vulnerability to change in climate in which runoff will decrease under warmer and drier conditions (Huq *et al.*, 2003). According to IFPRI (2008), the predicted increase in temperature by 2050 is greatest for Afar and Tigray regions and lowest for SNNPR, and the predicted change in precipitation is highest for Somali region and lowest for SNNPR. The

study further indicated that even under a very moderate climate change scenario, both water supply and cereal grain production in Ethiopia would decline, despite higher expected rainfall. For instance, climate change is projected to reduce yields of the wheat staple crop by 33% (NMA, 2007). This implies that preparations are required not only to combat the currently prevailing impacts but also for adapting to the predicted changes and their impacts.

## **2. 9 Impact of Climate Variability**

Climate change is likely to harm developing economies that generate the major portion of their GDP from climate sensitive sectors such as agriculture (Mideksa, *in press*). In Ethiopia, changes in the weather can seriously undermine the contribution of the agricultural sector to the country's economy (Temesgen *et al.*, 2008).

Mideksa (*in press*), made a study that analyzed the economic impact of climate change in Ethiopia. He found that climate change will make the prospects for economic development harder in at least two ways: first, by reducing agricultural production and output in the sectors linked to the agricultural sector, which is likely to reduce the country's GDP by about 10% from its level in 2005, which is used as a benchmark. Second, by raising the degree of income inequality, it is likely to further decrease economic growth and fuel poverty. Therefore, securing Ethiopia's economic and social wellbeing in the face of climate change requires that policymakers and stakeholders work together to integrate climate change adaptation into the country's development process (Assefa and Berhanu, 2008).

Extreme events, like droughts and flooding, lead to the destruction of capital stocks in the country such as agricultural land, crops, livestock, and infrastructure. In particular, pastoral and agro-pastoral communities, which are heavily reliant on livestock for their livelihoods, suffer severe asset losses during droughts. It takes many years for pastoralists to reconstitute, if possible, their cattle herd after each drought (Eyasu, 2009). The changes affect pasture availability and quality, which in turn reduce livestock health and productivity. According to Aklilu and Alebachew (2009), the number of livestock possessed by pastoral households in the southern lowlands has shrunk considerably over the past two decades. Weak livestock markets adversely affect the terms of trade as prices fall sharply relative to cereal prices

particularly at times of severe droughts. There is also growing evidence that there are links among conflict, security and disasters, as pressure on resources often leads to increased mobility and the probability of conflict (Chibber and Laajaj, 2008).

A study by Aklilu *et al.* (2009) in Oromiya and SNNPR attempted to link the concepts of population, fertility and family size to notions of vulnerability and resilience to climate change in Ethiopia. The study found that people in the study areas link population pressure to the effects of climate change and said that families should consider having fewer children in order to avoid as much hardship in making a living and in utilizing the natural resources for survival. The particular vulnerabilities of women and children were also highlighted.

Climate variability is already having profound effects on health in Ethiopia though available studies are limited and patchy. Malaria is prevalent in over 75% of the country, putting over 50 million of the total of 77 million people at risk (UNICEF, 2007). This disease is the major cause of mortality in the country. According to NMA (2007), climate change is projected to cause encroachment of malaria from lower altitudes in Somalia and Afar regions to higher altitudes in Tigray and Amhara.

Research so far has mostly focused on the direct health impacts of climate change such as thermal stress, extreme weather events, and outbreaks of infectious diseases. In the southern lowlands, for instance, communities link the emergence and spread of diseases to changes in wind patterns, temperature and rainfall regimes, and blame the recurrent and long droughts (Aklilu and Alebachew, 2009). However, the health impacts of climate change should be seen as part of a wider spectrum of health risks that result from social, demographic and economic disruptions caused by change and variability in climate (McMichael *et al.*, 2006). Poor health arises from a combination of factors including reduced food and water security, increase in water-borne diseases due to reduced water quality, floods and drought, and the spread of diseases.

Arndt *et al.* (2009) developed a model to identify economic sectors that are most likely to be affected by changes in climate in Ethiopia in order to evaluate potential adaptation policies. They found that a substantial potential exists for increases in agricultural productivity through

investment in water harvesting, irrigation and road infrastructure to combat climate change impacts in the relatively near term. The results further highlight the relative weakness of the country's non-agricultural sectors to absorb surplus labour. This is because existing opportunities for labour (either local or migratory) are still largely dependent on the outputs from rain-fed agriculture, implying that creating employment opportunities outside of agriculture will remain a major challenge both to development and for successful adaptation to climate change.

One of the most significant impacts of climate change is likely to be on the hydrological system, and hence on river flows and water resources. Deksyos and Abebe (2006) developed a model to predict the impacts of climate change on the hydrology of the Lake Tana sub-basin. They found that river flows will be reduced by amounts ranging from 15% to 80% of the monthly mean, in some months of the year, all over the basin.

## **2.10 Local Responses**

The people of Ethiopia are not unaware of the influences of climate variations. They have been facing the impacts in various forms over millennia and have developed a range of coping mechanisms to deal with the impacts (McKee, 2008). The most important coping mechanisms widely used include:

- changes in cropping and planting practices,
- reduction of consumption levels,
- collection of wild foods,
- use of inter-household transfers and loans,
- increased petty commodity production,
- temporary and permanent migration of people and animals,
- usage of hidden secure grain storage,
- sale of assets such as livestock and agricultural tools,
- becoming beneficiaries in Safety Net Program
- use of early warning systems, and
- Appeals for food and other forms of aid (NMA, 2006).

Most of the traditional coping mechanisms focus on agriculture and are based on local knowledge. Hence, they may not be able to counter all of the challenges to be faced in the future. But, the local perceptions of the changes and the challenges people face should be the basis for the choice of adaptation strategies. The analysis of farmers' perceptions of climate change in the Nile Basin of Ethiopia indicates that farmers are aware that the temperature is increasing and the level of precipitation is declining (Temesgen *et al.*, 2008). The study further indicated that farmers living in the cool highlands (*dega* areas) were most aware of the changes.

Farmers have a range of strategies to cope with drought. However, intense and repeated droughts have seriously eroded their capacities to withstand the shocks and they have thus become more vulnerable. Based on a study in the Nile Basin of Ethiopia, Temesgen *et al.* (2008) found that farmers' decisions to adopt yield-enhancing adaptation strategies are influenced by:

- informal and formal institutional support,
- the availability of information on possible future changes in climate,
- the amount of rainfall during the *belg* (small rains between March and May), and
- the socio-ecological setting-household-specific characteristics of size and age, and literacy levels of the household head.

Local responses vary according to the local environmental, socio-cultural and economic situation. For instance, in South Omo, people prefer to stay on the islands of Lake Turkana during prolonged droughts in order to have easy access to water, pasture and fish, and to have less risk of livestock raiding by other ethnic groups (Wongtschowski *et al.*, 2009). Pastoralists in the southern and eastern lowlands of Ethiopia have gradually shifted from raising cattle, which are grazers, to camels and goats as these animals are browsers and relatively drought resistant (Aklilu and Alebachew, 2009a; Wongtschowski *et al.*, 2009). The local institutions in several of the communities were found to still contribute to the management of the natural resources such as water and grazing areas as a strategy to cope with scarcity, although the influence of these institutions has progressively been weakened. This indicates that the

capacity of local coping strategies could reach limits to effectively deal with the problems unless supported by appropriate policy and institutional arrangements.

## **2. 11 Institutional Responses**

The Ethiopian government has recognized climate change as a threat to its national development aspirations. The country has signed most of the international environment conventions including those specifically focused on climate change: it ratified the UNFCCC in May 1994, UNCCD in June 1997, and the Kyoto Protocol in February 2005. The country prepared a National Adaptation Programme of Action (NAPA) to fight the impacts of climate change and desertification. However, by 2008, Ethiopia had no explicit policy for dealing with climate change. The country has formulated a number of policies, strategies and action plans aimed at promoting environmental protection, poverty reduction, and sustainable development. However, lack of focused policies and legislation are serious impediments to deal with the adverse impacts of changes and variability in climate (Wondwossen, 2008). Hence, as Daniel (2008) stated, it is important and high time to take climate change issues into the country's policies, programmes and guidelines. Despite the relatively high knowledge of the subject among policy-makers, and the prominent role being played by Ethiopia in international climate change negotiations, Ethiopia was still formulating its response in 2009 (Selam, 2009).

According to Temesgen *et al.* (2008), since vulnerability to climate change in Ethiopia is highly related to poverty through loss of coping or adaptive capacity, integrated rural development schemes can play the double role of reducing poverty and increasing adaptive capacity for dealing with climate change.

Based on a study in the Nile Basin of Ethiopia, Temesgen *et al.* (2008) suggested that farmers need timely information on predicted changes in climate in a readily accessible form to empower them to take appropriate steps to adjust their farming practices, such as adopting yield-enhancing adaptation strategies. The early warning system in the country is based on crop forecasts and assessments of food stocks, and deals mainly with preparedness for food emergency relief rather than providing the rural communities with advance information for

coping with climate related hazards. Furthermore, efforts should also be made to reduce the risks of disasters, and extend access to credit markets and extension services in order to facilitate adaptation.

Since 2011, the government of Ethiopia put in place the building block necessary to implement its green economic initiatives. The Government has developed an action plan to set up permanent financial mechanism, initiate the stakeholder integument process, and set priorities for implementation of initiatives. Four initiatives have been selected for fast-track implementation: attracting the investment required to exploit hydropower potential; promoting advanced rural cooking technologies on a large scale: improving the efficiency of the livestock value chain: and Reducing Emissions from Deforestation and Forest Degradation (EFDR, CRGE Strategy, 2011).

The government is using significant resources to build and implement its green economy, but to capture the full potential of the plan; it welcomes the partnership with bilateral and multilateral development partners as well as contributions by the private sector. At the federal level, ministries and other sectorial agencies will participate and encourage the participation of other entities in their respective sectors in the formulation and implementation of the components of the green economy. These ministries and other sectorial agencies are responsible for.

- Formulation proposals of green economy initiatives for financial support or carbon credit,
- Coordinating the implementation of sectorial or sub-sectorial green economy initiatives,
- Preparing and submitting monitoring reports,
- Designing, establishing and staffing their respective environmental units.

National regional states-in collaboration with the relevant federal level institutions-are responsible for implementing the majority of the initiatives outlined in the CRGE strategy. The coordination between regional and federal levels will be under the responsibility of the respective environmental agencies of the national regional states. This collaboration has proved efficient in numerous other undertakings. (FDRE, Green Economy Strategy, 2011).

The Government's response so far has been challenged by shortage of funds, inadequate infrastructure. Hence, the role of non-state actors is very crucial and their contribution in enhancing local adaptive capacities is generally encouraging. However, as observed in the southern lowlands of the country (Aklilu and Alebachew, 2009a), most of their efforts suffer from lack of cooperation among each other, fragmented approaches, weak institutional linkages, and problems of continuity.

## **2.12 Conceptual Framework of Study**

The conceptual framework accommodates the integrated vulnerability assessment approach, which considers both the biophysical and the socioeconomic indicators in assessing vulnerability. Hence, to study the extent of vulnerability of the local people of Targeted area-Sidama Zone, the integrated conceptual framework having both biophysical and socioeconomic vulnerability is constructed as below.

As figure 2.4 below shows vulnerability of people to climate change and variability is determined by the exposure to the area, their system's sensitivity to be affected with the impact of the change and their adaptive capacity, the potential of their methods to adapt or cope with the change. These factors are interrelated. Exposure of the area to the change in precipitation and temperature causes climatic extremes like flood and drought. This exposure influences both the biophysical system and adaptive capacity. This means that the higher the exposure (frequent change and extremes) highly affect the livelihood (income and yield) and health of the households, sensitivity and also reduces the adaptive capacity. Sensitivity and an adaptive capacity are also linked. If exposure is constant, the higher the adaptive capacity results lower sensitivity and vice versa. Then, high sensitivity is biophysical vulnerability, low adaptive capacity, which is low economic status, poor service and infrastructure and effective adaptation and coping strategies, leads to socioeconomic vulnerability and the combination of biophysical, and socio economic vulnerability can show the areas vulnerability.

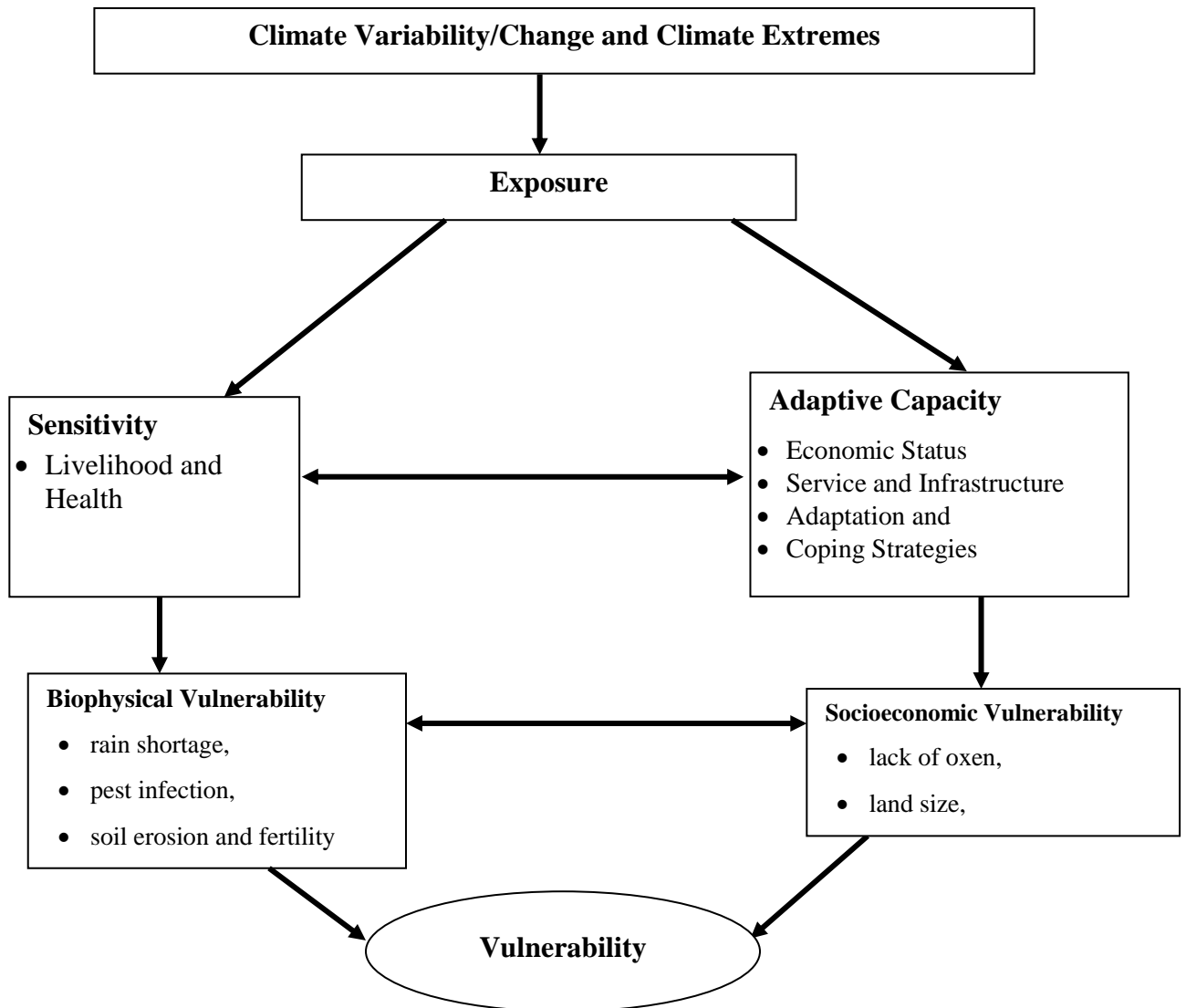


Figure 2.4 Conceptual Framework of the Study  
 Source: Modified and Adopted from Temesgen *et.al*, 2008.

## CHAPTER THREE

### 3. RESEARCH DESIGN AND METHODOLOGY

#### 3.1 The Description of the Study Area

This chapter describes the study area's physical feature, demographic characteristics and socioeconomic standards.

##### 3.1.1 Location and Size

The South Nation Nationalities and People's Regional State (SNNPRS) is located in the Southern and South-Western part of Ethiopia. It roughly lies between 4° 43' to 8° 58' North Latitude and 34° 88' to 39° 14' East Longitude. The total region is estimated to be 109,066.6 sq.Kms. The Region divided in to 14 Zones, one city administration and four Special *Woredas*. Among which Sidama is one of the 14 Zones in the region. It is located in the North Eastern part of the region and bounded by Oromiya in the North, East and South East, with Gedieo Zone in the South, and Wolayta Zone in the West. Its geographic location lies between 6°14' and 7°14' North latitude and 37°02' and 39°14' East longitude.

Total area of the Sidama Administrative Zone is about 6981.8 Km<sup>2</sup>. It consists 19 *Woradas* and two administrative town namely: *Hwassa Zuria, Malga, Wondo-Genet, Gorche, Wonsho, Chuko, Loka Abaya, Bursa, Bona-Zutiya, Chire, Shebedino. Dalle, Aleta-Wondo, Sara, Hula, Aroresa, Arbegona, and Boricha Woredas* including the two towns i.e. *Alata Wondo and Yirgalem Town Administrations* (SZFED, 2012/2013).

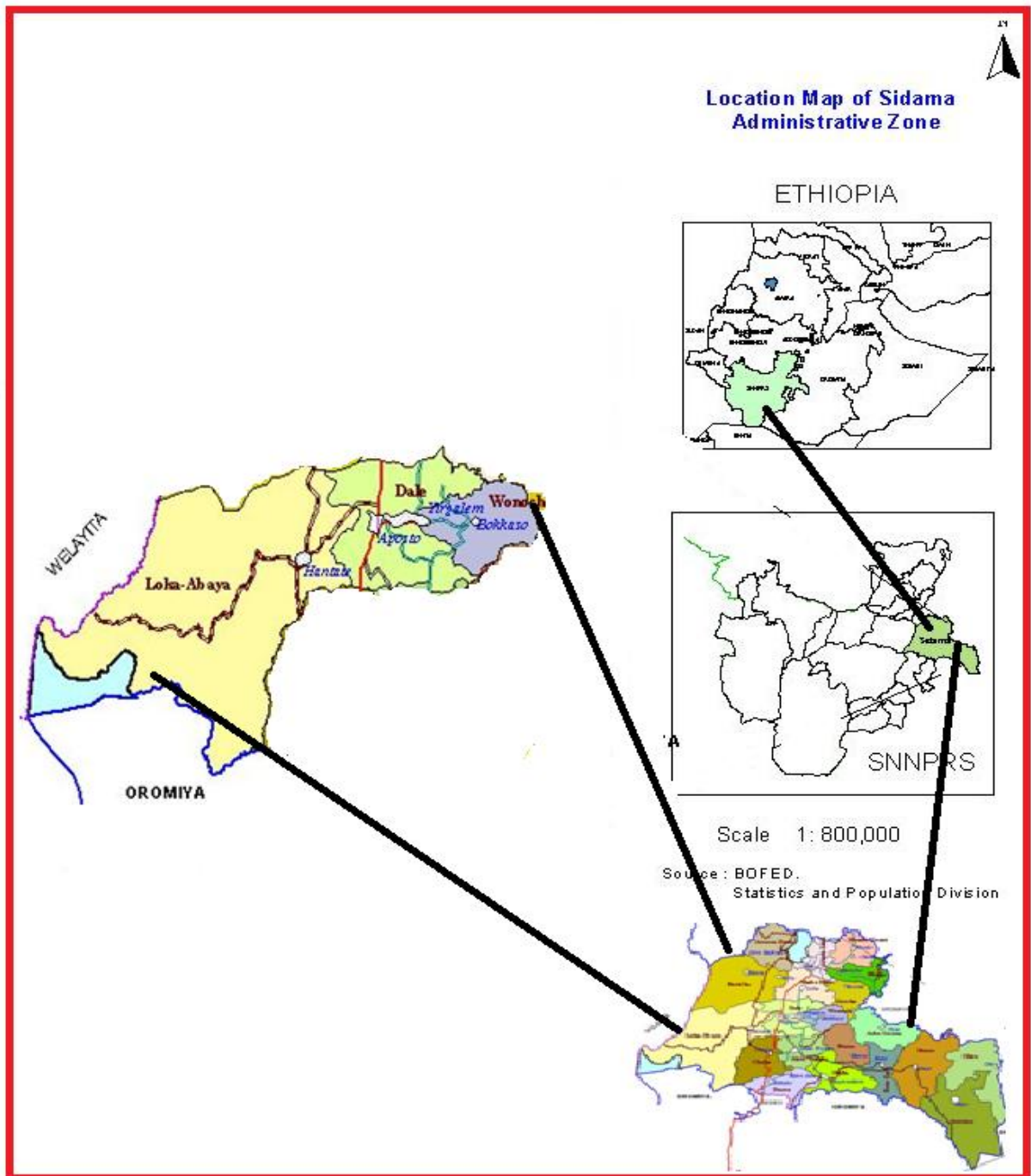


Figure 3.1: Location Map of Sidama Administrative Zone  
 Source: SZFEDD, 2012/2013.

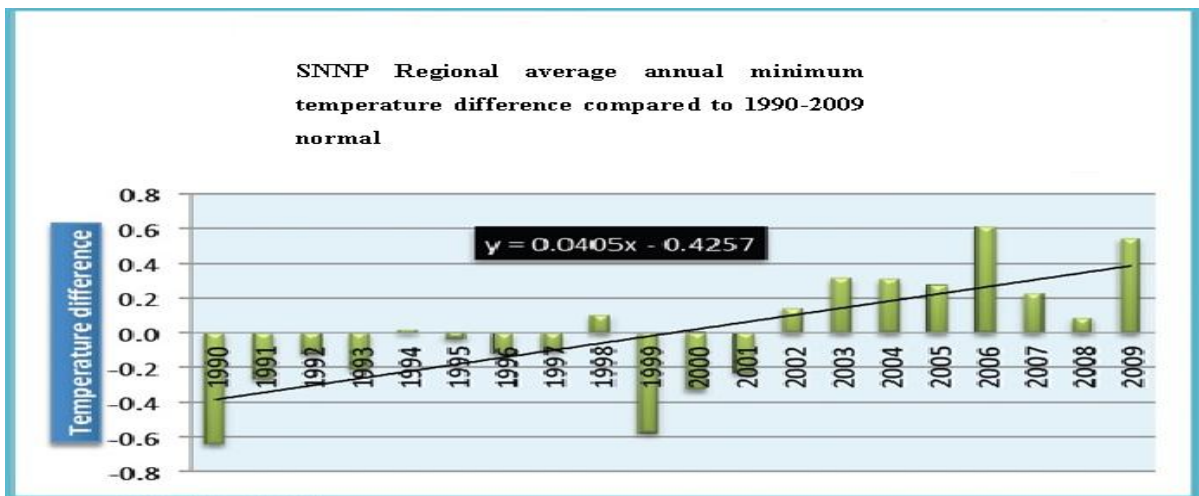
### 3.1.2 Physical Characteristics

Sidama Zone is characterised by different landforms and climatic features that varies from higher elevation areas of mountains and low lands, as it exists in different parts of the Zone. The altitude variation ranges between the highest peak of Garamba mountain 3500m up to low lands 1190m around Bilate River in Loka-Abaya and *Boricha Woredas*. Most parts of the Zone have relatively lower altitude ranging from 1501-2000 masl containing 46.34%. While the high land contains only lower portion, which is 0.6 and ranging from 3001-3500m. The remaining 20.57% and 20.43% is covered with altitudes from 2001-2500 and 2501-300 masl respectively (SZFEDD, 2012/2013).

The relief feature of any region can affect its physical, social and economic characteristics. Topography and climatic condition of any place is highly related. From this, climatic condition of Sidama zone can be described as “Wet moist *woina dega*” and “Wet moist *dega*” containing 45.4% and 27.7% respectively, Followed by dry *woina dega*, dry *kola*, and wet moist *kola* are 14.5%, 8.6%, and 3.8% respectively (SZFED, 2012/2013).

#### 3.1.2.1 Temperature

Sidama Zone and SNNPR region have been experiencing climate change. In the last decade, average temperature of the SNNPR region had risen by 0.4<sup>0</sup>c (NREPA, 2012) above the national 0.37<sup>0</sup>c (MoWRNMA, 2007). This shows the seriousness of the problem in the region.



(Source: NREPA, 2012)

Figure 3.2 Regional as well as Zonal Temperature Pattern through Year

### **3.1.2.2 Rainfall Pattern**

According to U.S. Geological Survey (2012), the Great Rift Valley in Ethiopia is a densely populated area stretching southward from the capital city, Addis Ababa. During the Belg season, South of Shashemene, they observed 500 mm rainfall isohyets for 1960–1989 and 1999–2009 indicate a substantial retreat, indicating increased climatic pressure on the valley's agricultural livelihoods. The most recent observations (1990–2009) indicate that this area no longer receives an average of 500 mm of rainfall during the March-June season. If the rate of recent rainfall declines persists, the 500mm rainfall contour appear likely to retreat to the west of Lake Abaya (South West of Shashemene).

### **3.1.3 Population Size**

#### **3.1.3.1 Demographic Characteristics**

Based on 2003 census data the population of the country is estimated to be 73,750,935. In the same year, (2003) housing and population census conducted by Central Statistic Authority; the total number population of SNNPR and Sidama is about 14,929,548 and 2,954,136 respectively. For the year (2010/11), Sidama population is estimated to be 3,216,671, and for the year 2012/13 is estimated to be 3,372,760. Within the zone, the number of population varies from one locality to another. Among the 19 rural *woredas* and 2 town administration, most populated *Woreda* is Bensa of 289,196 and the least populated *Woreda* is Wonsho with total population 103,174 (SZFED, 2012/2013).

### **3.1.4 Socio-economic Profile**

#### **3.1.4.1 Economic Activity**

##### **3.1.4.1.1 Agriculture**

Agriculture is the backbone of Ethiopia's economy in general and dominant economic sector in Sidama Zone in particular. This dominant economic sector encompasses growing of plants and rearing of animals and it is practiced in every *Woredas* of Sidama Zone. Crop production and plant growing mainly includes production of coffee, enset, maize and barely for consumption as well as commercial purpose. Based on the ecology zone, areas suitable for

productivity such as Loka-Abaya, Hula, Bursa, Boricha, Wondo-genet, Malga, Hawassa-Zuria are termed as food crop growing *Woredas* while Aleta-wondo, Chuko, *Dalle*, Dara, *Wonsho*, Bona-zuria, Shebedino, Chire and Bensa are dominantly coffee growing and they also produce food crops. In addition to these, some vegetables and root seeds also practised in different *Woredas* of the zone.

Hence, unless and otherwise coordinated and enlarged scale of natural resource management is undertaken, the productivity of agriculture were affected. In the area inappropriate utilization of forest and vegetation cover, resulted in flood and erosion which in turn causes serious problem in decreasing agricultural productivity (SZEFD, 2011/2012).

Rearing of livestock is also one of the economic activity which, is practiced in the Zone in addition to crop production. As population increases, the grazing land become farm and as well as the availability and quality of pasture decreased and potable fodder is being diminished due to excessive grazing. It is obvious that shortage of food has inevitably caused decline in livestock production (SZEFD, 2011/2012). Because of a growing demand for fuel, wood, cutting of trees for construction materials, and other uses depleted forest resources.

#### **3.1.4.1.2 Institutions Supporting Smallholder Farmers**

In the Zone, there are different institutions, which are established to facilitate and provide support for smallholder farmers. Among which, there are two health extension workers, more than three agricultural extension workers in each *kebele*. In each *kebele* there are one FTC (Farmer's Training Center), one health post, more than one primary schools and one health center for five kebeles which provide different services to enhance the capacity of smallholder farmer's to increase their productivity.

### **3.2 Study Design**

Research design is considered as the blueprint and cornerstone of any study since it facilitates various research operations. In this regard, Kothari (2006) argues that research design helps the researcher plan in advance of the methods to be adopted for collecting the relevant data and techniques to be used during analysis. The nature and objectives of the problem to be studied and the means of obtaining information were the most important factors to be

considered in order to choose the appropriate research design. Quantitative data provides precise summaries and comparisons, while the qualitative data provided general elaborations, explanations, meanings and relatively new ideas. Considering all these, multiple approaches, which combine both quantitative and qualitative methods, were used for this study.

Based on the above justification, this research employed both quantitative and qualitative in the form of triangulation and with the intention of backing numerical information with qualitative aspects from the farmers, extension workers and different officials of governmental organizations because it is known that the approaches are just different and they have their own strength and weakness.

Quantitative methodology was used in order to produce statistical data relating to the study. Eventually semi-structured survey questionnaire were used to collect quantitative data. In addition, qualitative approach was used to explore the attribute and experience of participants (households and officials) toward the linkage between climate variability and its impact on the rural community and adaptation mechanisms at local level. In this regard, data collection techniques such as focus group discussion, key informants interview and personal observation were used to generate the data.

### **3.3 Population and Sample Size**

The targeted populations for this study were household head smallholder farmers of the selected study area. Statistical considerations, data collection procedures and sample sizes are systematically determined, by employing the probability proportional to size sampling method, in order to avoid bias.

#### **3.3.1 Sampling Procedure and Sample Size Determination**

Several reasons make sampling useful rather than complete enumeration. These include considerations regarding time, cost, available resources and practicability. Based on this, a multi-stage sampling procedure involving purposive selection of the zone is employed. According to their major climatic inclination of the Zone was categorized in to three major agro ecological zones, (high land-Dega, mid land-Woina dega and low land-Qola). Simple random selection is used to get three sample Kebeles namely Gudmo from *Wonsho*, Warra

from *Dalle* and *Bartu* from *Loka-Abaya Woreda*. Convenient sampling approach was used to select government officials, agricultural extension workers and experts from the study area. The focus group discussion participants-the elders, *kebeles* leadership and the religious leaders purposively selected. Finally, stratified and simple random techniques were used to select household heads. Thus, multi-stage sampling technique was used to select *Zone*, *Woredas*, *kebeles* and respondents stated under (figure 3.3).

At the first stage, *Sidama Zone* was selected purposely. Researcher personal experience in this *Zone* revealed that, the *Zone* needs to have detailed study document regarding climate variability and its impacts on small landholder farmers.

At the second stage, the *Zone* has three major agro-ecological zones and it was stratified into lowland (*kolla*), mid land (*woina dega*) and high land (*dega*).

At the third stage, from each agro-ecological zones covering three *Woredas* (one from *kolla*, one from *Woina dega* and one from *dega* zones) were selected by using simple random sampling technique to represent each agro-ecologic zone. In this study, household heads were the major units of analysis . Therefore, the populations of the study were the total household heads of the randomly selected *kebeles* of three *Woredas*.

At the fourth stage, sampling units (household heads) were selected by using systematic sampling method. From the sampling frame complete list of household heads in the three *kebeles* obtained from the *Woreda* Administration, Office of Finance and Economic Development and *kebeles* offices.

From total population of 2,885 household heads who are living in the three sample *kebeles*, 191 are selected using the simplified formula, which is provided by Yamane to calculate sample sizes. The formula is adopted to determine sample sizes of house hold heads with the desired precision level of  $\pm 7\%$ . (Yemane, 1967) (See equation 1 below).

Equation- 1

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

Where: n- is the sample size,

N- is the population size,

e- is the level of precision. So,

$$n = \frac{N}{1 + N(e)^2} = \frac{2885}{1 + 2885(0.07)^2} \approx 191$$

From a total of 2,885 (male=2,656, female=229) 191 (male=175, and female=16) household heads (92 (male=84, female=8) from *Warra kebele* of *Dalle Woreda*, 34 (male=31, female=3) from *Bartu kebele* of *Loka Abaya Woreda* and 65 (male=60, female=5) from *Gudumo kebele* of *Wonsho Woreda*). By using proportionate sampling, samples were randomly selected and participated in the survey sampling. A target of aforementioned households, from zone Agricultural Department 4 (2 from each) key respondents and from targeted *Woredas* 6 (2 from each) and at *kebele* level 6 (2 from each) agricultural workers and totally 191 participants were sampled and participated in the formal interview as indicated in the table below.

Table 3.1: Population and Sampling Technique

Name		Population	Sample sizes	Sampling Technique
<i>Woredas</i>	High land	6	1	Stratified Random Sampling
	Mid land	9	1	
	Low land	4	1	
<b>Total</b>		<b>19</b>	<b>3</b>	
No of <i>Kebeles</i> in	<i>Dalle Woreda</i>	36	1	Simple Random
	<i>Wonsho Woreda</i>	18	1	
	Loka Abayya	27	1	
	<b>Total</b>	<b>79</b>	<b>3</b>	
	Male	2656	175	
Households	Female	229	19	Systematic Sampling
	<b>Total</b>	<b>2885</b>	<b>191</b>	

Table 3.2: Population and Sample Size

Zone	Sample <i>Woredas</i>	Sample <i>Kebeles</i>	Populati on of <i>Kebeles</i>	Selected HHs		
				M	F	T
<b>Sidama</b>	<i>Wonsho</i> (Dega)	Gudmo	971	60	5	65
	<i>Dalle</i> (Woyne dega)	Warra	1,399	84	8	92
	Loka- Abaya (kola)	Bartu	515	31	3	34
	<b>Total</b>		<b>2,885</b>	<b>175</b>	<b>16</b>	<b>191</b>

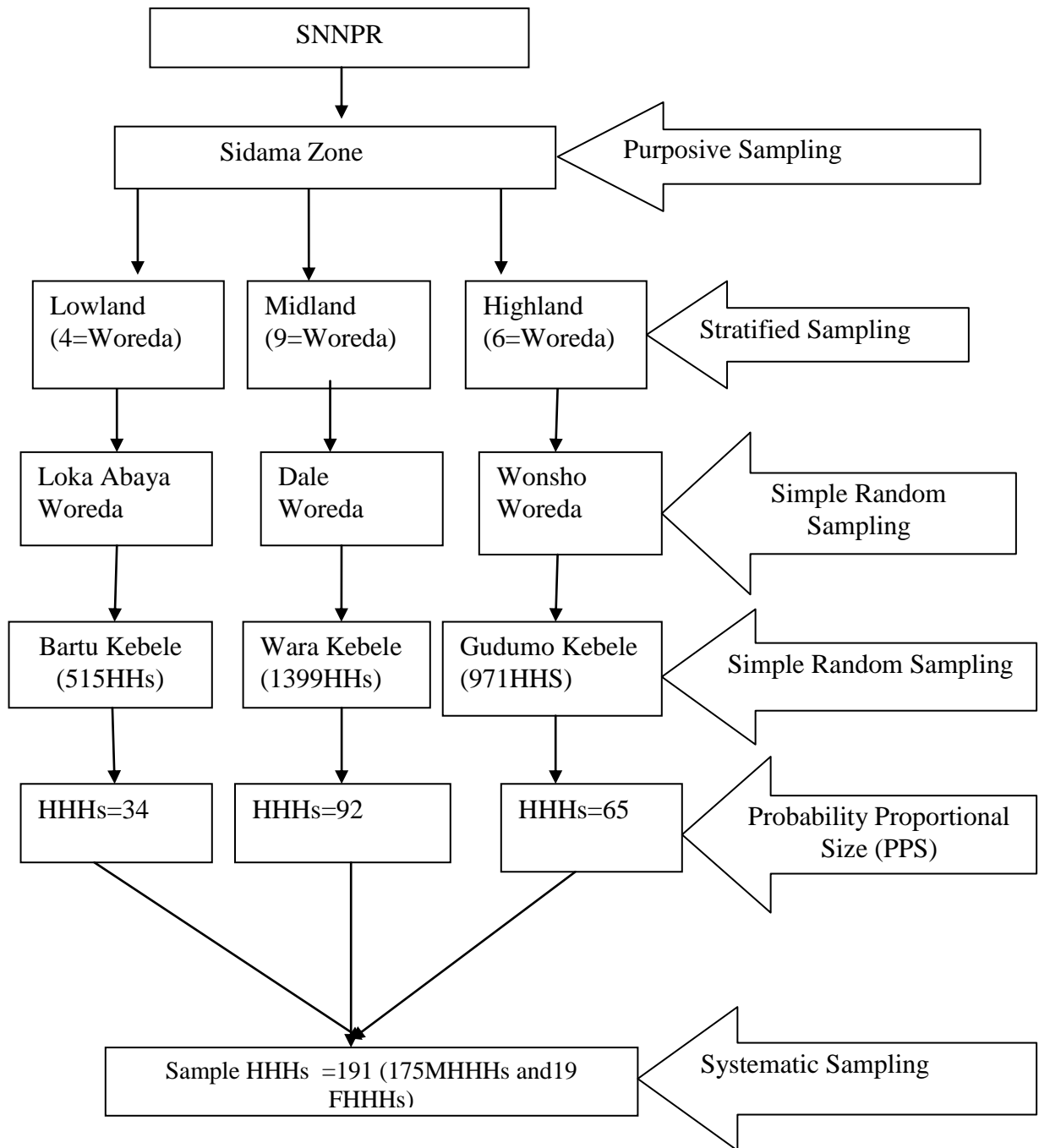


Figure 3.3 Sampling Procedure  
Source: Own Construction

### **3.3.2 Data Type and Data Sources**

Both primary and secondary data from different sources were collected for this study. Primary source of data was obtained from household heads, local level government and professionals working in the area of environment protection and agriculture using survey questionnaire, key informant interview and focus group discussion. Relevant secondary data was obtained from official documents.

### **3.4 Data Collection Instruments**

In this study, multiple approaches of data collection tools were used in order to obtain adequate information of both quantitative and qualitative nature. Thus, the desired information for the research were collected from participants through major and complementary instruments of data gathering, namely interview schedule.

#### **3.4.1 Questionnaire**

Interview schedule is the appropriate instrument to collect information about conditions from relatively large sample studies. In time of data collection. Interview schedule were considered as main sources of data gathering tool. Because, interview schedule are less expensive, offer greater freedom from identification of respondents and appropriate for collecting factual information (Kish, 1965). This justification made questionnaires more appropriate for this study. The interview schedule includes closed ended and open ended questions, semi structured interview schedules in English language and latter translated into Amharic and finally to local language (Sidamigna) which enables the enumerators and respondents to easily understand the questions, express their ideas comfortably and reduce communication barrier.

#### **3.4.2 Interview**

In this research, interview was chosen to be one of the information gathering instruments. Because, if it was conducted well, it can provide in-depth information which might not possible with a interview schedule. Besides, it is important to support and crosscheck the findings from the questionnaire. By its nature, it allows chance to explain the constructs for

further clarification and can be applied to any type of population (Best and Kahn, 2004). Therefore, check list was prepared and administered to collect reliable information in depth. The interview has enabled the researcher to capture and ascertain both subjective and objective factual information from the selected key informants.

### **3.4.3 Focus Group Discussions**

One focus group discussion was carried out in each kebele to clarify issues not fully covered by the interview schedule and to triangulate the data gathered from key informant interview. Focus Group Discussion was organized with the group composed of *kebele* leadership, household heads, elders, religious leaders, youths who are involved in agriculture, Development Agents, Health extension workers who serves farmers. It was conducted in each kebele administrations and involved nine participants. A guideline of issues check list was prepared to conduct discussions and allow participants to analyze their own experience.

### **3.4.4 Document Analysis**

Documents such as manuals, reports, policies, official statements, statistical data and agricultural tracts from sample *Kebeles*, *Woredas*, Sidama Zone, SNNPR and MoA agricultural yearly abstracts as secondary sources of information were employed to triangulate the findings.

### **3.5 Methods of Data Processing and Analysis**

Based on the nature of the data that were collected, the study has employed descriptive statistical tools like percentage, frequencies, mean values and cross tabulation. From the responses of the respondents, frequency tables were constructed, data tailed and grouped by using computer software (SPSS version 20). Thus, the resulting frequencies were computed and expressed as percentages. Qualitative data were analyzed in narration under some category in the tables that are relevant to the issues addressed through questions.

## CHAPTER FOUR

### 4 RESULTS AND DISCUSSION

This chapter deals with the major findings of the study. It presents background of the respondents and the responses given by them. Their responses have also been presented and analyzed in the subsequent sub-chapters as presented here after.

#### 4.1 General Background of Respondents

This section provides the descriptive results of the surveyed households' profile of sex, age, marital status, household size, educational status of household.

##### 4.1.1: Household Head Composition of Age, Sex and Marital Status

Table 4.1 Sex, Age and Marital Status of the Household Head

		<i>Name of the Woreda</i>			
		<i>Loka Abaya</i>	<i>Dalle</i>	<i>Wonsho</i>	<b>Total</b>
<b>Sex</b>	Male	31(17.7%)	84(48.0%)	60(34.3%)	<b>175(100.0%)</b>
	Female	3(18.8%)	8(50.0%)	5(31.2%)	<b>16(100.0%)</b>
	<b>Total</b>	<b>34(17.8%)</b>	<b>92(48.2%)</b>	<b>65(34.0%)</b>	<b>191(100.0%)</b>
<b>Age (in years)</b>					
<b>Age</b>	20-25	1 (9.1%)	5 (45.5%)	5 (45.5%)	<b>11 (100.0%)</b>
	26-30	6(18.8%)	16(50.0%)	10(31.2%)	<b>32(100.0%)</b>
	31-35	10(35.7%)	10(35.7%)	8(28.6%)	<b>28(100.0%)</b>
	36-40	5(16.1%)	19(61.3%)	7(22.6%)	<b>31(100.0%)</b>
	41-45	5(13.5%)	13(35.1%)	19(51.4%)	<b>37(100.0%)</b>
	46-50	4(23.5%)	8(47.1%)	5(29.4%)	<b>17(100.0%)</b>
	51-55	1(6.7%)	11(73.3%)	3(20.0%)	<b>15(100.0%)</b>
	56 and above	2(10.0%)	10(50.0%)	8(40.0%)	<b>20(100.0%)</b>
	<b>Total</b>	<b>34(17.8%)</b>	<b>92(48.2%)</b>	<b>65(34.0%)</b>	<b>191(100.0%)</b>
<b>Marital Status</b>	Married	33(97.1%)	88(95.7%)	65(100.0%)	<b>186(97.4%)</b>
	Widowed	0(0.0%)	2(2.2%)	0(0.0%)	<b>2(1.0%)</b>
	Divorced	0(0.0%)	1(1.1%)	0(0.0%)	<b>1(0.5%)</b>
	Separated	1(2.9%)	1(1.1%)	0(0.0%)	<b>2(1.0%)</b>
	<b>Total</b>	<b>34(100.0%)</b>	<b>92(100.0%)</b>	<b>65(100.0%)</b>	<b>191(100.0%)</b>

Source: Field Survey by the Author, 2014

Demographic variables such as population size and sex composition are important inputs in the process of socioeconomic development planning, where its ultimate goal is to improve the welfare of the people. From the survey of this study, age composition and distributions indicated that the percentage of age category of the respondent are 20-25(11%), 26-30(32%), 31-35(28%), 36-40(31%), 41-45(37%), 46-50(17%), 51-55(15%), and 56(20%). The population distribution was such that most of the sample household heads were between the age group of 41-45 and followed by 26-30 years, and 36-40 respectively. The least age category of sample household head were 20-25, average age of respondents was 38.2 year. In the survey, demographic information was collected for 175 men and 16 women, with men being more than women. So the sex composition of the sample population covered was 91.6% male and 8.4% female. While the survey results indicate that *Loka Abaya* has 17.7% male sample population, *Dalle* 48.0% and *Wonsho* 34.3%. *Dalle* had the highest female-headed household population accounted for 50.0%. In addition, from the surveyed households, about 97.4% of household heads were married, 1% widowed, 0.5% divorced, and 1% separated.

Table 4.2 Educational Status of the household heads

Name of the Woreda	Can't Read and Write	Can Read Write	1-4	5-8	9-10	11-12	Certificate	Diploma and above	Total
<i>Loka Abaya</i>	16(47.1%)	8(23.5%)	4(11.8%)	4(11.8)	1(2.9%)	0(0.0%)	1(2.9%)	0(0.0%)	<b>34(100.0%)</b>
<i>Dalle</i>	17(18.5%)	13(14.1%)	13(14.1%)	35(38.0%)	11(12.0%)	3(3.3%)	0(0.0%)	0(0.0%)	<b>92(100.0%)</b>
<i>Wonsho</i>	30(46.2%)	9(13.8%)	5(7.7%)	16(24.6%)	0(0.0%)	2(3.1%)	1(1.5%)	2(3.1%)	<b>65(100.0%)</b>
<b>Total</b>	<b>63(33.0%)</b>	<b>30(15.7%)</b>	<b>22(11.5%)</b>	<b>55(28.8%)</b>	<b>12(6.3%)</b>	<b>5(2.6%)</b>	<b>2(1.0%)</b>	<b>2(1.0%)</b>	<b>191(100.0%)</b>

Source: Field Survey by the Author, 2014

As Phillips (1994), stated that the level of education (years of schooling) of a rural household plays vital role in improving the productivity (both at individual and community level) by equipping people with the skills and knowledge to actively participate in the economic endeavours of the society and in promoting entrepreneurship.

Especially, level of education in drought prone areas has indispensable contribution to understand the lessons and training given by agricultural experts to adapt the impacts of climate variability. Therefore, an attempt was made to assess the educational level of the respondents and it was found that, of total sampled population, 33% of the respondents can't read and write while, the highest is in *Loka Abaya* (47.1%). About 15.7% of the total respondents were reported that they can read and write but have no formal education. The rate was highest in *Loka Abaya*, i.e., 23.5%, while it was 14.1% and 13.8% in *Dalle* and *Wonsho* respectively. Those who have primary education 1-4, and 5-8, were 11%, and 28.8%, correspondingly. On the other hand, secondary education was 8.9%. There is also significant difference between the three *Woredas* in secondary school attendance. Farmer's education has serious implication with regard to adoption of technologies and practices in agriculture in general and for adapting climate variability in particular

In contrary, who can read and write the survey data shown that highest in *Loka Abaya*, 23.5%, while it was 14.1% and 13.8% in *Dalle* and *Wonsho* respectively. Those who have primary education 1-4, and 5-8, were 11%, and 28.8%, correspondingly. On the other hand, secondary education was 8.9%. There is also difference between the three *Woredas* in secondary school attainment.

Table 4.3 Family Size of the Household Heads

Family Size	Distribution of respondents by <i>Woredas</i>			Total
	<i>Loka Abaya</i>	<i>Dalle</i>	<i>Wonsho</i>	
1 - 3	2(5.9%)	6(6.5%)	2(3.1%)	<b>10(5.2%)</b>
4 - 6	14(41.2%)	46(50.0%)	21(32.3%)	<b>81(42.4%)</b>
7 - 9	17(50.0%)	33(35.9%)	30(46.2%)	<b>80(41.9%)</b>
10 and above	1(2.9%)	7(7.6%)	12(18.5%)	<b>20(10.5%)</b>
<b>Total</b>	<b>34(100.0%)</b>	<b>92(100.0%)</b>	<b>65(100.0%)</b>	<b>191(100.0%)</b>
<b>Average Household Size</b>	<b>4.45</b>	<b>4.87</b>	<b>4.82</b>	<b>4.71</b>
<b>Unproductive</b>				
1-2	1(2.9%)	42(45.7%)	17(26.2%)	<b>60(31.4%)</b>
3-4	15(44.1%)	40(43.5%)	26(40.0%)	<b>81(42.4%)</b>
5-6	18(52.9%)	9(9.8%)	16(24.6%)	<b>43(22.5%)</b>
7 and above	0(0.0%)	1(1.1%)	6(9.2%)	<b>7(3.7%)</b>
<b>Total</b>	<b>34(100.0%)</b>	<b>92(100.0%)</b>	<b>65(100.0%)</b>	<b>191(100.0%)</b>
<b>Productive</b>				
1-2	21(61.8%)	27(29.3%)	19(29.2%)	<b>67(35.14%)</b>
3-4	12(35.3%)	35(38.0%)	28(43.1%)	<b>75(39.3%)</b>
5 and above	1(2.9%)	30(32.6%)	18(27.7%)	<b>49(25.7%)</b>
<b>Total</b>	<b>34(100.0%)</b>	<b>92(100.0%)</b>	<b>65(100.0%)</b>	<b>191(100.0%)</b>

Source: Field Survey by the Author, 2014

Family size or the numbers of permanent household members especially being productive and unproductive are one of the determinant factors in the agricultural productivity. According to the surveyed data, more than half of the sample households (84.3%) have 4-9 of which 42.4% have 4-6 and 41.9% have 7-9 family members. The small proportion of respondents, 5.2% have less than 4 family members. On the other hand, the number of unproductive members whose age is >14 and < 65age) accounts 64.9% and only 39.3% of family members being productive family members. This indicates that most of the households in the study area have large dependent family members and this adversely affects the productivity of the household. With regard to family size, the result of the study showed that, the average household size was 4.71. Hence, from this we can conclude that, the minimal difference in the mean household

size across the three *Woredas* with the smallest being for Loka Abbaya (4.45), and followed by Wonsho (4.82) and the biggest for Dalle (4.87). Table 4.3 indicated majority of the households' had 4 to 6 members.

## 4.2 Analysis of Productivity with Climate Variability

### 4.2.1 Status of Productivity Related to Climate Variability

If climate variability is happening, it has direct or indirect impact on life. The magnitude of its impact is high on the people that engaged on climate sensitive sectors like agriculture. Thus, those people can be familiar with the variability in their day-to-day activities. In addition to this, it is important to have an insight of local peoples view on temperature and rainfall trends of variability to dig out locally available climate variability and its adaptation mechanisms (UNFCCC, 2008).

Table 4.4 Effect related with Climate Variability

Indicators of the Effect	Climate Variability in <i>Woredas</i>			Total
	<i>Loka Abaya</i>	<i>Dalle</i>	<i>Wonsho</i>	
Decrease in rainfall amount	23(67.6%)	73(79.3%)	54(83.1%)	<b>150(78.5%)</b>
Decrease crop production	2(5.9%)	0(0.0%)	5(7.7%)	<b>7(3.7%)</b>
Decrease of Livestock production	20(58.8%)	0(0.0%)	3(4.6%)	<b>23(12.0%)</b>
Extinction of indigenous plants and crops	19(55.8%)	65(70.7%)	54(83.1%)	<b>138(72.2%)</b>
Decrease river volume	10(29.4%)	14(15.2%)	11(17%)	<b>35(18.3%)</b>
Drought	23(67.6%)	66(71.7%)	54(83.1%)	<b>143(74.9%)</b>
Temperature rise	26(76.5%)	79(85.9%)	54(83.1%)	<b>159(83.2%)</b>
Flood and soil erosion	14(41.2%)	34(37.0%)	20(30.8%)	<b>68(35.6%)</b>

Source: Field Survey by the Author, 2014

Key: Multiple answers were possible; Percentages calculated according to the persons interviewed does not add up to 100 percent.

This study attempted to identify farmer's feeling about the situation of rainfall, temperature and related issues. As evidence, some of the occurrences related with climate variability were stated in their order of severity.

As the above table 4.4 indicates that, temperature rise is the major problem related with climate variability that the majority respondents agreed. In addition, 76% of people from *Loka Abaya*, 85.9% from *Dalle* and 83.1% from *Wonsho* said there is temperature variability and again 67.6% of *Loka Abaya*, 79.3 % of *Dalle* and 83.1% of *Wonsho* respondents indicated that there is decrease in rainfall amount. Drought and extinction of indigenous plants and crops are also the other problems. Higher number of respondents from *Dega Woreda (Wonsho)* perceived increasing temperature. In addition, decrease of Livestock production is higher in *kola Woreda (Loka Abaya)*.

Inconsistency of rainfall in its intensity, time it comes and goes as well as the amount as well is one of the major indicators of climate variability. Accordingly, the entire households of sampled *Woredas* agreed that, there is shortage of rain and appearing gradually. In addition, they perceived that the temperature is increasing from time to time and became a cause to drought and extinction of indigenous plants and crops.

Participants of focus group discussion mentioned that, the duration of rain is decreasing but the intensity is increasing especially in *woina dega (Dalle)* and *kola (Loka Abaya) Woredas*. This results flood and soil erosion in some areas, which leads to declining of productivity. Generally, this all imply that the society perceive the climate is varying.

Climate variability brings different problems that directly affect the local people. These are food shortage, drought, and disease, decreasing productivity of the land, erosion and flood. Drought is repeatedly appearing problem in *Loka Abaya Woreda*. As elders from the area indicated, that at first severe drought was occurred in the 2001/02. As experts of *Woreda* office of agriculture informed, after the drought appeared in most parts of the Zone from 2001/02, the area became highly vulnerable to climate variability. The year 2001/02, was the time where the harshest famine occurred in most parts of the study area. The condition in the case of *kola Woreda's* of the study area was very much serious. Because of this, many livestock's have died due to drought. People were fled from their locality. The focus group interview participants support these ideas. In addition to this, 74.9% of the selected households confirmed that drought is a serious problem. This shows that, most of the respondents and the focus group participants from the sampled *Woredas* indicated that, there

is variability in duration of rainfall from the past ten years on wards. In addition to this, the respondents explained that, the increasing of temperature through time.

Generally, the main impacts of the drought in the *weredas* include crop damage, loss of pasture and water sources, loss of animals, food shortage, disease outbreak, asset depletion, malnutrition (particularly among the children) and migration of household members to other areas. The community perceived erratic and uneven distribution of rainfall and increasing temperature over time. In addition, the level of deforestation has been reported to be very high during the last two decades.

Metrological drought years can be other evidences to show the years that drought occurred. According to the definition of National Meteorological Service Agency of Ethiopia (1996) defines drought by using rainfall anomaly (the percentage deviation of annual and seasonal rainfall from the mean). Based on this, drought occur over a region if the negative anomaly from the mean seasonal rainfall 19% or more. The result is also classified as, 19%-21% less drought, 21%-25 moderate, and more than 25% sever.

The average minimum and maximum air temperature data for twenty five years (1986-2011) (Appendix 5,6) ranged from 11.7 (1986) to 28.3°C (2009), respectively. Temperature and rainfall are considered to be the two most important factors in the agriculture of the study area as further recognized by the traditional names used to describe their combined effects on the climate of the area.

The average annual temperature of the study area for the period 1986-2011 is 19.6<sup>0</sup>c. The warmest year was 2009 with an average annual temperature of 20.8<sup>0</sup>c. The coldest year was 1974 with an average annual temperature of 18.5<sup>0</sup>c. During most of the year average annual temperatures are relatively stable showing a remark between small degrees of variation from 2001 onwards.

The variance in average temperatures for each of the summer months of June, July and August is almost similar i.e. 19.6<sup>0</sup>c (June), 19<sup>0</sup>c (July) and 19.1<sup>0</sup>c (August) for the entire period under consideration (National Metrology Agency, 2011). However, temperature pattern for the three winter months of Dec, Jan and Feb. are slightly increased i.e. 18.6<sup>0</sup>c

(Dec), 19.4<sup>0</sup>c (Jan) and 20.5<sup>0</sup>c (Feb). As far as a 10 year moving average temperature is concerned, there are insignificant variations between themselves. As a result, the temperature trend line for the period 1986-2011 has an ups and down nature or an irregular slope due to a natural and anthropogenic factor during the indicated period.

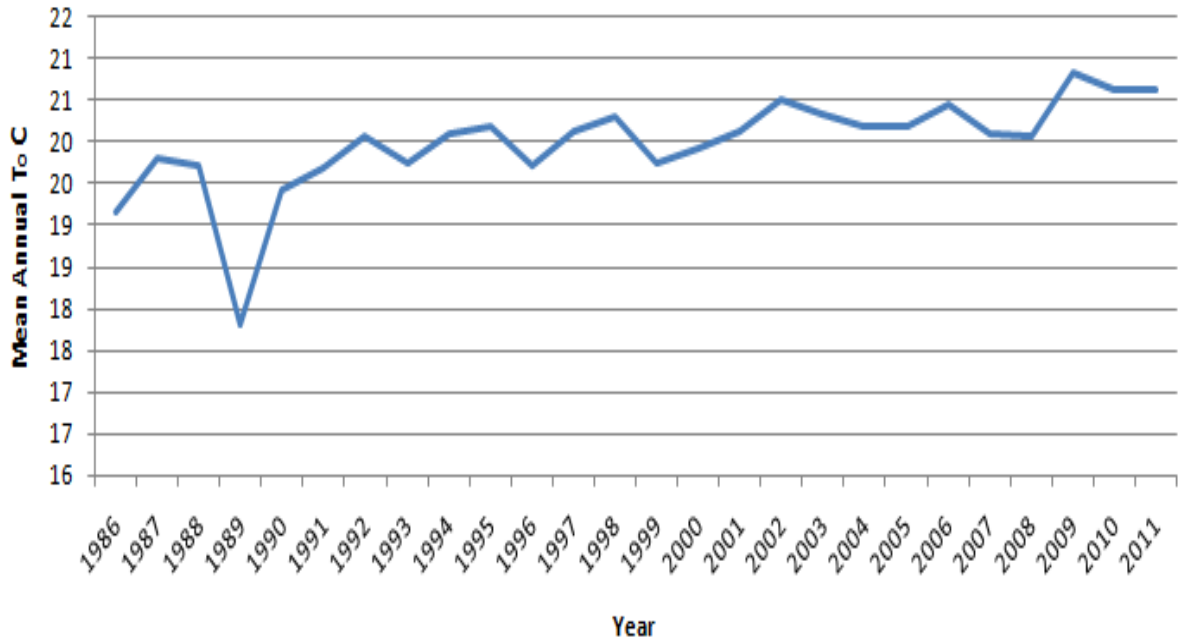


Figure 4.1 Annual Temperature pattern (1986-2011) of the Study Area

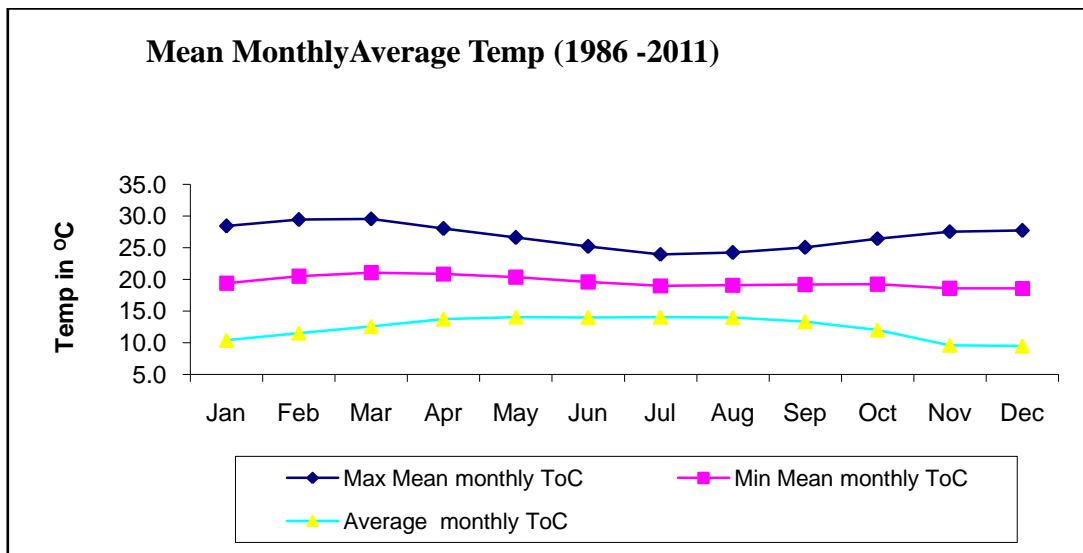


Figure 4.2 Monthly Temperature pattern (1986-2011) Study Area  
 Source: Ethiopian Meteorological Service Agency, Hawassa Branch Office, 2013/14

The weather data reported here is based on information from Hawassa Research center Station, which is the nearest station around the study area. The long-term (1986-2011) annual rainfall of the area is 1,794.5 mm on an average rainfall shows large seasonal variability. The area has a bimodal rainfall pattern, with the small rains occurring from October to March and the main rains from May to September. Based on the long-term data, more than 75% of the annual rainfall is received during the main rains, which is when cropping normally takes place. The highest rainfall was recorded in the year 1990 with 1442 mm, which has lower than the average and. the driest year was 2009 with only 704 mm. (Appendix 4). The small rains could sometimes be erratic but there is no cropping during this period, except it is important for softening the land, which will facilitate land preparation in addition to growth of some fluffy grasses for livestock. The annual rainfall range 702 to 1442 mm. (National Metrology Agency, 2011).

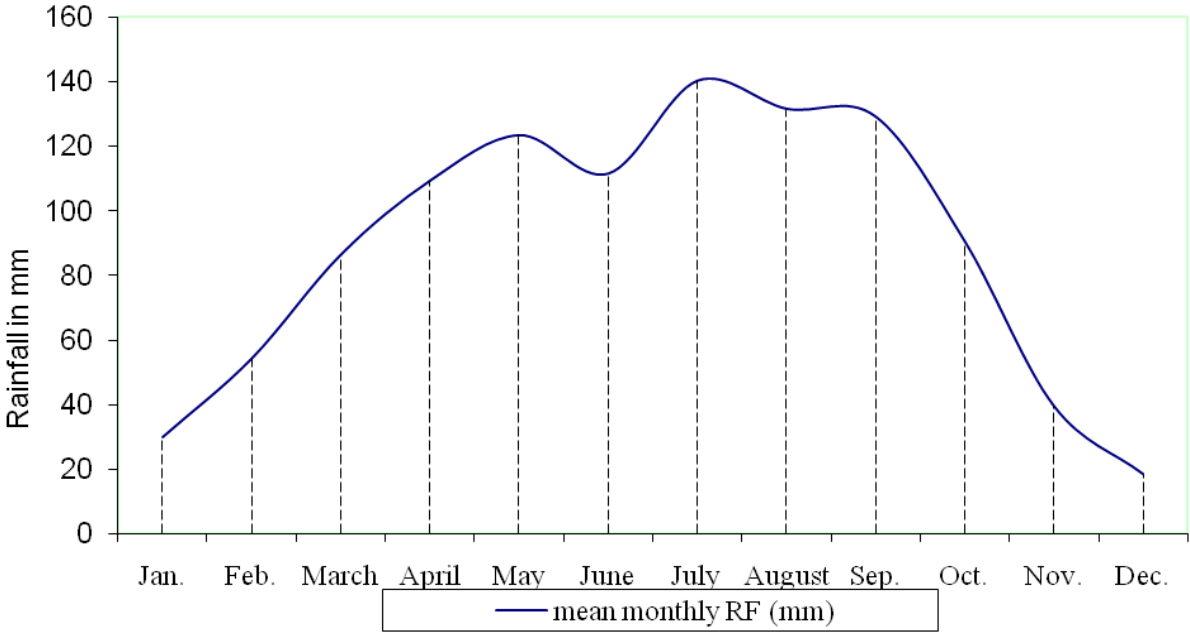


Figure 4.3 Annual Average Rainfall Pattern (1986-2011) of the Study Area  
 Source: Ethiopian Meteorological Service Agency, Hawassa Branch 2014

#### 4.2.2 Factors Affecting Productivity of Local People

Similar to the most of rural areas of Ethiopia, the source of income for most of the people of the study area (Sidama Zone) is agriculture mainly crop production and livestock rearing. Around 83.6% of the local people are engaged in crop production and livestock rearing as their main source of income. Whereas, 2.7% of the total sampled population are engaged on only livestock rearing and 13.7% earned their income only from crop production. Mixed agricultural system is dominantly practiced in the study area.

As mentioned earlier, the study area is characterized by erratic rainfall and frequent drought, as the result productivity of the area is being affected. This implies that climate variability of the area is affecting crop production. To understand the extent of its impact the respondents mention the factors affecting crop production. Hence, during drought and delay in the onset of rain land becomes dry and difficult to plough, forage deficit leads to weakness and oxen mortality (engine of subsistent cultivation), and lack of precipitation hinders seed cultivation and germination of cultivated seeds.

Table 4.5 Factors affecting crop production and livestock rearing

Factors		Vulnerability in Woredas		
		<i>Loka Abaya</i>	<i>Dalle</i>	<i>Wonsho</i>
<b>Physical</b>	Rain Shortage	17(24.3%)	41(58.6%)	14(20.0%)
	Pest Infection/Crop	16(22.9%)	19(27.1%)	15(21.4%)
	Intense Rain	6(8.6%)	9(12.9%)	8(11.4%)
	Soil Erosion and Lack of Soil Fertility	8(11.4%)	4(5.7%)	9(12.9%)
<b>Economic</b>	Shortage of Farm Land	4(5.7%)	24(34.3%)	19(27.1%)
	Lack of Oxen	4(5.7%)	6(8.5%)	3(4.3%)
	Lack of Agricultural Inputs	10(14.3%)	13(18.6%)	16(22.9%)
<b>Technology</b>	Rudimentary Farming Method	5(7.1%)	16(22.9%)	19(27.1%)

Source: Field Survey by the Author, 2014

Table 4.5, indicated the main factors that affect crop production and livestock rearing in the study *Woredas*. These factors are classified into three as physical, economic and technological factors influencing income for the local people.

#### **4.2.2.1 Physical Factors**

As shown in the table 4.5, most of the factors that influence crop production are physical factors. These include rain shortage, pest infection, soil erosion and lack of soil fertility and heavy or intense rain. All the respondents in three *Woredas* agreed that shortage of rain is the most severe problem that affects crop production, which is followed by pest infection.

This implies that, shortening of rainy season and intense rain, which are the result of the changing climate are the major problems in the *Woredas* crop cultivation. The beginning and end of the summer (kiremit) is changing from year to year. As confirmed by the participants of FGD that before last ten years, rainfall begins at around April and may ends at end of October and beginning of November. Now the situation is changed and the rainfall begins in July and ends in the half of September. Thus, the households support this idea. All of them indicate that since the past ten years the situation is worsened from time to time. This situation is affecting crop production which most of the livelihoods of the people depends on. As the office of agriculture of the *Loka Abaya Woreda* indicates that before ten years the area was known for its *teff*, *maize*, *haricot bean* and honey production. *Dalle Woreda* is dominantly produce coffee, *enset*, *maize* and *haricot bean*. Similarly, *Wonsho Woreda* office of agriculture pointed out that coffee, barley, wheat and beans were dominantly produced. However, at this time, because of the fluctuation of rainfall, the farmers have been forced to produce short season crop types. Hence, the types of crops produced at this time are early maturing *teff*, *haricot bean*, and others as indicated by the participants of FGD from *Loka Abaya Woreda*. The amount of yield per household is also significantly decreasing during the past ten years due to the decreasing land holding size of the households (Office of agriculture of the study area, 2014).

Pest infection is the other major problem in the *Woreda* particularly in *Kola Woredas*. The disturbance made on the ecosystem has forced the non-pest insects to become crop pests and

transformed in to devastating agents of crop loss. The combined effect of these factors have resulted a sever crop yield reduction. Consequently, this has induced shortage of food crop and income and hence they became destitute.

#### **4.2.2.2 Economical and Technological Factors**

The other factors that influence crop production in the *Woredas* were shortage of farmland, lack of oxen, lack of agricultural inputs and rudimentary farming method. Most of these are related to economical status of the local people. Therefore, household heads who face the problems such as shortage of oxen, farmland and inability to buy agricultural inputs are highly vulnerable to shortage of food crops. Technologically, the method that the farmers used influences the amount of the yield. These means as the method modified the yield increased and vice versa. Generally, these all factors directly aggravate the people's vulnerability to the impacts of climate variability.

### **4.3 Vulnerability to Climate Variability**

#### **4.3.1 Socio-economic Features of the Households and Vulnerability**

Since the impacts of climate variability are affecting the environmental system and the livelihood of the local people, the area is biophysically vulnerable. In other words, the *Woredas* are negatively sensitive to climate variability impacts. Then, in this part, the socio economic status of the local people is assessed to show the adaptive capacity of the society.

The adaptive capacity in this study includes economic conditions of the households, the situations of major infrastructures and the mechanisms that the local people used to adapt or cope with the changing climate.

#### **4.3.2 Economic conditions of the local people**

##### **4.3.2.1 Income**

Generally, because of traditional beliefs and norms, it is difficult to get information about income and number of children in Ethiopia and particularly in the study area. However, to assess the economic status of the respondents, different related questions such as income, land holding, livestock are asked.

The average monthly income of the households is classified into four based on the response from the HHs. These are very low with less than 1200 birr per year, low (1200-2400 birr) per year, average (2401-3600 birr) per year and relatively better (3601-4800 birr) per year.

Table 4.6 Annual Income of House hold Heads per year

Income In Birr	Annual Income status by Woredas			Total
	<i>Loka Abaya</i>	<i>Dalle</i>	<i>Wonsho</i>	
< 1200(Very Low)	8(23.5%)	25(27.2%)	30(46.2%)	<b>63(100.0%)</b>
1200-2400 (Low)	12(35.3%)	36(39.1%)	25(38.5%)	<b>73((100.0%))</b>
2401- 3600 (Average)	8(23.5%)	21(22.8%)	6(9.2%)	<b>35(100.0%)</b>
3601-4800 (Relatively Better)	6(17.6%)	10(10.9%)	4(6.2%)	<b>20(100.0%)</b>
<b>Total</b>	<b>34(10.0%)</b>	<b>92(100.0%)</b>	<b>65(100.0%)</b>	<b>191(100.0%)</b>

Source: Field Survey by the Author, 2014

Based on this classification, 23.5% from *Loka Abaya*, 27.2% from *Dalle* and 46.2% from *Wonsho* get very low income. The highest number of the respondents that is 35.3% of *Loka Abaya*, 39.1% of *Dalle* and 38.5% of *Wonsho* are categorized as low. 23.5% of *Loka Abaya*, 22.8% of *Dalle* and 9.2% of *Wonsho* categorized as average income households. The households categorized in relatively better income are very few or insignificant compared to others that is only 6.2% are found in *Wonsho*.

Most of the people are in the income category of low and very low. This indicates that they are highly needy and easily affected by natural problems. In general, as the information from the FGD, the proportion of income among the sampled population has declined significantly, while the share of low and very low households has been increasing during the last ten years.

Table 4.7 Supplementary mechanism of the household to sustain their family

<b>Responses of the respondents</b>	<b>Level of income to sustain their family throughout the year</b>			
	<b>Loka Abaya</b>	<b>Dale</b>	<b>Wonsho</b>	<b>Total</b>
Enough	3(8.8%)	13(14.1%)	15(23.1%)	31(16.2)
Not enough	31(91.2%)	79(85.9%)	50(76.9%)	160(83.8%)
<b>Total</b>	<b>34(100.0%)</b>	<b>92(100.0%)</b>	<b>65(100.0%)</b>	<b>191(100.0%)</b>
<b>If not enough what do you do to supplement it and sustain your family</b>				
Borrow money or grain	4(12.9%)	9(11.4%)	15(30.0%)	<b>28(17.5%)</b>
Move to other places (migrate)	10(32.3%)	6(7.6%)	7(14.0%)	<b>23(14.4%)</b>
Sell fixed assets	3(9.7%)	47(59.5%)	5(10.0%)	<b>55(34.4%)</b>
Sell livestock	10(32.3%)	14(17.7%)	20 (40.0%)	<b>44(27.5%)</b>
Borrow money, grain and sell fixed assets	4(12.9%)	3(3.8%)	3(6.0%)	<b>10(6.3%)</b>
<b>Total</b>	<b>31(100.0%)</b>	<b>79(100.0%)</b>	<b>50(100.0%)</b>	<b>160(100.0%)</b>

Source: Field Survey by the Author, 2014

There are multiple drivers of food insecurity in Ethiopia—including drought risk, environmental degradation, demographic pressure, rural-urban migration and conflict. In the absence of adaptation measures, climate variability and change act as risk multipliers, aggravating the conditions, which affect food security trends (FAO/WFP, 2012).

If the income can't sufficiently feed the household for the whole year, then the household will be in dangerous situation. That means its adaptive capacity is very low. In this case, the household become vulnerable to any risk such as climate variability and drought. As indicated on table 4.7, 91.2% respondents from *Kebeles* of *Loka Abaya*, 85.9% from *Kebele* of *Dalle Woreda* and 76.9% respondents from *Kebele* of *Wonsho* stated that, their income is not enough to sustain their family all year round. Whereas, only the rest 8.8%, 14.1% and 23.1% from the three *Kebeles* of targeted study areas can sustain their family with income the whole year. Even there is slight difference among *Kebeles* of the *Woreda* from this; one can understand that, in almost all households, it is very difficult to pass the whole year by their

own production. On the other hand, as indicated in table 4.7, the respondents depicted that 32.3% can sustain their family life through migrating to the other places and selling of livestock from *Kebele of Loka Abaya*, 59.9% by selling fixed assets *Kebele of Dalle* and 40% of the respondents by selling of livestock to sustain their family life from *Kebele of Wonsho Woreda*. Furthermore, as the information from both FGD participants of all *kebeles* confirmed, people that have additional income source other than crop production, can live better life than those fully dependant on crop production.

In addition to this, from the responses of the respondents, to the open-ended questions for how many months they sufficiently feed their family from their own production. The answers from the respondents showed that almost all could feed only for four to seven months. Hence, one can deduce that there is food insecurity the study area. FAO/WFP reveal similar results: an estimated 7.6 million (or 11 per cent of the rural population) are considered chronically food insecure, meaning each year they are relying on resource transfers to meet their minimal food requirements. Over the past four years between 2.2 and 6.4 million additional people were food-insecure or not able to meet their food needs in the short term due to transitional factors. They are temporarily dependent on relief food assistance (FAO/WFP, 2012).

It is observed that, the households of *Kebele's* of sampled *Woredas* are vulnerable to the impacts of climate variability. However, still there is a difference on the capacity to adapt those impacts among the households. Therefore, some socio economic indicators are selected to expose who the most vulnerable is/are. In this study, income, livestock, family size, age and sex are chosen to assess the rate of vulnerability. On top of this, the poor people with low income, no oxen, no land & livestock, and large family size are chosen as most vulnerable group.

Based on their weight or contribution to the local people vulnerability, the researcher has categorized indicators in to two groups. These are high-level indicators and medium level indicators of vulnerability, based on the content of the situation of the *Kebele's* of sampled *Woredas*. Thus, monthly incomes, family size, availability of land are high level indicators of vulnerability. Whereas, household head (female, old), livestock, additional source of income are medium level indicators of vulnerability.

Table 4.8 Land holding of Household Heads

Item		Distribution of respondents by <i>Woredas</i>		
		<i>Loka Abaya</i>	<i>Dalle</i>	<i>Wonsha</i>
Own Land	Yes	34(100.0%)	92(100.0%)	65(100.0%)
	No	0(0.00%)	0(0.00%)	0(0.00%)
<b>Total</b>		<b>34(100.0%)</b>	<b>92(100.0%)</b>	<b>65(100.0%)</b>
Land in hectare (timad)	0.125 hectare ( $\frac{1}{2}$ timad)	3(8.8%)	13(14.1%)	9(13.8%)
	0.25 hectare (1 timad)	2(5.9%)	29(31.5%)	25(38.5%)
	0.5 hectare (2 timad)	9(26.5%)	28(30.4%)	12(18.5%)
	0.75 hectare (3 timad)	2(5.9%)	5(5.4%)	2(3.1%)
	1 hectare (4 timad) and above	18(52.8%)	17(18.4%)	17(26.1%)
<b>Total</b>		<b>34(100.0%)</b>	<b>92(100.0%)</b>	<b>65(100.0%)</b>

Source: Field Survey by the Author, 2014

#### 4.3.2.2 Land holding and Fertility

As shown in table 4.8, 100% of respondents from *Loka Abaya*, 100% from *Dalle* and 100% of respondents from *Wonsho* have their own land of different size. The proportion of the land size in *Loka Abaya* is higher than *Dalle* and *Wonsho*. Out of sampled population in *Loka Abaya* have one and above hectare rather than *Dalle* and *Wonsho*, the high percentage is between 1-2 hectare of land in *Loka Abaya*. In contrast, the smallest land holding that is from 0.125 hectare to 0.5 hectare that accounts 7.4%, 36.6% and 24.1% in *Loka Abaya*, *Dalle* and *Wonsho* respectively. As replied by the respondents that the trends of possessing the land from government redistribution, share from parents and inheritance accounts 4%, 90.6%, 5.8% and 1.6% respectively. Majority of respondents have possessed land from their parents in the study area. On the other hand, the trend of the land holding during the last ten years in the study area was decreased due to sharing for their son and long time contract.

Table 4.9 Household Source of Income (Livestock)

Livestock Type	Distribution of Respondents by <i>Woredas</i>						Total	
	<i>Loka Abaya</i>		<i>Dalle</i>		<i>Wonsho</i>		2002	2014
	2002	2014	2002	2014	2002	2014		
Oxen, Bull	89(10.8%)	27(6.3%)	169(23.1%)	74(12.6%)	124(9.9%)	63(7.8%)	<b>382(13.6%)</b>	<b>164(9.0%)</b>
Cow, Heifers, Calves	421(51.1%)	157(36.8%)	251(34.1%)	112(19.1%)	373(29.8%)	224(27.7%)	<b>1045(37.2%)</b>	<b>493(27.0%)</b>
Donkeys	4(0.5%)	3(0.7%)	15(2.1%)	23(3.9%)	21(1.7%)	37(4.6%)	<b>40(1.4%)</b>	<b>63(3.5%)</b>
Horses	14(1.7%)	5(1.2%)	9(1.2%)	11(1.9%)	5(0.4%)	15(1.9%)	<b>28(1.0%)</b>	<b>31(1.7%)</b>
Sheep	185(2.5%)	52(12.2%)	23(3.1%)	15(2.6%)	103(8.2%)	52(6.4%)	<b>311(11.1%)</b>	<b>119(6.5%)</b>
Goats	29(3.5%)	61(14.3%)	52(7.1%)	31(5.3%)	23(1.8%)	37(4.6%)	<b>104(3.7%)</b>	<b>129(7.1%)</b>
Chicken	82(10.0%)	122(28.6%)	212(29.0%)	321(54.7%)	604(48.2%)	381(47.1%)	<b>898(32.0%)</b>	<b>824(45.2%)</b>
<b>Total</b>	<b>824(29.4%)</b>	<b>427(23.4%)</b>	<b>731(26.0%)</b>	<b>587(32.2%)</b>	<b>1253(44.6%)</b>	<b>809(44.4%)</b>	<b>2808(100.0%)</b>	<b>1823(100.0)</b>

Source: Field Survey by the Author, 2014

Most of the households used livestock as the source of income, in addition to crop cultivation. Both in *Kola Woreda*(*Loka Abaya*) and *Dega Woreda* (*Wonsho*) the number of livestock in the past ten year declined from 29.4% to 23.4% and 44.6% to 44.4% respectively. Whereas, the number of livestock in *Woina Dega* (*Dalle*) *Woreda* seems slightly increasing from 26.0% to 32.2% due to the number of chickens increase. As comparing the *Dega Woreda's* with other sampled *Woredas* the people who live in *Dega Woreda's* more used livestock and its products more as shown on table 4.9 above. The result of this study showed that the number of live stock decreases from time to time due to rainfall shortage which results in decreasing of animal feeding and land holding size.

The types of the livestock found in the sampled *Woredas* are oxen, cow, sheep, goat, donkey, horses and chickens. The proportion of these animals in three *Kebeles* of the sampled *Woredas* from the entire farmers that have livestock 9.0% have oxen, 27.0% cow, 6.5% sheep, 7.1% goat, 45.2% chickens, 1.7% horse and 3.5% donkey. Most of the farmers have chickens and cow. In addition to this, the goat and chickens production is increasing in the area that may relate with the desertification. Even if we looked at the *Dega Woreda Kebele's* *i.e Gudumo of Wonsho* the number of goats increases slightly from 1.8% to 4.6%. This indicates that, one of the adaptations mechanisms to climate variability.

As the information from FGD indicates that before last ten years, the *Loka Abaya Woreda Kebele* was known for production of cattle, but now because of deforestation and expanding of population, the production of cattle is minimal. Landholding size is decreasing which leads to shortage of animal feeding. Hence, most of the farmers were highly engaged in goats raring than cattle. The livestock with the largest number that can easily be produced is chickens. Minimum and maximum number of chickens in one household is 0 and 18 respectively, and in most of the households, in average, there are 3.6 Chickens.

In the three sampled *Kebeles* of the *Woreda*, the maximum number of oxen is 6, cow 10, and Sheep 5, goats 4 and donkey 2 per households and the minimum is zero. In most households, there are one ox, two cows and four goats. The maximum number of sheep is 5 and mostly three sheep are found per household. In general, in the sampled *Woredas* the number of livestock available in each household is very few in number and less productive, which cannot give much support on the livelihood.

Table 4.10 Indicators of Vulnerable Groups

Level of indicator's	Indicator's of Vulnerability	Distribution of Respondents by Woreda			Total	Cum %
		<i>Loka Abaya</i>	<i>Dalle</i>	<i>Wonsho</i>		
High	Large family size	18(18%)	40(40%)	42(42.0%)	<b>100(19.0%)</b>	
	Low Monthly income	28(19.4%)	61(42.4%)	55(32.2%)	<b>144(27.3%)</b>	
	Less land holding	14(10.8%)	70(53.8%)	46(35.4%)	<b>130(24.7%)</b>	<b>71.0%</b>
Medium	Elder house hold heads and children	2(10.0%)	10(50.0%)	8(40.0%)	<b>20(3.8%)</b>	
	Female house hold heads	3(18.8%)	8(50.0%)	5(31.3%)	<b>16(3.0%)</b>	
	Less number of livestock	9(18.4%)	25(51.0%)	15(30.6%)	<b>49(9.3%)</b>	
	Less additional source of income	20(29.4%)	35(51.3%)	13(19.1%)	<b>68(12.9%)</b>	<b>29.0%</b>

Source: Field Survey by the Author, 2014

As shown in the table 4.10, on average 27.3% of the respondent from all *Kebeles* of the *Woredas* have low monthly income, 24.7% are less landholding and 19.0% of them have large family size. This pointed out that people with low monthly income, less landholding and large family size are highly vulnerable groups to climate shocks in the study area. In addition 12.9% are less additional source of income, 9.3% have less number of livestock, 3.8% old aged house hold headed and 3.0% of them are female household headed are vulnerable to climate variability with medium level indicators.

### 4.3.3 Poor

As all participants of FGD are suggested, economically poor people are the first vulnerable bodies. The average monthly income, physical assets and availability of additional income source determine the wealth of the household in this study. If people have no additional income and cannot sustain their family life, they are more vulnerable. As a result, most of them are categorized as poor and they have very low capabilities to respond to the impact of climate change or have low adaptive capacity. Specially, those who do not have additional

source of income, with large family size are the most vulnerable ones. These are because they cannot afford the consuming costs with only crop production or animal rearing in the fluctuating rainfall.

#### **4.3.4 Availability of Land and Ox**

As crop production is the major source of income, availability of land and ox are the backbone of the household's life. As the respondents indicated that, most of them have no their own oxen to plough and less land holding. This may be due to population increase and lack of income or subsistent living style of the local people. Therefore, these people are as the most vulnerable households in the targeted *Woredas*.

#### **4.3.5 Female Headed House hold and Old aged**

Traditionally women are dependent on income generated by men and they do not engage in plugging and other activities that need strength. However, in case of death of the husband and divorce the woman takes all responsibility of taking care of household. Specially, if they are land less and have many dependants, the situation become difficult and they face socio-economic pains of the situations. Therefore, in most cases female-headed households are more vulnerable than male-headed households are. The same is true in the house with old aged household head and have support. If the household head become very old and if there is no elder to support, the household will vulnerable to lack of labour.

#### **4.4 Copping and Adaptation Mechanisms**

Climate is one of the main factors resulting vulnerability; households across most of Ethiopia consider lack of (or erratic) rainfall to be the main risk they face. This is especially the case in the South-Eastern, South-central, and Eastern parts of the country, where rainfall is both decreasing and becoming more erratic (FAO/WFP, 2012). Hence, countries with limited economic development and those who rely on rain-fed agriculture in the form of subsistence farming or livestock rearing are more vulnerable to the impacts of climate change. Drastic changes in ecosystems could have a rapid impact on the livelihoods of local communities that rely on poor livelihood standards. Even if the capacity differs from country to country, from region to region and from *woreda* to *Woreda* due to the nature of the area and development,

people are working to minimize the influence by adapting and coping. Hence, as *Sidama Zone* is one of the exposed areas for climate variability, there are different local and institutional adaptive and coping mechanisms.

Table 4.11 Adaptation and Copping Mechanism

Copping Mechanism	Distribution of Respondents by <i>Woredas</i>			Total
	Loka Abaya	Dale	Wonsho	
Sales of livestock	24(24.7%)	31(32.0%)	42(43.3%)	<b>96(13.1%)</b>
Sales of fixed assets other than livestock	15(19.0%)	47(59.5%)	17(21.5%)	<b>79(10.7%)</b>
Sale of charcoal	10(100%)	0(0.0%)	0(0.0%)	<b>10(1.4%)</b>
Sale of fire wood	14(21.9%)	31(48.4%)	19(29.7%)	<b>64(8.7%)</b>
Donkey and horse cart service	8(17.4%)	19(41.3%)	19(41.3%)	<b>46(6.2%)</b>
Soil and water conservation	25(30.9%)	29(35.8%)	27(33.3%)	<b>81(11.0%)</b>
Petty trade	6(19.4%)	20(64.5%)	5(16.1%)	<b>31(4.2%)</b>
Migrant labour	5(33.3%)	10(66.7%)	0(0.0%)	<b>15(2.0%)</b>
Motor bicycle service/rent	2(28.6%)	3(42.0%)	2(28.6%)	<b>7(0.9%)</b>
Growing short seasons Crops	7(17.1%)	21(51.2%)	13(31.7%)	<b>41(5.5%)</b>
Supplying agricultural inputs	28(21.4%)	82(62.6%)	21(16.0%)	<b>131(17.7%)</b>
Irrigation	0(0.0%)	18(52.9%)	16(47.1%)	<b>34(4.6%)</b>

Source: Field Survey by the Author, 2014

*Key:* Multiple answer were possible; Percentages calculated according to the persons interviewed does not add up to 100 percent

#### 4.4.1 Local Adaptation and Copping Strategies

Communities use a variety of coping mechanisms, for deal with erratic rainfall and drought. The most widespread coping mechanism, as the responses of respondents, households in the study area depend on livestock sales, selling fixed assets and migration during shocks. This is particularly the case in the *Kebele's* of *Dega Woreda* where livestock selling, which accounts

43.3%, in the case of *Kebele of Dalle* migrant labour and selling of fixed assets and which accounts 66.7% and 59.5% respectively. In case of *Kebele of Loka Abaya* migrant labour accounting 33.3% is dominant during a shocking years.

In addition to this, extra firewood sales and petty trade are common coping strategies in the study area to better cope with erratic rainfall and drought risk. As depicted on the open-ended questionnaire, some farmers have planted improved varieties of crops adapted to moisture-deficit conditions and have diversified into high-value crops like *teff*, *haricot bean*. These cash crops are sold for higher prices at markets. Apart from farming, some agro-pastoral communities also raise small ruminants and chickens to compensate for decreasing livestock population owing to climate risks. The negative effects of erratic precipitation might have been countered by adaptation measures taken by vulnerable populations, such as shifting away from their traditional livelihoods. Some communities have gradually changed their choice of crops or planting dates, while others have migrated from vulnerable areas. There is also a shift in animal husbandry in different parts of the areas. Some farmers, for instance, shifted their form of animal husbandry from open grazing system to tethered feeding with collected and conserved crop residues as a response to the diminishing grazing resource due to both climate extremes and man-made environmental degradation.

#### **4.4.2 Institutional Coping Mechanism**

Climate risk, particularly droughts and floods, affects livelihoods and exacerbates environmental degradation, poverty, and food insecurity. Policies to tackle risks at different spatial scales are required to manage the negative impacts of climate on livelihoods and food security. Hence, a number of coping strategies are taking place by the respondents to address climate risk impacts:

**Modifying farming techniques:** Farmers are using early maturing and drought-tolerant crops.

**Undertaking soil and water conservation/management practices:** The government and non-governmental organizations in the past 5 to 10 years, have worked with communities to conserve forests and to introduce tree species adapted to arid and semi-arid conditions. Residents are participating in soil and water conservation. Some food insecure households with few options are collecting and selling fragrant woods to generate income.

#### **4.4.3 Mainstreaming Climate Risk Management into Development and Food Security Strategies**

One of the key messages of this analysis is that impact of climate variability to less productivity or hunger risk multiplier, aggravating current vulnerability trends. As such, it is difficult to isolate climate impacts from food insecurity. Therefore, managing climate risk should not take place in isolation but should be integrated into broader disaster risk reduction strategies, development plans, food security and poverty reduction strategies, and national adaptation plans. Integrating climate risk management structures into broader development pathways offers a cost-effective manner of addressing multiple development challenges, while accounting for the emerging risks posed by climate variability and change.

#### **4.4.4 Environmental Rehabilitation**

As *Woreda* and *Zonal* agricultural office and department key informant interviewee explained soil and water conservation activities are crucial for stabilizing the equilibrium of the environment, preventing run-off and reversing the considerable loss of soil fertility in the watersheds. This in turn gives rise to agricultural productivity in treated areas. Massive natural resources rehabilitation on degraded farmland and grazing areas has been implemented using different Soil and Water Conservation techniques to reduce soil erosion and increase vegetation cover. Some of the interventions made by the *Woredas* Office of Agriculture to cope with the climate change and variability were:

- a) Construction of water-harvesting check dams, construction of fords and different type of terraces,
- b) Soil and Water Conservation on farms, in back yards and on communal land,
- c) Enclosure of degraded communal areas in order to rehabilitate the land and regenerate the natural forest.

The area enclosure aims at stabilizing the soil, natural regeneration of the vegetation, and reduces erosion, which damages the farmland.

#### **4.4.5 Adaptation with Water/Rain Water Harvesting**

Climate change adaptation for agricultural cropping systems requires a higher resilience against both excess of water (due to high intensity rainfall) and lack of water (due to extended drought periods). A key element to respond to both problems is soil organic matter, which improves and stabilizes the soil structure so that the soils can absorb higher amounts of water without causing surface run off which could result in soil erosion and further downstream, in flooding. Soil organic matter also improves the water absorption capacity of the soil during extended drought.

At present, almost all of the rural people rely entirely on rain-fed agriculture (crop and livestock production). Rainwater harvesting is necessary and it is good adaptation method or option in alleviating effects of recurrent drought and food crisis in the region.

As adaptation alternatives to address the impacts of variability change in the study area use of available rainwater through different harvesting techniques, including floodwater diversion, on farm runoff retention, soil moisture conservation and impounding in storage structures were implemented by the *Woredas* office of agriculture. This option focuses on harvesting and utilizing as much rainwater as possible and making maximum use of it to increase production and productivity of the land. The *Woredas* office of agriculture believes small-scale irrigation intervention to be a climate variability proofing/adaptation strategy in the study area (FGD).

Accordingly, in an effort to address the problems of recurring climate variability conditions and food insecurity, the *Woredas* office of agriculture engaged in variety of water harvesting programs to supplement the rain fed agriculture and there by address drought and food shortages.

At the time of this field survey, what were observed were involving irrigation activities at *Dalle* and *Loka Abaya* runoff diversion to farm lands and run off storage for supplementary irrigation was also part of the adaptation strategy in areas of moisture deficit. Some farmers also use water pumps to produce vegetables, cereals and pulses. Water harvesting is considered as a single most important means to increase productivity and adapt the impacts of climate change.

#### **4.4.6 Adaptation with Livestock Feed**

The *Woredas* Office of agriculture is trying to protect pasture land from overgrazing through a variety of management measures. They try to introduce a rotation system whereby while one part of the pasture is used another part is closed to grazing to allow the grass to recover. Attempts have also been made to introduce high yielding varieties of grass like alpha-alpha and lab-lab. Even though all these efforts are there, attitudinal, information and skill gaps as well as shortage of technological inputs supply are the challenges to achieve the desired results.

## CHAPTER FIVE

### 5 Conclusion and Recommendations

#### 5.1 Summary and Conclusion

##### 5.1.1 Summary

A large segment of population in Ethiopia are chronically and seasonally food insecure at household level because of recurrent drought. Climate variability goes hand-in-hand with poverty, drought which results to unreliable rainfall conditions and temperature. The complex nature of climate in the study area took many lives; which also entails loss of assets in the form of crops, livestock, and productive capacity was damaged as a direct consequence of water shortages and pasture degradation. As of all these factors the lives of thousands of people has been threatened.

The study employed was targeted to assess the impact of climate variability on farmers' productivity in Sidama Zone. The main findings of the research are summarized below.

**Climate variability:** As to the statistical results and farmers perception on climate condition, the study area has had shown changes in rainfall and temperature patterns. The rainfall pattern of the study area has become erratic through time and expected to continue decreasing in the future. On the contrary, in general and the targeted zone in particular, temperature pattern has shown an increasing trend and expected to increase in the coming future also. In the coming decades, climate variability will have a major impact on crop and livestock production and on biophysical and human environments.

**Indicators on climate variability:** The findings of the study revealed that uncertainty in climate, decrease in rainfall amount, and extinction of the availability of indigenous crops and vegetation as the major indicators of climate change and variability.

**Vulnerability to climate change:** The magnitude of vulnerability to climate variability is quite different at household level, different age group, and wealth and landholding of the community. Thus, the result of the study indicates, female-headed households, elders and children and landless peoples were found more vulnerable to climate variability. As to the

respondents justification females headed households' vulnerability to climate change was found higher. This is because women were engaged in too many tasks as compared to other segments of the society.

**Impact of climate variability:** According to the findings from the study climate variability has resulted in impact on different sectors. The major impacts were on crop and livestock production. Because of the variability in rainfall amount in the past 10 years, higher rate of variation in crop yields has recorded. Because, of climate variability the cropping pattern has been changed especially long cycle crops were replaced by short cycle crops.

Number of livestock production also decreased in the past ten years. Contrary to the cattle population, positive rate of change was observed for goats and chickens. From this, it is possible to conclude that, the climate variability condition, warming of climate, favoured by goats and chickens than cattle population due their capability to with stand shortage of feed and long dry seasons.

**Coping Mechanisms:** The most commonly cited coping strategies was used first by households when dealing with shocks were: eat less preferred or less expensive foods, reducing the number of meals, food aid and selling labour.

**Adaptation to climate change induced shocks:** The research shows that *Sidama Zone* sampled *Woreds* farmers were more likely to adapt if they had access to non-farm income, owned livestock, had more farming experience and education/training, and were economically better off. Access to credit, agricultural extension, information on climate change, and other rural services was important as well. Water and soil conservation, rainwater harvesting, construction of dams, environmental rehabilitation, and expansion of spate irrigation were some of the major strategies initiated by office of agriculture to adapt the impacts of climate change and variability.

**Obstacles to Adapting to Climate Variability:** Traditional farming system, less farmland holding as well as their educational level, hindered farmers of the study area from adaptation.

### **5.1.2 Conclusion**

Climate variability is a major driver of vulnerability in the sampled *Woredas* of the *Zone*. Since, the farmer's livelihood is dependent on crop and livestock production irregular annual rainfall highly affects the productivity of the them. However, it is difficult to say that the climate of the study area has changed since climate change is a total phenomenon of the climate condition of a given area from hot to cold or the reverse. However, this is not the reality in sampled *Woreda*; rather it is possible to say there is climate variability on the past two decades, with different range of impacts over the productivity of the peoples. Because of climate variability induced shocks and population growth the vegetation cover and grazing areas of the *Woredas* have been deteriorated and finally it caused livestock feed shortage and decrease in cattle production. Moreover, there is irregularity in rainfall timing in turn which affects the cropping pattern and crop production of farmers. Farmers of the study area are highly vulnerable to the impacts of climate variability and almost about 83.8% of the farmers were insufficient to sustain their family life. Even though, female headed households were more vulnerable to the impacts of climate variability.

Generally, the farmers have practiced different types of coping and adaptation strategies to cope up with the impacts of climate variability. Feeding to livestock (cattle) and feed less expensive crops for own feed consumption were the common ones. Poor source of income hinders the farmers not to cope up the impacts of climate variability. While, the local as well as regional government have been trying to minimize the impacts of climate variability by working on soil and water conservation, environmental rehabilitation degraded and deforested areas.

### **5.2 Recommendations**

Given the nature of the data and based on the findings and results of the study the following policy oriented recommendations are suggested to minimize the impacts of climate variability on farmers' productivity of the study area.

1. The result of the study showed that rainfall intensity, fluctuation of rain fall and temperature increase resulted in drought, flooding, loss of indigenous plants and crops, decrease of livestock production, decrease of crop production which in turn affects

productivity of the smallholder farmer's of the study area. Therefore, to tackle these problems the government and other stakeholders

- Should encourage farmers to use drought resistant crop seeds together with commercial fertilizer, chemicals and soil moisture management practices,
- Strengthen water and soil conservation and expand the area cultivated with irrigation schemes,
- In relation to shortage of livestock feeding, there should be possible interventions by plating fodder trees around enclosure areas and irrigation dike. Train farmers on cut and carry so as to decrease overgrazing, protecting the environment from restless cutting down of trees and deforestation, and promote reforestation and afforestation (planting and managing of seedlings) activities,
- There should be collaborative farmers effort on preventing and controlling the expansion of invasive plant species, especially *pests (locally named da'mulcho)* which adversely damages livestock and crop production (teff, coffee, enset) and over all of natural environment,
- Moreover, farmers are wise in the long dry seasons to feed drought and pest resistance plants or grasses for their cattle, and government should encourage them to plant drought and pest resistance plants or grasses in their backyards for cattle and their own feed/consumptions.

2. The study result also indicated that, the farmers with low income, less land holding, large family size, female headed household, elders house headed as well children are highly vulnerable to climate shocks in the study area. Therefore; in order to alleviate all these problems,

- The government and non-government organizations should provide credit access to create a possible way to generate income and train family planning and/or education of couples should be provided,
- To enhance the productivity of crops from small landholding area the only alternative is maximizing the utilization of modern agricultural technologies such as improved seeds, improved agronomic practices, small scale irrigation etc and boosting participation of the

farmers in off-farm activities like poultry, dairy farm, getting involved in petty trade etc.

3. The study result showed that, smallholder farmer's are coping with climate variability through migration, selling livestock, cutting trees for sells of firewood and charcoal, sells of fixed assets. The government and some other Non Governmental Organizations are trying to widen opportunity to change these negative trends through taking different measures. However all these efforts are there, due to level of understanding, information and skill gaps as well as shortage of technological inputs supply there are challenges to achieve the desired results. Therefore;
  - The government should focus to strengthen farmer training centre (FTC) to raise the understanding, and skills of the farmers. The study area is suitable for horticulture so the development partners should train farmers, which can have an enormous adaptation effect by promoting resilience to impacts of climate variability,
  - Local as well as national media's should play an important role in order to create an access to information,
  - Integrated Functional Adult Literacy program should be Strengthen to raise the level of understanding in health, education, improved farming practices, cooperatives and marketing,
  - Introduction of area specific intervention to enhance household income such as food to work (public work) and other wage earning activities like digging community well, river diversion or canal, irrigation and the like .

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**APPENDIX I**  
**Hawassa University**  
**School of Governance and Development Studies Department**  
**Questionnaire for Household Survey**

Date of questionnaire filled \_\_\_\_\_

**Instrument One**

The main objective of this questionnaire is to get first hand information on the extent of the impacts of climate variability on smallholder farmers' productivity in your *Woreda*. The information from respondents will keep confidential and will not affect any body in any way. Hence, personnel who are directly involved in the program understudy you are kindly requested to provide information that is highly valued for this academic study.

**Please answer each item to the best of your knowledge**

**NB**

- Do not write your name,
- Indicate your response in the space provided by marking "X" on the space provided,
- Write your additional comment and suggestion on the given space

**Thank you in advance!**

**Part I. 1. General information**

1. Sex household head            Male \_\_\_\_\_            Female \_\_\_\_\_
2. Age household head \_\_\_\_\_
3. Marital status 1.Married \_\_\_\_\_ 2.Single \_\_\_\_\_ 3.Widowed \_\_\_\_\_ 4. Divorced \_\_\_\_\_  
5. Separated \_\_\_\_\_
4. Number of children (if you have) \_\_\_\_\_ 1. 1-2 2. 3-4 3. 5-6 4. 7 and above
5. Number of unproductive household whose age less than 14 and greater than 65 \_\_\_\_\_
6. Number of productive household whose age greater than 14 and less than 65 \_\_\_\_\_
7. Number of permanent household members including the household head  
Male \_\_\_\_\_ Female \_\_\_\_\_ Total \_\_\_\_\_
8. Educational Status of the household 1. Illiterate \_\_\_\_\_ 2. Read/write \_\_\_\_\_
9. 3. 1-4 \_\_\_\_\_ 4. 5-8 \_\_\_\_\_ 5. 9-10 \_\_\_\_\_ 6. 11-12 \_\_\_\_\_ 7. Certificate \_\_\_\_\_ 8. Diploma and above \_\_\_\_\_

10. What is highest level of education among your family members?

11. For how many time (year) you have been here? 1. <5 years 2. 5-10 3. 11 and above

**Part II. Issues Related to Socio-economic aspects of local households**

1. What is the main source of income for the household? (Multiple answers could be given)

1. Livestock rearing \_\_\_\_\_ 2. Agriculture (Crop production) \_\_\_\_\_ 3. Renting out land \_\_\_\_\_ 4. Daily laborer \_\_\_\_\_ 5. Selling firewood \_\_\_\_\_ 6. Other (specify)

2. How do you see your income last year (2005-06 E.C) as compared to last 10 years on wards? 1. Best \_\_\_\_\_ 2. As usual for most of the year \_\_\_\_\_ 3. Exceptionally low \_\_\_\_\_

3. If the main source of income for the household is a crop production, what are the main factors that adversely affect it? (Multiple answers could be given)

1. Rain shortage \_\_\_\_\_ 2. Too much rain \_\_\_\_\_ 3. pestinfestation (crop disease) \_\_\_\_\_ 4. Shortag of farm land \_\_\_\_\_ 5. Lack of agricultural inputs \_\_\_\_\_ 6. lack of labor \_\_\_\_\_ 7. Rudimentary farming method \_\_\_\_\_ 8. Shortage or lack of oxen \_\_\_\_\_ 9. other (specify) \_\_\_\_\_.

4. Is your income enough to sustain your family all the year round? (Enumerators please make sure that not only for food consumption)

1. Enough \_\_\_\_\_ 2. more than enough \_\_\_\_\_ 3. not enough \_\_\_\_\_

5. If your income is not enough to sustain your family all the year round, what do you do to supplement it and sustain your family?

1. Borrow money or grain \_\_\_\_\_ 2. Move to other places (migrate) \_\_\_\_\_ 3. Sell fixed assets \_\_\_\_\_ 4. Sell livestock \_\_\_\_\_ 5. Selling wood \_\_\_\_\_ 6. Other (specify) \_\_\_\_\_

6. Do you have land of your own? 1. Yes \_\_\_\_\_ 2. No \_\_\_\_\_

7. If you have land of your own, how big? Put it in hectare \_\_\_\_\_ 1. <0.25 hec 2. 0.25 to 0.5 hec 3. 0.51 to 0.75 hec 4. 0.76 to 1 hec 5. 1.1 to 2 hec 6. above 2 hec

8. Do you have your own livestock? 1. Yes \_\_\_\_\_ 2. No \_\_\_\_\_ if yes, how many livestock do you own?

Number of livestock	Oxen	Cows	Bulls	Heifers	Calves	Sheep adult	Sheep young	Goats adult	Goats young	Donkey adult	Donkey young	Horses	Chickens	Beehive
No of livestock before 10 year														
No of livestock currently 2006EC														

### Part III. Climate Variability and Vulnerability

1. Are you vulnerable to problems like economic shocks, health, price fluctuations....?
  1. Yes \_\_\_\_\_
  2. No \_\_\_\_\_
2. If your response to question number 1 is yes, which one of the following affects your life? (Please put in order of severity)
  1. Drought \_\_\_\_\_
  2. Food inadequacy \_\_\_\_\_
  3. Price fluctuations for agricultural products \_\_\_\_\_
  4. Disease \_\_\_\_\_
  5. Flood \_\_\_\_\_
  6. Shortage of water supply \_\_\_\_\_
  7. Other (specify) \_\_\_\_\_
3. Which of the following environmental problems are very common in your area? (Please put in order of severity)
  1. Soil erosion \_\_\_\_\_
  2. Deforestation \_\_\_\_\_
  3. Climate variability (shortage of rain water, much rain fall, unseasonal rainfall) \_\_\_\_\_
  4. Land degradation \_\_\_\_\_
  5. Water pollution \_\_\_\_\_
  6. Other (specify) \_\_\_\_\_
4. Have you heard about the issue of climate change/ variability?
  1. Yes
  2. No
5. If your answer for question number 4 is yes, what are the local indicators of climate change/variability? (Multiple answers are possible)
  1. Increased uncertainty in climate \_\_\_\_\_
  2. Decrease crop and livestock production \_\_\_\_\_
  3. Extinction of indigenous and crops \_\_\_\_\_
  - D. Decrease river volume \_\_\_\_\_
  - E. Decrease in rainfall amount \_\_\_\_\_
  4. Decrease (drop) in ground water \_\_\_\_\_
  5. Temperature rise \_\_\_\_\_
  6. Deforestation (deteriorated vegetation cover) \_\_\_\_\_
  - I. Others \_\_\_\_\_
6. Have you ever faced any climate related (serious) impact in your lifetime?
  1. Yes \_\_\_\_\_
  2. No \_\_\_\_\_

7. What type of climatic shock is your concern, if you faced climate related impact in your lifetime?
- A. Drought/ irregular rains \_\_\_\_\_ B. Shortage of animal feed \_\_\_\_\_ C. Drying up of water streams \_\_\_\_\_ D. Unusually high food prices \_\_\_\_\_ E. Temperature rise \_\_\_\_\_ F. Prohibition/exclusion from safety net program \_\_\_\_\_ G. Unusually high level of crop pests and disease \_\_\_\_\_ H. Others \_\_\_\_\_
8. If you faced climate related impact in your lifetime, did it affect your cattle or/and crop?
- A. Yes \_\_\_\_\_ B. No \_\_\_\_\_ If yes how much?
- A. Very high (with animal disease and death) \_\_\_\_\_ B. Moderate \_\_\_\_\_ C. Low \_\_\_\_\_ D. Very low \_\_\_\_\_
9. Is there change in the timing (duration) of the rain? 1. Yes \_\_\_\_\_ 2. No \_\_\_\_\_
10. If there is a change in duration of climate, how do you characterize it? A. Comes early and goes late \_\_\_\_\_ B. Comes late and goes late \_\_\_\_\_ C. Comes late and goes early \_\_\_\_\_
11. If the duration of a climate comes late and goes early, what changes you have seen in your crop production? A. Decrease in crop yield \_\_\_\_\_ B. Increase in crop yield \_\_\_\_\_ C. No change in production \_\_\_\_\_ D. Decrease of long cycle crops \_\_\_\_\_ E. Others \_\_\_\_\_
12. What problem have you observed due to changing of climate? (Multiple answers are possible)
- A. Fluctuation of rainfall \_\_\_\_\_ B. Increased temperature \_\_\_\_\_ C. More flooding \_\_\_\_\_ D. disease incidence such as malaria \_\_\_\_\_ E. deforestation \_\_\_\_\_ F. Drying up of water streams \_\_\_\_\_ G. other (specify) \_\_\_\_\_
13. Whom do you think that more vulnerable to the above shocks?
- A. Female headed household B. Male headed household \_\_\_\_\_ B. Landless \_\_\_\_\_ D. Elders \_\_\_\_\_
14. Why do you think, you are more vulnerable to the impact of climate variability?
- A. Lack of information on climate conditions/weather \_\_\_\_\_ B. Poor administration system \_\_\_\_\_ C. Poor livelihood /source of income \_\_\_\_\_ D. Other (specify) \_\_\_\_\_

15. From where do the household get drinking water? (Multiple answers are possible)  
 A. River \_\_\_\_\_ B. Protected spring \_\_\_\_\_ C. unprotected spring \_\_\_\_\_  
 D. Hand dug well \_\_\_\_\_ E. Pipe line \_\_\_\_\_ F. Pond \_\_\_\_\_ G. Dams \_\_\_\_\_ H. Open  
 walls \_\_\_\_\_ I. Other (specify) \_\_\_\_\_
16. Did **you** make a change to the crop type that you cultivate before? A. Yes \_\_\_\_\_ 2. No  
 \_\_\_\_\_ If yes what did you cultivate before? 1.Sorgam 2. Barley 3. Maize 4. Hardcot  
 bean 5. Coffee 6. Inset 7. Teff 8. Others (secify) Now? \_\_\_\_\_
17. Why did you change the type of crop that you cultivate?  
 A. Because of the change in rain water \_\_\_\_\_ B. Because the changed crop price is  
 good in market \_\_\_\_\_ C. Governmental or other developmental organizations forced  
 to do it \_\_\_\_\_ D. Because of increased temperature \_\_\_\_\_ E. Other (specify)
18. What is the pattern of your crop productivity since passed 10 year?  
 A. Increased \_\_\_\_\_ B. Decreased \_\_\_\_\_ C. The same
19. If your response to the pattern of crop productivity since past 10 years is decreased,  
 what do you think is the cause?  
 A. Erratic rainfall during the main season \_\_\_\_\_ B. Poor farming system \_\_\_\_\_ C.  
 Infertile farm Land \_\_\_\_\_ D. Other constraints \_\_\_\_\_
20. Which do you estimate, the highest composition of livestock on the past 10 years?  
 A. Cattle \_\_\_\_\_ B. Small ruminants' \_\_\_\_\_ C. Equines \_\_\_\_\_ D. Others \_\_\_\_\_
21. Which livestock composition do you think have the highest composition nowadays?  
 A. Cattle \_\_\_\_\_ B. Small ruminants' \_\_\_\_\_ C. Equines \_\_\_\_\_ D. Others \_\_\_\_\_
22. Is there any change on livestock number, composition and feeding of your area?  
 A. Yes \_\_\_\_\_ B. No \_\_\_\_\_
23. What crops you used to grow before 10 years?  
 \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_
24. What are the main crops you product now?  
 \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_
25. If there is a change, please explain the reason why there is any change on livestock  
 number.....
26. Do you think that production of livestock has increased or decreased in your village?

- A. Increased\_\_\_\_ B. Decreased\_\_\_\_
27. If the productivity of livestock decreased please specify the reasons;  
 A. Livestock disease \_\_\_\_ B. Shortage of pasture (animal feed) \_\_\_\_ C. Shortage of water\_\_\_\_ D. Others (specify) \_\_\_\_
28. How many livestock you have loss because of climate change related shocks in the past 10 years?-----
29. What was the source of feed for your livestock before 10 year? (multiple answer is possible)-----
30. What is your main source of animal feed at present time?  
 .....
31. What do you think the possible ways to minimize the impacts of climate variability or change on your livelihood?  
 A. Applying new cropping system and irrigation \_\_\_\_ B. Make diversification on crop and livestock production \_\_\_\_ C. Safety net program \_\_\_\_ D. Other (specify) \_\_\_\_
32. What do you think the responsible factors for change on vegetation pattern and land use type of your area?  
 A. Climate change/variability \_\_\_\_ B. Soil erosion \_\_\_\_ D. Deforestation \_\_\_\_  
 D. Others \_\_\_\_
33. How did the government, GOs and NGO's responded to reduce the impact of climate change?  
 A. Providing credit \_\_\_\_ B. Safety net programs \_\_\_\_ C. Improving infrastructures\_\_\_\_  
 D. No one gives attention to the problem \_\_\_\_ E. Other (specify) \_\_\_\_\_

**Part IV. Adaptive and Copping strategies**

1. Do you think it is possible to prevent or adapt to the impacts of climate change (shortage of rain water, much rain fall, and unseasonal rainfall) by action in your locality? A. Yes \_\_ B. No \_\_\_\_

2. What local actions do you think possible in your capacity
  - A. Aforestation \_\_\_\_
  - B. Doing additional non-farm activities \_\_\_\_
  - C. Agricultural practices such as terracing \_\_\_\_
  - D. Irrigation \_\_\_\_
  - E. Using renewable energy source \_\_\_\_
  - F. Other (specify) \_\_\_\_\_
  
3. What are the major coping/adaptation strategies you used related to livestock production?
  - A. Increase livestock diversification \_\_\_\_
  - B. Sale weak and old animals before the outbreak of long dry season \_\_\_\_
  - C. Moving with livestock in search of pastures and water \_\_\_\_
  - D. Decreasing number of livestock \_\_\_\_
  - E. Cattle fattening \_\_\_\_
  - F. Food aid \_\_\_\_
  - G. Others (specify) \_\_\_\_
  
4. How do you try to cope with some of your problems related to your vulnerability?
  - A. Through aid \_\_\_\_
  - B. Through social works (like equb, senbte...) \_\_\_\_
  - C. Through seasonal movement to other places \_\_\_\_
  - D. Remittance from relatives \_\_\_\_
  - E. Through loan \_\_\_\_
  - F. Other (specify) \_\_\_\_\_
  
5. What are the major constraints that hinder you to adapt the impact of climate change?(multiple answer is possible)
  - A. Poor market accessibility in the area
  - B. Poverty \_\_\_\_
  - C. Lack of accessibility infrastructures (road, veterinary center, FTC) \_\_\_\_
  - D. Livestock disease \_\_\_\_
  - E. Poor administration \_\_\_\_
  - F. Others (specify) \_\_\_\_
  
6. Is there any locally accepted coping mechanisms? A. Yes \_\_\_\_ B. No \_\_\_\_ If your answer is 'yes', please explain the coping mechanism which is used in area by the community .....
  
7. What do you think the right way to adapt (minimize) the impact of climate variability in your village.....

**Part V. Institutional issues**

1. Do you think government services are adequate in minimizing your vulnerability and diversifying your livelihood? A. Yes \_\_\_\_ B. No \_\_\_\_ (please explain your answer)

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2. What type of aid does the government or other institutions give to you to minimize the impact of climate change?

A. Supplying agricultural inputs\_\_\_\_\_ B. giving money\_\_\_\_\_ C. Food aid \_\_\_\_\_

D. facilitating additional job opportunity\_\_\_\_\_ E. showing different adaptation

mechanisms\_\_\_\_\_ F. Other (specify)\_\_\_\_\_

**Thank you very much!**

**APPENDIX II**  
**Hawassa University**

**School of Governance and Development Studies Department**

**Checklist for focus group discussion**

Date of questionnaire filled\_\_\_\_\_

Semi-structured interview for focus group discussion; the following points are bench marks for the discussions that will be taken place with purposively selected persons.

1. Do you think there is change in climate condition of your area?
2. What do you think the local indicators of climate change?
3. Who is more vulnerable from your society?
4. What are the major climate variability induced shocks and effects?
5. Is there change in the timing (duration) of the rain? If yes what do you think the impacts?
6. What are the best coping strategies employed in your village?
7. What are the adaptation strategies employed by the local community?
8. What do you think the possible ways to minimize the impact of climate variability?

**Thank you**

**APPENDIX III**  
**Hawassa University**

**School of Governance and Development Studies Department**

**Checklist interview for key informants**

Date of questionnaire filled\_\_\_\_\_

1. Is there any form of climate change in the *kebeles*? If yes, please can you explain?
2. What is the impact of climate change and variability on the livelihood of the people there?
3. Who is more vulnerable to the impacts? Why?
4. What are the local coping mechanisms used to reduce the impacts?
5. What is the institutions effort to reduce future impacts?
6. What are the adaptation strategies employed by the institutions?
7. What do you think the possible ways to minimize the impact of climate variability?

**Thank you**

**Annex. 1. Monthly Rainfall Data of Hawassa Meteorological Station (1986 – 2011)**

<i>Year</i>	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>Jul</i>	<i>Aug</i>	<i>Sep</i>	<i>Oct</i>	<i>Nov</i>	<i>Dec</i>
1986	8.0	0.0	92.9	215.8	103.1	103.1	110.3	101.9	111.1	39.5	22.5	4.3
1987	0.0	17.3	125.9	87.1	247.0	55.1	104.5	105.5	75.7	47.0	30.0	6.0
1988	21.2	66.2	15.4	102.8	93.9	106.9	121.3	129.4	215.5	71.0	2.4	6.0
1989	30.3	36.6	52.1	183.8	63.0	160.8	66.4	85.2	160.7	46.8	24.1	66.4
1990	42.3	82.6	88.1	216.0	142.0	206.9	127.4	140.7	220.1	64.3	29.0	83.2
1991	24.0	92.0	72.0	64.3	158.0	92.2	121.9	110.9	118.8	35.0	9.7	33.5
1992	23.4	75.6	73.8	109.0	60.5	83.0	104.5	123.6	74.5	142.3	80.1	17.4
1993	101.6	109.1	22.3	104.9	165.3	46.7	54.7	130.8	47.8	130.8	10.5	3.9
1994	0.0	3.7	56.8	108.7	81.5	146.2	195.7	118.9	68.9	58.8	19.1	2.9
1995	0.8	21.4	61.8	156.1	43.6	118.7	175.7	134.7	166.8	22.3	18.3	84.2
1996	78.4	20.1	89.6	113.9	161.5	243.3	121.2	108.7	145.0	69.6	19.7	1.4
1997	23.4	1.7	75.1	125.0	72.8	111.2	98.8	113.9	119.1	157.5	132.2	24.0
1998	92.0	140.0	90.8	86.6	88.9	52.0	172.9	108.3	109.6	193.3	10.6	0.8
1999	19.8	0.4	105.5	26.4	64.7	99.8	135.1	83.8	117.4	120.4	20.1	16.8
2000	1.1	0.0	11.0	132.0	145.1	36.8	80.0	178.8	86.5	110.7	29.0	11.3
2001	1.8	39.9	122.7	67.2	233.7	137.8	93.4	131.7	89.7	80.2	2.6	21.3
2002	52.5	2.4	129.1	119.6	85.2	91.7	76.6	190.4	83.2	37.3	0.0	51.5
2003	30.4	2.0	78.2	179.1	40.4	110.5	107.8	76.1	85.5	53.4	6.2	51.8
2004	46.2	94.2	42.0	83.1	81.5	75.7	75.4	114.9	116.0	57.1	94.2	15.3
2005	81.1	7.7	120.9	156.0	144.5	73.2	150.9	61.3	117.2	28.4	46.0	10.4
2006	1.7	9.0	139.2	145.9	74.4	108.0	171.1	169.3	194.9	56.9	79.2	48.3
2007	18.0	55.0	76.4	112.0	166.1	225.4	129.1	104.3	233.8	32.7	3.7	0.0
2008	33.7	8.3	3.4	57.8	121.0	118.2	120.5	123.5	160.0	66.1	97.1	5.8
2009	32.8	9.0	60.3	45.6	103.1	51.6	92.6	112.0	81.7	41.6	4.1	69.9
2010	26.6	58.4	124.8	96.1	173.5	53.1	132.5	136.6	96.1	53.1	32.0	56.0
2011	2.3	7.1	55.5	73.7	193.6	65.5	150.5	155.2	125.5	5.5	88.2	0.2
<b>Monthly Mean RF</b>	<b>30.5</b>	<b>36.9</b>	<b>76.4</b>	<b>114.2</b>	<b>119.5</b>	<b>106.7</b>	<b>118.9</b>	<b>121.2</b>	<b>123.9</b>	<b>70.1</b>	<b>35.0</b>	<b>26.6</b>

## Annex.2 Average max Temperature Data of Hawassa Meteorological Station (1986 – 2011)

Station Name :- Hawassa

Element :- Monthly Average Max.Temp.(°C)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1986	28.8	29.4	28.9	26.3	26.5	23.9	23.5	24.5	25.1	26.7	28.3	28.2
1987	28.5	29.2	27.5	27.4	26.2	25.5	25.2	25.4	26.6	27	29.3	29.3
1988	29.2	29.6	31	28.4	27.5	24.9	22.8	23.8	24.8	25.9	27.9	27.8
1989	28.7	29	30	26	27	25	23	22.5	23	24	27	28
1990	29	28	31	27	26	25	24	23	23	24.5	27.5	27.6
1991	27	28.5	30.4	28.5	27	26	25	25	24.9	25	27.5	27
1992	28.5	28.4	30.5	29.6	27.5	26.3	24.5	23.7	24.9	25.9	27.1	28.5
1993	27.7	26.9	30.6	27.8	26.9	24.9	24.4	24.9	25.8	26.9	29.0	29.9
1994	30.5	31.6	30.8	29.5	26.7	24.7	23.5	24.5	26.2	28.3	28.3	29.3
1995	30.4	30.7	29.9	27.3	28.0	27.0	24.3	24.5	25.9	27.6	29.3	29.2
1996	28.2	30.8	29.5	27.6	26.7	23.8	23.8	24.3	25.0	27.1	28.1	28.6
1997	28.9	30.3	30.8	26.9	27.5	25.7	23.8	25.5	26.8	26.5	26.5	27.3
1998	27.5	28.9	29.0	29.7	27.3	26.3	24.3	24.0	25.4	25.4	27.5	28.1
1999	29.1	31.4	28.1	29.4	27.2	26.1	23.6	25.0	25.6	24.8	27.2	28.0
2000	29.5	30.7	31.8	28.9	26.1	25.7	24.9	24.8	25.1	25.8	27.2	28.1
2001	28.6	30.2	28.3	28.4	26.8	24.8	24.4	24.5	25.9	26.7	28.2	28.9
2002	28.2	30.9	28.8	28.6	27.6	25.7	26.3	25.3	26.1	28.3	29.8	28.2
2003	28.4	31.3	30.6	28.1	28.3	25.6	24.2	24.9	26.0	28.2	29.3	27.2
2004	28.9	28.7	30.2	27.3	28.6	25.9	25.3	25.5	25.5	26.7	28.6	28.6
2005	28.9	31.5	30.0	29.4	25.9	25.6	24.6	25.7	26.0	27.3	28.0	28.5
2006	30.1	31.3	29.3	27.3	27.7	26.2	24.5	24.7	25.2	26.7	27.6	27.5
2007	28.5	29.2	30.0	28.2	27.7	25.3	24.6	24.2	25.1	26.7	27.8	27.9
2008	29.5	29.4	31.5	29.4	26.3	25.6	24.4	24.8	25.7	26.6	26.6	27.8
2009	28.4	30.0	31.3	29.2	29.0	27.7	26.0	26.0	26.3	27.5	29.5	28.1
2010	28.5	28.4	27.7	28.0	26.1	26.2	24.4	25.0	25.3	27.7	28.7	28.2
2011	28.7	30.6	30.2	30.7	27.6	26.2	25.6	24.6	25.3	28.2	27.8	27.6

Annex. 3. Average min. Temperature Data of Hawassa Meteorological Station (1986 – 2011)

Station Name :- Hawassa

'Element :- Monthly Average Min.Temp.(°C)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1986	7.5	11.2	10.5	14.8	13.7	14.4	13.5	12.4	12.8	10.7	8.7	9.7
1987	9.9	11.5	14	13	14.5	14.3	13.9	13.4	12.7	12.7	9.2	9.5
1988	11.3	13.7	12.2	14.6	13.9	13.9	14.7	14.1	13.9	12.8	6.5	7.9
1989	11.5	12	12.5	13	13	13.7	14	14.4	13	12	7.5	7.8
1990	11.5	13	12.3	13.4	13.5	13.6	14.3	14	13	12.5	8.7	10.5
1991	12	13	12.5	13	13.4	13.5	13.7	13.8	12.6	13.1	10.1	10.3
1992	12.4	13.5	12.8	14.1	13.5	14.0	13.9	14.4	12.7	13.1	10.5	11.0
1993	12.1	12.3	9.6	14.1	14.1	14.2	14.3	13.7	12.8	12.8	9.3	9.1
1994	9.7	11.6	13.0	13.8	14.3	14.5	14.2	14.7	14.0	10.1	10.0	8.9
1995	9.5	12.7	13.7	14.9	13.1	13.6	14.2	14.5	13.0	12.3	8.4	10.6
1996	12.2	10.5	13.0	14.0	14.1	14.3	14.5	14.4	13.6	10.9	8.8	9.6
1997	12.4	10.0	13.3	13.9	13.1	13.6	14.1	14.2	13.2	13.6	13.8	11.3
1998	13.3	14.3	14.0	14.4	15.7	14.7	15.7	15.9	14.5	14.4	8.9	8.1
1999	10.2	9.9	13.8	12.5	13.6	14.0	14.3	13.7	13.8	14.0	9.3	9.3
2000	9.6	10.6	11.1	14.1	14.0	13.7	14.3	14.0	13.4	14.0	10.5	9.7
2001	11.6	11.1	14.0	14.4	14.2	14.6	14.8	15.0	13.1	13.7	10.3	10.9
2002	12.4	11.8	14.0	13.5	14.8	14.5	14.3	14.2	13.4	12.8	9.8	13.2
2003	11.8	11.6	13.2	14.3	14.2	14.3	14.6	14.7	14.0	11.9	11.2	10.4
2004	12.9	11.5	12.2	14.7	13.2	13.9	14.0	14.3	13.6	11.5	11.6	11.4
2005	11.3	11.4	13.8	14.0	15.0	14.6	14.2	14.7	14.4	13.1	9.5	7.8
2006	11.8	12.4	13.8	14.6	13.9	14.3	15.0	14.7	14.5	14.2	11.4	12.4
2007	12.7	12.9	12.4	14.2	14.8	15.0	14.8	14.6	14.3	11.1	10.9	9.0
2008	10.5	11.6	11.4	14.1	14.6	14.4	14.9	14.5	14.2	13.0	11.1	10.3
2009	11.8	12.4	12.9	14.3	14.4	13.9	14.2	14.7	14.8	13.2	10.7	13.6
2010	13.0	15.3	14.7	15.6	16.3	15.1	15.2	15.3	14.4	13.5	11.1	10.9
2011	12.6	11.8	13.4	14.3	15.1	15.3	14.7	14.9	14.7	12.3	13.0	10.0

