ADDIS ABABA UNIVERSITY

COLLEGE OF SOCIAL SCIENCES

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

Effects of Climate Change and Variability on Rural Livelihoods and Responses: The Case of Soro Woreda, Hadiya Zone, SNNPR

By: Astawsegn Zeleke

June, 2014

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Advisor: Aklilu Amsalu (PhD)

A Thesis Submitted to the Department of Geography and Environmental Studies Presented in Partial fulfillment of the requirement for the Degree of Masters (Climate change and adaptation)

Addis Ababa University
Addis Ababa, Ethiopia
June, 2014

Addis Ababa University

College of Social Sciences & Humanities

This is to certify that the thesis presented by Astawsegn Zeleke, entitled: Effects of climate change and variability on rural livelihoods and responses: the case of Soro woreda, Hadiya Zone, SNNPR, Ethiopia and submitted in partial fulfillment of the requirement for the degree of Master of Arts complies with the regulations of the university and meets the accepted standards with respect to originality and quality.

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Advisor **Aklilu Amsalu (PhD)** **Signature** _____ **Date** _____

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Acknowledgment

Above all, I would like to thank the Almighty God without whose support, it would have not been possible all my wishes to come in to reality.

First and for most I am deeply indebted to my advisor Aklilu Amsalu (PhD) for his earnest guidance, critical comment, encouragement and timely suggestion that would give this research a success. His support and advice makes me motivated and energetic all the way through this study.

Next, my appreciation goes to the AAU, Department of Geography and Environmental Studies for the timely release of fund. As well, I am thankful to Hosanna College of Teacher Education for its sending me for further education and release of learning fund.

Special thanks also goes to Soro woreda administration, office of Agriculture Rural Development. In addition, Ato Getachew Genore and Ato Selamu Demeke (Coordinators for Natural Resources Management in Soro *woreda*) who supported me with materials and information. I have no words to thank and appreciate the farmers of the three *kebles* for their hospitality and patience to answer the questionnaire. My appreciation goes to those development agents who were most helpful and cooperative in collecting data.

I am very much grateful to my sisters and brothers Ato Yako Ersulo, Friew Ammanuel, Daiso Gediro, Fitsum Gediro and Ebede Gediro for their encouraging telephone calls, love and care during my stay in the study.

The last but not the least, I am also thankful to my late father Ato Zeleke Hajeno who has never been to school but brought me to this end. I wish a long living to my beloved mother W/ro Workie Hajeno.

Abstract

The purpose of this study is to assess effects of climate change and variability on rural livelihoods and responses in Soro woreda, Hadiya zone, SNNPR. Thus, the study sought to examine the pattern of rainfall and temperature in the last three decades, to explore effects of climate change and variability on rural livelihoods and to assess individuals' communities and institutions response and identify the group of society most vulnerable to and impacted by the existing climate related stresses. To achieve the objectives set, appropriate data was collected from three sample kebeles which were selected through stratified sampling method based on their agro-ecologic conditions. And 96 household heads were purposively selected from the three sample kebeles. In addition, three FGD each composed of 6 individuals from different socio-economic status and age groups were selected and used as primary sources of information. Key informant interview was conducted with experts from SWARDO and DAs. The finding of the study reveals that some elements of climate (temperature and rainfall) show inter annual and seasonal variability with slightly increasing trend. And the main source of income in the study area is rain fed agriculture which is being adversely affected by unpredictable and decreasing rainfall, hailstorms and flooding, high temperature etc. To adapt to the changing climate of the area, farmers are already practicing long aged coping mechanisms and adaptation strategies along with some government interventions in response to the CC and variability. This study also identified women, children and elderly, the poor ad landless as most vulnerable to the existing CC and variability effects. Therefore, depending on the finding of the study, the following policy recommendations are forwarded are: increasing farmers' awareness on how to use agricultural technologies & inputs, restoring the degraded environment, facilitating access to credit services, diversifying source of income, building the capacity of farmers & encouraging CBA strategies as the main poverty reduction approach.

***Key words**: Climate change/variability, livelihoods, coping mechanisms, adaptation strategies.*

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Acronyms

CBA	Community based adaptation.
CC	Climate Change
CNCRE	Carbon neutral climate resilient economy
CRGE	Climate Resilient green Economy
CSA	Central Statistics Agency
CSE	Conservation Strategy of Ethiopia
Das	Development Agents
EPA	Environmental Protection Authority
EPE	Environmental Policy of Ethiopia
FAO	Food and Agriculture Organization
FDREEPA	Federal Democratic Republic of Ethiopia Environmental protection
FDRMC	Federal Disaster Risk Management Council
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GNI	Gross National Income
GoE	Government of Ethiopia
HH	Households
HHH	Household heads.
HIV	Human immunodeficiency Virus
HZARDO	Hadiya Zone Agriculture and Rural Development
IFPRI	International Food Policy and Research Institute
IPCC	Intergovernmental Panel on Climate Change
ISET	Institution for Social and Environmental Transition
MoFED	Ministry of Finance and Economic Development
NAMA	Nationally Appropriate Mitigation Action

NAPA	National Adaptation Production of Action
NMS	National Meteorology Service
PSNP	Productive Safety Net Program
SNNPR	Southern Nations Nationalities Region
SSA	Sub Saharan Africa
SWARDO	Soro Woreda Agriculture and Rural Development Office
SWC	Soil and Water Conservation
UK	United Kingdom
UNDP	United Nations Development Panel
UNFCCC	United Nations Framework Conventions on Climate Change
WMO	World Meteorology Organization

CHAPTER ONE

1. Introduction

1.1. Background

The debate on climate change has now reached a stage where all but the most extreme contrarians accept that whatever happens to future greenhouse gas emissions, we are now locked in to inevitable changes to climate patterns. Although a few skeptics remain, there is a remarkable scientific consensus that global climate change is occurring. Many including the scientists working with the IPCC have concluded that these changes are already under way (ISET, 2013).The fourth assessment report of the intergovernmental panel on climate change (IPCC, 2007) dispelled many uncertainties about climate change. The international consensus of scientific opinion, led by the Intergovernmental Panel on Climate Change, agreed that global temperature is increasing and that the main cause is the accumulation of carbon dioxide and other greenhouse gases in the atmosphere as a result of human activity,(Carr., *et al*, 2005). Warming of the climate system is now unequivocal. It is now clear that global warming is due to manmade emissions of greenhouse gas (GHG), mostly CO2. Over the last century atmospheric concentrations of carbon dioxide increased from pre-industrial value of 278 parts per million to 379 parts per million in 2005 and the average global temperature rose by 0.74 C (UNFCCC, 2007). If emissions remain at current rates, by 2050 the concentrations of GHGs in the atmosphere will reach 550 parts per million and continue to increase thereafter (World Bank, 2010).

The negative effects of climate change are threatening to reverse development gains in many parts of the world especially in Sub-Saharan Africa. It is now an accepted scientific phenomenon that the global climate is changing. Precipitation and temperature patterns are changing. In the Sub-Saharan region rainfall patterns have become less predictable, precipitation has decreased on average, and temperatures are rising(Holmgren and Oberg ,2006). Evidence shows that that the upward trend of the already high

temperatures and the reduction of precipitation levels will increasingly result in reduced agricultural production in Sub-Saharan Africa (Mano & Nhemachena, 2007).

Over the coming decades, global climate change will have an impact on food and water security in significant and highly uncertain ways, and there are strong indications that developing countries will bear the brunt of the adverse consequences, particularly from climate change. This is largely because poverty levels are high, and developing-country capacity to adapt to global change is weak. Furthermore, the rural populations of developing countries—for whom agricultural production is the primary source of direct and indirect employment and income—will be most affected due agriculture's vulnerability to global change processes (Ringler, *et al*, 2011).

Africa has been identified as one of the continents most vulnerable to the impacts of climate change. The reasons are the exposure of its population to climate variations and extremes, people's dependency on natural resources and the underdevelopment of much of the region. Africa is already affected by climatic extremes such as floods and droughts, which will be exacerbated by climate change. Such events are having a negative impact on livelihoods, especially those of the poor. Given the degraded environments, food insecurity, poverty and HIV/AIDS already affecting large parts of Africa, climate change poses a monumental problem for the region (Jones and Rahman, 2007).

Climate change and variability are likely to impose additional pressures on water availability, water accessibility and water demand in Africa. About 25% of Africa's population (about 200 million people) currently experience high water stress. The population at risk of increased water stress in Africa is projected to be between 75-250 million and 350-600 million people by 2020 and 2050, respectively (Boko *et al*, 2007).

In some countries harvests may be reduced to half the normal yield. Agricultural production will decline and access to food will become less secure so that more people may go hungry, (IPCC, 2007).Africa's vulnerability [1] to climate change is also

[1]. *Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes*,(IPCC).

exacerbated by the multiple other stresses it faces such as natural resources degradation, high dependence on rain fed agriculture and inadequate infrastructure, also low levels of technology, widespread poverty, weak governance and thus low level of adaptive capacity to climate variability and change.

Smallholders in many parts sub-Saharan Africa (SSA) generally face widespread problems related to inappropriate cultivation, overgrazing and deforestation, resulting soil erosion and soil fertility decline, also water scarcity, lack of pasture and livestock feed and the fuel wood crisis, There is much concern that the fragile African ecosystems (mountains, dry lands and Coastal areas) will undergo noticeable changes under future climate scenarios (FAO, 2011).

Ethiopia is one of the least developed countries in the world with a gross national income (GNI) of US$22.7 billion and a population of more than 80 million (World Bank, 2009). Agriculture is the source of livelihood to an overwhelming majority of the Ethiopian population and is the basis of the national economy, where small-scale subsistence farming is predominant. This sector employs more than 80% of the labor force and accounts for 45% of the GDP and 85% of the export revenue. Ethiopian agriculture is heavily dependent on natural rainfall, with irrigation agriculture accounting for less than 1% of the country's total cultivated land. The dependency of most of the farmers on rain fed agriculture has made the country's agricultural economy extremely vulnerable to the adversities of weather and climate. Agriculture in the country is exposed to the effect of failure of rains or occurrence of successive dry spells during the growing season, which could lead to food shortage (MoFED, 2010).

The major factors responsible for the low productivity include: reliance on traditional farming technologies, soil erosion caused by deforestation and overgrazing, poor complementary services such as extension, credit, marketing and infrastructure; and climatic factors such as drought and flooding. These factors reduced adaptive capacity or increased the vulnerability of farmers to future change in climate and negatively affect the performance of the already weak agricultural production (Temesgen, 2010).

It is therefore, important to have a good understanding of the potential impacts of predicted future climate trends to improve agricultural planning and productivity. Therefore, adaptation to climate change is critical to many proposed strategies, for reducing the negative impacts of climate change. Adaptive capacity building is increasingly embraced by governments and other institutions as a means to improve economic and ecological resilience, sustainable development and will require action across multiple sectors at all levels (*Bishaw et al*, 2013). There are three main reasons for this increase in interest. First, the impacts of climate change are already being observed and, because of lags in the natural system, more impacts are inevitable (Burton *et al*, 2002).Second, that mitigation responses have been slow and inadequate, making adaptation all the more necessary (Reid and Huq, 2007). Third, knowing that they are likely to bear the greatest physical impacts from climate change, governments in developing countries are increasingly demanding greater attention to adaptation on the international stage (Prowse and Scott, 2008). Therefore, the covariant mix of climate stresses and other factors in Africa means that for many in Africa adaptation is not an option but a necessity (Boko.et al, 2007).

The adaptation of humankind to climate change and variability is probably as old as humankind itself. Throughout human history, societies have adapted to climate variability through alternating settlements, agricultural patterns, and other sectors of their economies and lifestyles. Nevertheless, the record of collapsed societies shows that not all cultures have had the possibility to change their patterns of life in a timely manner, and were not successful in surviving in face of climate and environmental changes,(Andrade, Herrera and Cazzolla, 2010).

Even though adaptation is inevitably local, their reference to the local situation is very limited (Semu and Abebe *n.d, p.11).* Climate change should therefore be, systematically mainstreamed [2] into socio-economic development policy and planning at national, regional and continental levels. At a local level, adaptation programmers should involve and give ownership to communities at the grassroots, moving steadily towards a

[2] *'Mainstreaming' is a commonly used term that means integrating or including a cross-cutting issue like gender or climate change into all aspects of development work carried out*, Pender, J.S. 2010.

community-based adaptation approach. It is imperative that local government incorporates indigenous knowledge into adaptation policies and analyses and takes account of models of best practice and adaptation approaches at a grassroots level (Chevalier, 2010).

1.2. Statement of the Problem

As with many developing countries, Ethiopia currently faces a number of critical development and ecosystem management challenges that impact the lives and livelihoods of its citizens. Current climate variability, especially the cycles of drought and intense rainfall events in the highlands, exacerbates socioeconomic and environmental issues. Without urgent action, this could make it impossible for poor people to attain a wide range of development and social justice goals (ISET, 2013).

High degradation, climate change/variability, decrease in grazing land and increasing food and energy demand as a result of ever increasing population pressure are considered as some of the development challenges in Ethiopia. (Climate change and variability worsened the situation by increasing moisture stress in the growing seasons of most cereal crops (Kindu *et al*, 2013).If agricultural production in the low-income developing countries of sub-Saharan Africa like Ethiopia is adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and their vulnerability to food insecurity increases (Abebe, 2013).

The vulnerability of the country is aggravated by poor agricultural and livestock practices, a fragile and degraded natural environment, extensive poverty, limited transport and communication infrastructure, inefficient markets, variable and changing climatic conditions, high population growth, lack of good governance, competition over scarce resources and border issues(FDREDRMC,2009).

Soro *woreda* was one of the agricultural surplus producer areas of Hadiya zone. Farmers in the woreda practice mixed farming in most parts of *dega* and *woyine-dega* agro-

ecological conditions and pastoralism and agro-pastoralsim in *kolla* agro- ecologic conditions of the woreda.

Nowadays, like in most rural areas of Ethiopia, the *Woreda* is characterized by heavily fragile natural resource base, shortage of agricultural land and speedy deforestation which resulted in high land degradation in most high lands of the area. Since recent past, farmers in the woreda are facing adverse impacts of climate change and variability on their livelihood. As a result of this, crop and livestock production has decreased and the woreda has become significantly vulnerable to the impacts of climate change and variability. In addition to this, due to the change in the pattern and timing of rain fall, there is change in the cropping pattern of the study area.

In spite of the long age local farmers endeavor to adapt to the changing climate, their effort to achieve resilient livelihood is constrained by various factors. This may be partly because, their adaptation strategies are not well organized, not integrated with development polices, may not be in accordance with community priorities and needs. Furthermore, it could be assumed that their attempt to adapt to climate variability and attain more resilient livelihood lacks, collective action and social capital and does not emphasize local decision making processes.

Climate change impact assessment research conducted so far in the study area is very limited and most of it focuses on policy responses to climate change leaving out the efforts made to adapt in household and community level. Therefore, to fill this gap, this study as the first climate change effect assessment study in *soro woreda,* paid due attention to both house hold and community based adaptation strategies being practiced in the study area.

1.3. Objectives of the Study

The main objective of the study is to assess effects of climate change and variability on rural livelihoods, and the adaptation responses being undertaken in soro *woreda* (district), Hadiya zone, SNNPR, Ethiopia.

The specific objectives of this study include:

- To examine the pattern of rainfall and temperature in the last three decades in the woreda;
- To explore effects of climate change and variability on livelihood strategies with particular focus on agriculture and water resources.
- To identify the type and group of society impacted by and vulnerable to climate change and vulnerability.
- To assess the existing responses and adaptation strategies being practiced to climate change or variability risks;

1.4. Research Questions

1. What are the effects of climate change and variability on rural livelihoods of soro *woreda?*
2. How do local communities respond to the effects of climate change and variability?
3. Which group of the society is most impacted by climate change and variability?

1.5. Significance of the Study

Climate change and variability has become a serious challenging factor for the implementation of the country's development strategies. Even though climate change is affecting the whole world, the extent differs from region to region and from locality to locality. Similarly, the coping mechanism differs from community to community. These together indicate the fact that local studies are necessary to understand the extent of variability and climate change at different levels and different coping mechanisms that may be replicated and used as remedial measures in other similar occasions. As the majority of Ethiopia's economy depends on rain fed agriculture, it would be imperative to

enable farmers better understand and adapt to the changing climate of the country. Cognizant of this fact, over the last few years, the Government of Ethiopia (GoE), has been implementing a reform program aimed at poverty reduction through rapid economic growth and macroeconomic stability, which would enable the small holder farmers better adapt to the adverse effects of CC & variability**.** As the issue is the concern of the entire world, especially those of developing countries, which have limited adaptive capacity to respond to the adverse effects of climate change and variability effects, Context based adaptation is imperative. Therefore, this study may contribute little about how to cope up and adapt the effects of climate change and variability. Furthermore, it can provide GOs, NGOs, researchers and policy makers with climate related information about the woreda.

1.6. Limitation of the study

This study had limitation in relation to number of sample size; this is mainly because of absence of the HHHs at their home during the survey and constraints of money. The other challenge encountered during the survey was shortage of secondary data and unwillingness of some officials to be interviewed.

1.7. Delimitation of the Study

Livelihood is very wide concept including many elements and explanatory variables that are related to each other in a complex way. And climate change and variability can affect all elements of livelihood resources (natural capital, human capital and social capital etc). However, this study focused only on the effects of climate variability and change on agricultural production, both crop production and animal rearing and water resources in the study area.

1.8. Organization of the Study

This paper is organized in five chapters. The first chapter deals with the introduction part which includes the background of the study, statement of the problem, objectives, research questions, significance of the study, limitation and organization of the paper. Chapter two is all about review of related literature .The third chapter describes research methodology and description of the study area. Chapter four presents discussion and findings of the study. And the fifth chapter deals with conclusion and recommendations forwarded by the researcher.

CHAPTER TWO

2. Review of Related Literature

This chapter presents the review of related literature. Hence it describes concepts and definitions, causes and manifestations of climate change, observed patterns and projections, the impacts of climate change in Ethiopia and Ethiopia's responses to climate change impacts.

2.1. Concepts and Definitions

Climate change in IPCC usage refers to a change in the state of the climate that can be identified (E.g. using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural Climate variability observed over comparable time periods (IPCC, 2007). Each of these two definitions is relevant and important to keep in mind.

Climate Variability

There is no internationally agreed definition of the term "climate variability". Climate has been in a constant state of change throughout the earth's 4.5 billion-year history, but most of these changes occur on astronomical or geological time scales, and are too slow to be observed on a human scale. For meteorologists and climatologists, however, climate variability refers only to the year-to-year variations of atmospheric conditions around a mean state (NMSA, 1996).

Climate variability refers to a variations in the mean state and other statistics (such as standard deviations, statistics of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events,(http://unfcc.int/resource/cd-roms/na1/gnginventories/english18 -glossary/Glossry.htm).

Vulnerability

As Temesgen, *et al* (2009) argued, the term "vulnerability" has no universally accepted definition, largely because different disciplines use the term differently to explain their area of concern. Studies on natural hazards and epidemiology define vulnerability as the degree to which an exposed unit is susceptible to being harmed by exposure to a perturbation or stress, in conjunction with its ability (or lack thereof) to cope, recover or fundamentally adapt or become a new system or go extinct(Kasperson. *et al*, 2001 cited in Temesgen *et al*, 2009). Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity (IPCC, 2001).

The vulnerability of countries and societies to the effects of climate change depends not only on the magnitude of climatic stress, but also on the sensitivity and capacity of affected societies to adapt to or cope with such stress, Sensitivity to climatic stress is higher for activities entailing climate-dependent natural resources, such as agriculture and coastal resources – often critical for the livelihoods of the poor. The capacity to adapt and cope depends upon many factors, including wealth, technology, education, institutions, information, skills and access to resources, which are generally scarce in poor countries and communities (OECD, 2009).

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information, skills and access to resources, which are generally scarce in poor countries and communities (Ibid, 2009).

Adaptation to Climate Change

Adjustment in natural or human systems is response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptations can be distinguished such as anticipatory, autonomous and planned adaptation (IPCC , 2007).

According to UNFCCC, adaptation is defined as Practical steps to protect countries and communities from the likely disruption and damage that will result from effects of climate change. For example, flood walls should be built and in numerous cases it is probably advisable to move human settlements out of flood plains and other low-lying areas. UNDP, (2010) also defines adaptation as process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed, and implemented. Adaptation is process or outcome of a process that leads to a reduction in harm or risk of harm, or realization of benefits associated with climate variability and climate change. UK Climate Impact Programme (UKCIP, 2003).

Community based adaptation

Community-based Adaptation describes the process of reducing negative impacts of climate change on vulnerable populations–communities, households and individuals– from the bottom up (CARE, 2012). Community-based adaptation is targeted at those most vulnerable to climate change and represents a relatively new approach consisting of community-based development activities, practices, research and policies (Reid, *et al*, 2010). *Community Based Adaptation* (CBA) is increasingly popular as an approach to support vulnerable communities to adapt to climate change. Impacts are already being felt by the pastoralist and farming communities (ALIN and ALP, 2012).

2.2. Conceptual framework

This study is aimed at assessing the effects of climate change and variability on rural livelihoods and the responses of rural people to the effects of, CC and variability.

Communities and households face climate related stresses such as increased surface temperature, changes in the timing and amount of rainfall, hail storms, floods, droughts, wind instability etc (IPCC, 2007). Thus, the lives and livelihood assets of the rural community are under such threats and their associated consequences.

The institutions and processes operating from the household to national level determine an individuals' household' s or communities' access to assets, livelihood options, and thereby affect the vulnerability to climate change impacts. As reported by different researchers, Deresa *et al*. (2008), Yusuf *et al*. (2008), there are many climate change adaptation livelihood strategies, including changes in crop variety and planting dates, crop diversification, irrigation development, water harvesting, tree planting, herd splitting, herd mobility, cattle breeding, migration, etc. Therefore, understanding the diverse and dynamic rural livelihoods strategies helps to identify appropriate intervention (adaptation measures) so as to improve the wellbeing of livelihood out comes

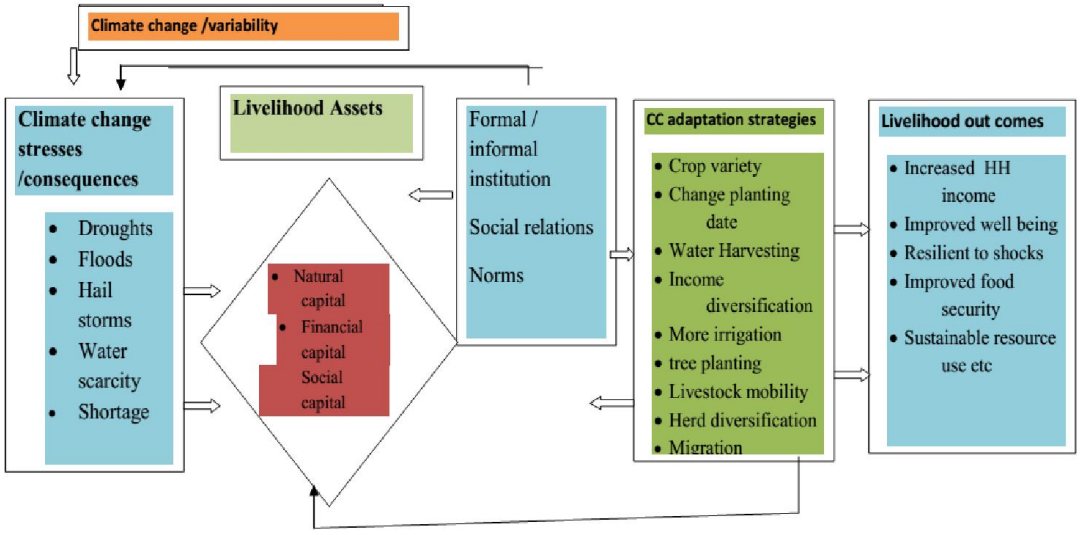

Figure 2.1 Conceptual framweork.Source; adapted from Habtamu & Dawit,2011.

2.3. Causes and Manifestations of Climate Change

The Earth's climate has changed many times during the planet's history, with events ranging from ice ages to long periods of warmth. During the last centuries natural factors such as volcanic eruptions or the amount of energy released from the sun have affected the Earth's climate on a smaller scale. By the 1950s and early 1960s, it was becoming clear that human activities were releasing CO2 fast enough to significantly increase its atmospheric abundance (Dessler & Parson, 2006).

Beginning since the 19th century, due to human activities associated with emissions of carbon dioxide and other greenhouse gases the composition of the atmosphere has changed. The Fourth Assessment Report of the IPCC published in 2007 stated that: 'Most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic (*human caused)* greenhouse gas concentrations (Pender, J.S. 2001). The scientific community has reached consensus that this changes cause a warming of the atmosphere and therefore influencing the Earth's climate. Continuation of greenhouse gas emissions can result in additional warming over the 21st century up to 4.5 °C by 2100, (Mosbrugger*, et al,* 2008).

Land-use and land- cover changes influence carbon fluxes and GHG emissions (Houghton, 1995; Braswell *et al*. 1997), which directly alter atmospheric composition and radiative forcing properties. They also change land-surface characteristics and, indirectly, climatic processes. Established evidence links land degradation to the loss of biodiversity and climate change, both as cause and effect. CO2 -induced climate change and land degradation remain inextricably linked because of feedbacks between land degradation and precipitation. Climate change might exacerbate land degradation through alteration of spatial and temporal patterns in temperature, rainfall, solar radiation, and winds (Sivakumar , 2011).

As noted above, natural variability and human activities are the causes of climate change. The contribution of human activities to climate change, however, is increasing. The probability that human activities are the main cause for the increase in temperature since the mid-twentieth century has risen from 66 % in 2001 to more than 90 % in 2007(Keshav and Niraji, 2013)

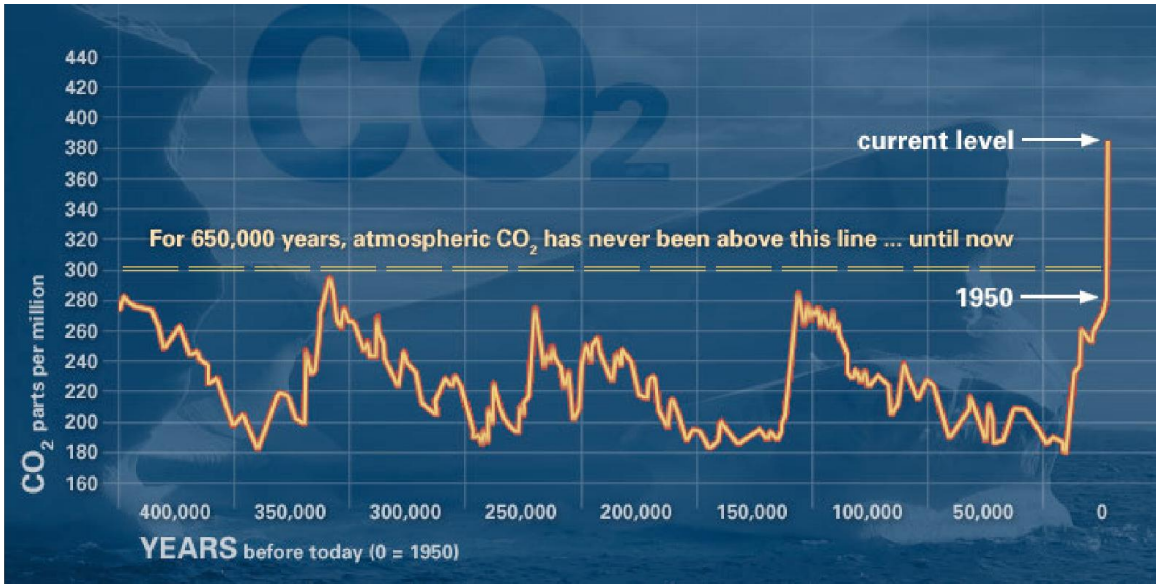

Figure. 2.2. The trend of atmospheric CO2 since the industrial revolution

This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO2 has increased since the Industrial Revolution.**(Source: NOAA***).*

Rising fossil fuel burning and land use changes have emitted, and are continuing to emit, increasing quantities of greenhouse gases into the Earth's atmosphere (UNFCCC, 2007). These greenhouse gases include carbon dioxide (CO2), methane (CH4) and nitrogen dioxide (N2O), and rise in these gases has caused raise in the amount of heat from the sun with held in the earth's atmosphere, heat that would normally be back into space, (Ibid).Greenhouse gases and aerosols affect climate by altering incoming solar radiation and out-going infrared (thermal) radiation that are part of Earth's energy balance. Changing the atmospheric abundance or properties of these gases and particles can lead to a warming or cooling of the climate system. Since the start of the industrial era (about

1750), the overall effect of human activities on climate has been a warming influence. The human impact on climate during this era greatly exceeds due to known changes in natural processes, such as solar changes and volcanic eruptions (IPCC, 2007).

The knowledge of climate change manifestations is of paramount importance to understand its impact on different sectors. The increase in average temperature of the planet and change in hydrological cycle are major manifestations of climate change (Lovejoy and Hannah, 2005 cited in Leta A.).The main characteristics of climate change are increases in average global temperature (global warming); changes in cloud cover and precipitation particularly over land; melting of ice caps and glaciers and reduced snow cover; and increases in ocean temperatures and ocean acidity –due to seawater absorbing heat and carbon dioxide from the atmosphere (Ibid).

2.4. The Impacts of Climate Change

Climate change is considered as the biggest environmental threat in human history and the defining human challenge for the twenty-first century. Consequences of climate change are already felt throughout the earth system. The effects of climate change are observed on every continent and in all sectors (IPCC, 2007). Climate change is already affecting rainfall amounts, distribution, and intensity in many places. This has direct effects on the timing and duration of crop growing seasons, with concomitant impacts on plant growth. Rainfall variability is expected to increase in the future, and floods and droughts will become more common. Changes in temperature and rainfall regime may have considerable impacts on agricultural productivity and on the ecosystem provisioning services provided by forests and agro forestry systems on which many people depend (Thornton & Lipper, 2014).

Climate change affects all countries, but those likely to be worst affected are the world's poorest countries, especially poor and marginalized communities within these countries. Ironically it is these poor countries and people who have contributed least to the problem of climate change, because of their very low greenhouse gas emissions, but who will suffer most from its consequences (Hannah, *et al*, 2010). The foregoing argument shows

that climate change can no longer be sidelined as a development issue. The effect that climate change has on the poor communities in sub-Saharan Africa is increasingly prominent (Dube, 2013).

As indicated in IPCC (2007) report, climate change impacts on water demand are predicted to be highly significant in Africa. The number of people facing water scarcity due to unreliable rainfall and drying up of springs and rivers is expected to be between 75 to250 million people by 2025. Furthermore, this is likely to have severe impacts on crop yields, as the majority of the African population (over 85 percent in the case of Ethiopia) depend on rain fed agriculture, (IPCC, 2007). Climate change will aggravate the water stress currently faced by some countries, while some countries that currently do not experience water stress will become at risk of water stress (IPCC, 2007).

2.5. Climate Change in Ethiopia; Observed patterns & projections

Like much of Africa, Ethiopia has become warmer over the past century and human induced climate change will bring further warming over the next century at unprecedented rates, (EPA, 2011).In the last decade, the country has been subjected to drought, floods, new insect pests, new vector-borne diseases and other problems made worse by climate change. According to the UNDP Climate Change Profile for Ethiopia (Oxford, 2008, cited in Dawit and Habtamu,2011), the mean annual temperature in Ethiopia has increased by 1.3°C between and 2006, at an average rate of 0.28°C per decade. The temperature increase has been most rapid from July to September (0.32°C per decade). It is reported that the average number of hot days per year has increased by 73 (additional 20% of days) and the number of hot nights has increased by 137 (additional 37.5% of nights) between 1960 and 2006(Dawit and Habtamu,2011).

Ethiopia's diverse agro ecological zones are characterized by a dazzling variety of micro-climates and corresponding weather patterns. Over centuries, its people have developed agricultural systems adapted to Ethiopia's diverse environment. However, the rapid pace of climate change, along with increasing socioeconomic pressures, threatens to overwhelm their ability to cope (Bishaw, *et al*, 2013). Over the past three decades,

Ethiopia has experienced countless localized drought events and seven major droughts, five of which resulted in famines (World Bank Group , 2010).

A recent mapping on vulnerability and poverty in Africa, by Yusuf *et al* (2008), put Ethiopia as one of the countries most vulnerable to climate change with the least capacity to respond. Cycles of drought create poverty traps for many households, constantly thwarting efforts to build up assets and increase income. These shocks are a major cause of transient poverty: had households been able to smooth consumption, then poverty in 2004 would have been at least 14% lower, a figure that translates11 million fewer people below the poverty line. Food shortage and famine associated with rainfall variability cause a situation of high dependency on international food aid. And Ethiopia is one of the biggest food aid receipt countries in Africa that accounts to 20-30% of all food aid to sub-Saharan Africa(Bezu and Holden , 2008).

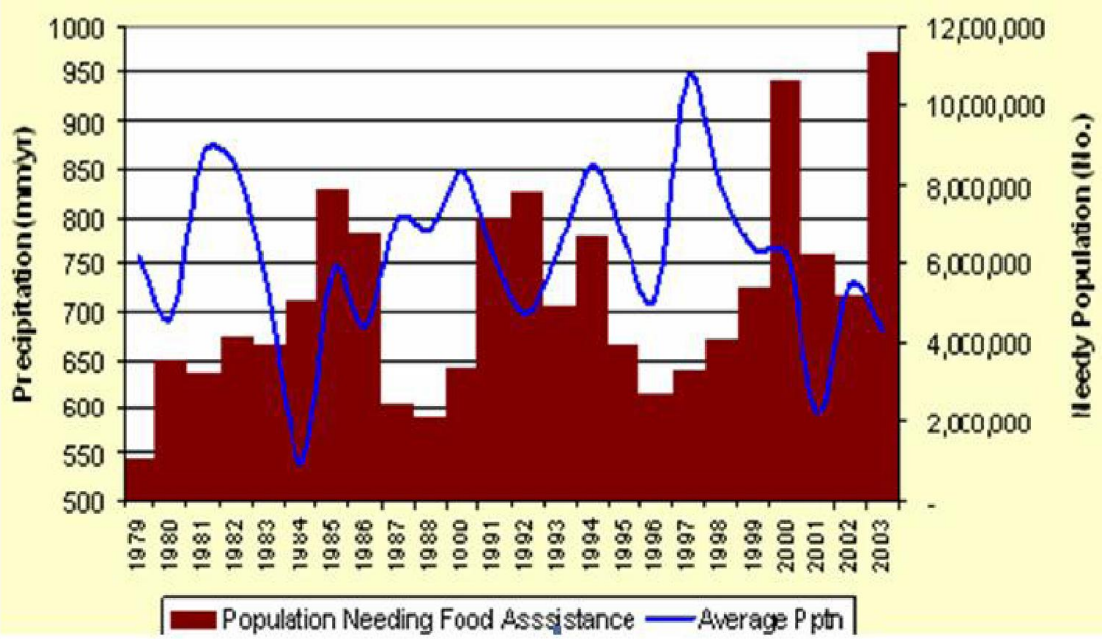

Figure.2.3. Rain fall variability and food aid in Ethiopia

Source: site resources. worldbank.org/.../Ethiopia_ Country- Note. pdf (2007), adapted from, (IDRC, 2010).

The country faces considerable hurdles in coping with the adverse impacts of long-term climate change. Low economic development, inadequate infrastructure, and lack of institutional capacity all contribute to the country's vulnerability to the adverse impacts of climate change (IFPRI, 2011).

As explained in NMA (2007), baseline climate that was developed using historical data of temperature and precipitation from 1971- 2000 for selected stations in Ethiopia, showed a very high year-to-year variation in rainfall for the period 1951 to 2005 over the country expressed in terms of normalized rainfall . Over those periods (1951-2000), some of the years have been dry resulting in droughts and famine while others were characterized by wet conditions (NMA, 2007). During extreme drought conditions, it is common that many farmers in the country either die due to hunger or depend on foreign food aid to sustain their lives (Temesgen., *et al*., 2010). The observed trend in annual rainfall, however, remained more or less constant when averaged over the whole country (NMA, 2007).

Studies also indicate that there has been a very high temperature variation and change in its trend over time. Annual minimum temperatures for the period 1951 to 2005 expressed in terms of temperature differences from the mean and averaged over 40 stations showed a very high variability (NMA, 2007). The country experienced both warm and cool years over those 55 years even though the recent years are generally warmest compared to the early periods.

According to NMA (2007) forecast, the country will experience an increasing level of temperature and precipitation in the coming decades. Using the software MAGICC/SCENGEN (Model for the Assessment of Greenhouse-gas Induced Climate Change)/ (Regional and global Climate Scenario Generator) coupled model for three periods centered around the years 2030, 2050 and 2080, NMA (2007) generated that the mean annual temperature will increase in the range of 0.9-1.1°C by 2030, in the range of 1.7-2.1°C by 2050 and in the range of 2.7-3.4°C by 2080 over Ethiopia for the IPCC mid range emission scenario compared to the 1961-1990 normal.

According to the National Meteorological Agency, long-term climate change in Ethiopia is associated with changes in precipitation patterns, rainfall variability, and temperature, which could increase the country's frequency of both droughts and floods. Although both developed and developing countries are affected by climate change, developing countries face greater challenges in overcoming its adverse consequences. Ethiopia is one of the least developed countries in the world; with a per capita income of less than US$130 in 2006. Low economic development, inadequate infrastructure, and lack of institutional capacity all contribute to the country's vulnerability to the adverse impacts of climate change (IFPRI, 2010).

2.6. The Impacts of Climate Change & Variability in Ethiopia

Ethiopian climate is characterized by a history of climate extremes, such as: droughts and floods; and increase and decreasing in temperature and precipitation, respectively. The history of climate extremes, especially drought, is not a new phenomena in Ethiopia. The most drought prone and affected areas of the country are in the northern, eastern and southern parts. Total failure or shortage of rainfall is often cited as the major cause for the recurring droughts and harvest failures. Such a problem or situation is further exacerbated by the social, economic and ecological situations (Dawit & Habtamu, 2011).

Continued climate change is expected to bring greater variability, and extreme weather events (e.g. droughts) which will further drive degradation of the country's ecosystems. The impact of climate change in Ethiopia is already apparent in the increasing temperature and declining rainfall, particularly in northern parts which are exceptionally vulnerable to drought (Cesar and Ekbom, 2013).

Ethiopia is also vulnerable to the health impacts of climate change, and to climate induced damage to transportation infrastructure. The implications of future climate change will be felt throughout these particularly vulnerable sectors, although secondary impacts will be felt more widely, for example in education and gender equity. A recent study by the World Bank projects that, unless steps to build resilience are effective,

climate change will reduce Ethiopia's GDP growth by between 0.5 and 2.5% each year(CRGE, n. d)Ethiopia is also vulnerable to the health impacts of climate change, and to climate induced damage to transportation infrastructure. There are strong links between environment and health concerns in Ethiopia, particularly related to malnutrition, indoor air pollution and water-related diseases (Cesar and Ekbom, 2013).

Ethiopia is especially vulnerable to climate variability and change because large segments of the population are poor and depend on agricultural income, which is highly sensitive to rainfall variability. Most have low access to education, information, technology, and basic social and support services, and, as a result, have low adaptive capacity to deal with the consequences of climate variability and change (Oxfam 2010, The World Bank Group 2010, Regassa *et al*, 2010, cited in Bishaw *et al*., 2013).

2.6.1. Impacts on Agriculture

Climate change can affect agricultural production in a variety of ways. Temperature and precipitation patterns, extreme climate conditions, surface water runoff, soil moisture and CO2 concentration are some of the variables which can considerably affect agricultural development (IPCC, 2007; Zhai and Zhuang, 2009).

Ethiopian agriculture is heavily dependent on natural rainfall, with irrigation agriculture accounting for less than 1% of the country's total cultivated land. Thus, the amount and temporal distribution of rainfall and other climatic factors during the growing season are critical to crop yields and can induce food shortages and famine (CSA, 2008). Like many other developing countries, agriculture (with the largest number of livestock in Africa) is the single largest livelihood of an overwhelming majority in Ethiopia, 85% of the population (ibid).

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. Even

weeks delay in the onset of rain was found to have significant difference on the harvest and has deprivation of households' livelihood (Abate, 2009).

2.6.2. Impacts on Livestock Production

Similar to crop production, the impact of climate change and variability in the livestock production is generally negative. Heat stress and its impact on seasonal water availability have a variety of detrimental effects on livestock, with significant effects on milk production and reproduction in dairy cows, and swine fertility (Nigus, 2011). Drought and delay in the onset of rain led to poor grass regeneration/forage deficit, water shortage and heat stress on livestock, and consequently increased the mortality of the livestock, vulnerability to diseases and physical deterioration due to long distance travel for water and pastures (Abate, 2009).

Climate change affects livestock both directly and indirectly. The direct effects from air temperature, humidity, wind speed and other climate factors influence animal performance: growth, milk production, wool production and reproduction. Climate change will have far-reaching consequences for dairy and meat production, especially in vulnerable parts of the world where it is vital for nutrition and livelihoods. The impact of climate change can heighten the vulnerability of livestock systems and exacerbate existing stresses upon them, such as drought(Abebe, 2013). The most vulnerable communities to the impacts of climate change inhabit the dry lands areas. Pastoralists inhabiting dry lands have been able to survive the harsh environments practicing various sustainable livelihood approaches including seasonal movements, keeping livestock, among others(UNDP, 2010).

2.6.3. Impacts on Water Resources

Water is an essential resource for all life and a requirement for good health and sanitation. It is a critical input for industry and essential for sustainable growth and poverty reduction. Climate change will alter patterns of water availability by intensifying

the water cycle. Droughts and floods will become more severe in many areas. There will be more rain at high latitudes, and less rain in the dry subtropics (Pender, J.S. 2001).

Observed warming over several decades has been linked to changes in the large-scale hydrological cycle such as: increasing atmospheric water vapor content; changing precipitation patterns, intensity and extremes; reduced snow cover and widespread melting of ice; and changes in soil moisture and runoff. Precipitation changes show substantial spatial and inter-decadal variability (*Bates et al,* 2008).

Climate change is also likely to intensify the current challenges of water scarcity and water competition within and between communities and nations, linked by hydrological flows across watersheds and basins. By the middle of the 21st century, annual average river runoff and water availability are projected to increase as a result of climate change at high latitudes and in some wet tropical areas, and decrease over some dry regions at mid-latitudes and in the dry tropics.

Poor and vulnerable populations of SSA are likely to face the greatest risk. Moreover, there is recognition that climate change, mainly as a result of human action, is impacting SSA more than other continents because its economies are largely based on weather-sensitive crop-livestock and agro pastoral production systems and also due to the low adaptation capacity of SSA countries to climate change and variability (FAO, 2011).

2.7. Responses to Climate Change in Ethiopia

2.7.1. Individual and Community Responses

Societies are dynamic and they use all possible strategies to reduce the vulnerability to climatic impacts. There are two kinds of responses to crisis that overlaps across the temporal scale, coping mechanisms and adaptive capacity. Coping mechanisms are the actual responses to crisis on livelihood systems in the face of unwelcome situations, and are considered as short-term responses (Berkes& Jolly 2001, as cited in Abate, 2009). Adaptation to climate change is a response (processes) through which people reduce the adverse effects of climate on their health and well-being, and take advantage of the

opportunities that their climatic environment provides (Burton 1992, cited in Niguse, 2011).

As already mentioned, for many centuries, Ethiopia has been characterized by climate variability and change and the local people have developed different adaptation strategies. These include early , indigenous soil and water conservation techniques, diversification of crop and livestock species, mobility, reciprocity, customary conflict resolution etc. Thus, the historical accounts indicate that adaptation had been practiced in Ethiopia before the concept of "climate change" was developed (OECD,2009) .

A study conducted in Ethiopia by Habtamu., G, (1999) , stated that there is evidence that ancient churches, monasteries and castles used to collect rain water from rooftops and the history of rain water harvesting by the Axumite kingdom dates back as early as 560B. During this period rainwater was harvested and stored in ponds for agriculture and water supply purposes. Even to this day water harvesting is often practiced individuals different parts of Ethiopia using small bunds or dikes made of dirt, stone or living vegetation along slope contours. In SNNPRS Inset (false banana) is a drought resistance crop considered as a crop of bad times using it as last resort (IPCC, 2007). Hence, this is also one of the coping mechanisms where drought anticipated.

According to Sorhaug., A.,(2013) locally the most widely practiced coping and adaptation strategies to climate change in Ethiopia includes: crop diversification, mixed farming, tree planting, off farm activities, soil and water conservation, selling of assets, use of improved seeds Inset production , food aids and irrigation as the most widely practiced adaption strategies by individuals in response to climate change and variability effects in Ethiopia.

According to (2007) NMA report, traditional and contemporary coping mechanisms to climate variability and extreme in Ethiopia 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 in search of employment, grain storage, sale of assets such as

livestock and agricultural tools, mortgaging of land, credit from merchants and money lenders, food appeal/aid, etc.

Communities and societies in general have long been responding or adaption measures to climate changes, but these adaptations have typically been discrete and reactive. The idea that adaptation to climate change should be planned, proactive, and anticipatory is relatively new and is an important element of CBA (UNDP, 2010). Although climate change is universal phenomenon, its indicators and manifestations are entirely local. However, until recently, most efforts to help countries adapt focused on national planning and top-down approaches based on climate change modeling. Remarkably little attention has been paid to the ways in which poor people have been coping with climate variability and extremes for decades. There has, thus, been increasing emphasis on the bottom – up approach that climate change studies should be conducted at the local level where adaptation ultimately takes place (Maharaja & Joshi, 2013).

Community-based adaptation (CBA) as a response to climate change has evolved as a systematic, participatory, *bottom-up* approach. And it strengthens the resilience of communities and the ecosystems, upon which they rely in light of climate impacts, (Mannke, 2011). The use of genuine participatory processes is important if CBA is to fit with community priorities and build on existing practices or those used in the past. Participatory tools are sometimes used as a way of collecting local information about vulnerability and climate change to be used and analyzed by outsiders and it is not uncommon for the priorities and interests of outsiders to over ride those of communities in any subsequent planning,(Reid, Huq and Murray ,2010).

The aim of CBA is to enable the community to understand and integrate the concept of climate risk into their livelihood activities in order to increase their resilience to immediate climate variability and long-term climate change. Community-based adaptation is essentially an action research approach to the problem of climate change impacts on livelihoods,(Ensor and Berger,2009). Incorporating or integrating adaptation to climate change into planning processes is a necessary strategy for sustainable development over the long term. Climate change impacts do not happen in isolation;

impacts in one sector can adversely or positively affect another; sectors can be affected directly and/or indirectly by climate change. In order that real progress can be made, key governmental departments (such as ministries of finance) need to be involved in the development of adaptation strategies, (UNFCCC, 2007).

Accordingly, this study describes CBA as any group–based approach to adaptation with the following characteristics:

- It requires collective action and social capital.
- It incorporates information about long–term climate change and the anticipated impacts into planning processes.
- It integrates local knowledge and perceptions of climate change and risk management strategies.
- It emphasizes local decision-making processes.
- It is in accordance with community priorities and needs.
- It provides poverty reduction or livelihood benefits.

2.7.2. Institutional and Policy Responses

Ethiopia has ratified the UNFCCC and Kyoto Protocol in April 1994 and 1997 respectively. It has also designated institutions to follow up the implementation of the environmental and climate issues in the country (Dawit & Habtamu, 2011). Over the last two decades, the Ethiopian government has put in place a number of policies, strategies and laws that are designed to support sustainable development. The country has developed and implemented a wide range of legal, policy and institutional frameworks on environment, water, forests, climate change, and biodiversity (César & Ekbom, 2013). Among others, the Environment Policy of Ethiopia (EPE) and the Conservation Strategy of Ethiopia (CSE) approved in 1997 enabled the country to develop specific mechanisms to fulfill its obligations regarding the UN Framework Convention on Climate Change.

The Ethiopian Environmental Protection Authority (EPA) issued the Climate Change National Adaptation Programmes of Action (NAPA), thus identifying the integration of climate change adaptation activities with national development policies. The NAPA process in Ethiopia identified arid and dry sub-humid areas of the country as being most vulnerable to drought; in addition, agriculture was identified as the most vulnerable sector where small-scale rain-fed subsistence farmers and pastoralists are identified as the most at risk(Ibid,.P.13).

Established under the leadership of the late prime minister Meles Zenawi, the country embarked on a Climate Resilient Green Economy (CRGE) initiative, a key plank in the wider and even more ambitious Growth and Transformation Plan, GTP (MoFED, 2010). This plan seeks to enable an economic transformation to middle income status by 2025. The CRGE is receiving substantial support from UKAid, South Korea, Japan and the UNDP (Leulseged, *et al*, 2013).

Government and development agencies are now emphasizing that future agriculture development should be 'climate smart', enabling systems that are more resilient and adaptive to climate change. The basic concept is of a system that maintains or increases production of foods or other crops, supports livelihoods and sustains environmental resources and ecosystems, adapts to existing and future climate, sequesters carbon and/or reduces GHG emissions (Beddington *et al*, 2012).

The Ethiopian Environmental Protection Authority is also leading the process to ensure effectiveness of the climate agenda in a coordinated yet decentralized manner. In its national response, EPA will build on the existing climate change policies and strategies: (1) the National Adaptation Framework Program, comprising of 20 vulnerable sectors and groups, is developed, negotiated and accepted with some modifications; and (2) the Nationally Appropriate Mitigation Actions (NAMA) of Ethiopia, which comprises of various sectors and 83 concrete projects, has been registered by the Secretariat of the UNFCCC in line with the Copenhagen Accord.

The country is also synthesizing the existing strategic policies and thinking of the government with the sole objective of facilitating the national process to construct a carbon neutral/climate resilient economy (CNCR Ethiopia). The aim of the program is to put in place strategic and action oriented framework that enables Ethiopia to respond effectively to climate change starting from the lowest effective administrative unit. It is expected to provide strategic directions and guidance on how and what elements should be mainstreamed into Ethiopia's core socio-economic development programs in order to construct a carbon neutral/climate resilient economy (Dawit and Habtamu, 2011).

According to CRGE plan, though there are the environmental policy and laws set out the basis for dealing with climate change, it is essential to recognize that the implications of climate change and the steps required for an effective response go well beyond environmental management. Climate change must not be considered as a narrow sectoral issue. Instead a cross-sect oral response is needed, involving the whole of the government. The response will require cooperation, planning and action across government sectoral ministries and agencies, from finance to agriculture, from education to foreign affairs; regional government and woreda administrations; and outside government, by civil society, religious groups, the private sector, local communities, academic and research institutions, international and national NGOs and development partners. With so much complexity, and the need for involvement of so many different actors, the response needs strong strategic leadership (CRGE,n.d).

Climate resilience is therefore, the ability to cope with, and manage the change brought by weather stresses and shocks. A climate resilient economy is one which is protected against the negative impacts of extreme climate events, normally referred to as the weather, and climate change so that the well-being of the people and the economic growth and prospects of the country are not damaged by the impacts. Climate change will impact on all aspects of Ethiopia's economy, and particularly on health, infrastructure/ transport, agriculture, natural resources, energy and industry sectors. Climate resiliency has tremendous dimensions and the impact goes accordingly on environment

(environmental resilience, Biodiversity resilience), social (community resilience, knowledge resilience) and economy (Kindu ,*et al*, 2012)

It is critically important to understand better the role of institutions in shaping adaptation, especially the role of local institutions, if adaptation to climate change is to help the most vulnerable social groups. Adaptation to climate change is highly local, and its effectiveness depends on local and extra-local institutions through which incentives for individual and collective action are structured. Not only have existing institutions affected how rural residents responded to environmental challenges in the past, they are also the fundamental mediating mechanisms that will translate the impact of external interventions to facilitate adaptation to climate change(Agrawal ,2008)

Local institutions structure livelihood impacts of climate hazards through a range of indispensable functions they perform in rural contexts. Institutional functions include information gathering and dissemination, resource mobilization and allocation, skills development and capacity building, providing leadership, and relating to other decision makers and institutions. Each of these functions can be disaggregated further, but the extent to which any given institution performs the above functions depends greatly on the objectives with which the institution was formed, and the problems it has come to address over the course of its existence (ibid, p.11).

Adaptation depends not only on access to assets, information, and biophysical characteristics, but must also be viewed within the context of the institutional environment in which it takes place. Institutions, including markets, laws, policies, organizations, and social and cultural norms influence how an individual, household, or community perceives, is affected by, and responds to climate change (Agrwal and Perrin 2008).

CHAPTER THREE

3. Methodology

This chapter briefly describes the methodology part of the study and the study area. Thus, this study employed both qualitative and quantitative approaches to collect analyze and interpret data.

3.1. Description of the Study Area

3.1.1. The Hadiya Zone

The Hadiya zone is found in the southern Nations, nationalities and people's regional state of Ethiopia. The zone is geographically located in 7°3′19″-7°56′1″N and 37°33′14″-38°52′12″ E. It is one of the most densely populated parts of Ethiopia. Its population reaches 1243776 (CSA , 2007). By 2010 based on the census report projection, it has increased to 1316962. Total area of the study is 3850 square km and the population density is 357/square km. More than 90% of its population depends on agriculture for subsistence.

Hadiya zone has three distinctive agro-ecological zones with average rainfall and temperature 1150mm and 16.4 respectively. The zone is traditionally divided in to three agro ecological conditions such as *Dega*,(cool and humid) 23.7% experiencing higher rainfall and cooler temperature, *woyine dega* 64.7%(cool and sub humid), with somewhat moderate amount of rainfall and temperature, and kola(warm and semi arid), 11.6% ,with relatively low rain fall and high temperature. Altitude and humidity have significant impact on temperature condition in Ethiopia. The warmest months of the area are between February and May. On the contrary, the coldest months of the study area range between June and August. October and November are windy months.Hadiya zone has the total area of 309492.74 hectares of land. Of which 2159.16 ha is covered by water. From the total land area of Hadiya zone , 236511.43 ha(76.4%) is cultivated , 17454.12 ha (5.6%) is grazing land , 17326.74 ha(5.59%) is covered by forests of both

manmade and natural and the remaining 246041.29 ha (11.67) is used for settlements, construction of social institutions and other purposes(HZARDO, 2013).

3.1.2. Soro Woreda

The study was conducted in Soro district. Soro is one of 10 *woredas* in Hadiya zone which is located at *7030'-70 43_* North latitude and *37035'-380 05'* East longitudes (See, Fig. 3.1). It is situated in the Southern-tip of the zone and bordered by Gombora district in the North; Oromiya Region (Omo River) and Yem Special District in the West; Dawro Zone, Kambeta (KAT) Zone, and Duna *Woreda (*District) in South and Southeast; Lemo *woreda (*District) and again Kembata Timbaro Zone in the Northeast and East. The total land area of the district is 58,061ha which comprises of 46 rural *kebeles*. The administrative center for *Soro woreda* (District) is *Gimbichu town*; which is 264 km far from Addis Ababa (National capital) and 200 km far from *Hawasa* city the regional capital, of the SNNPR.

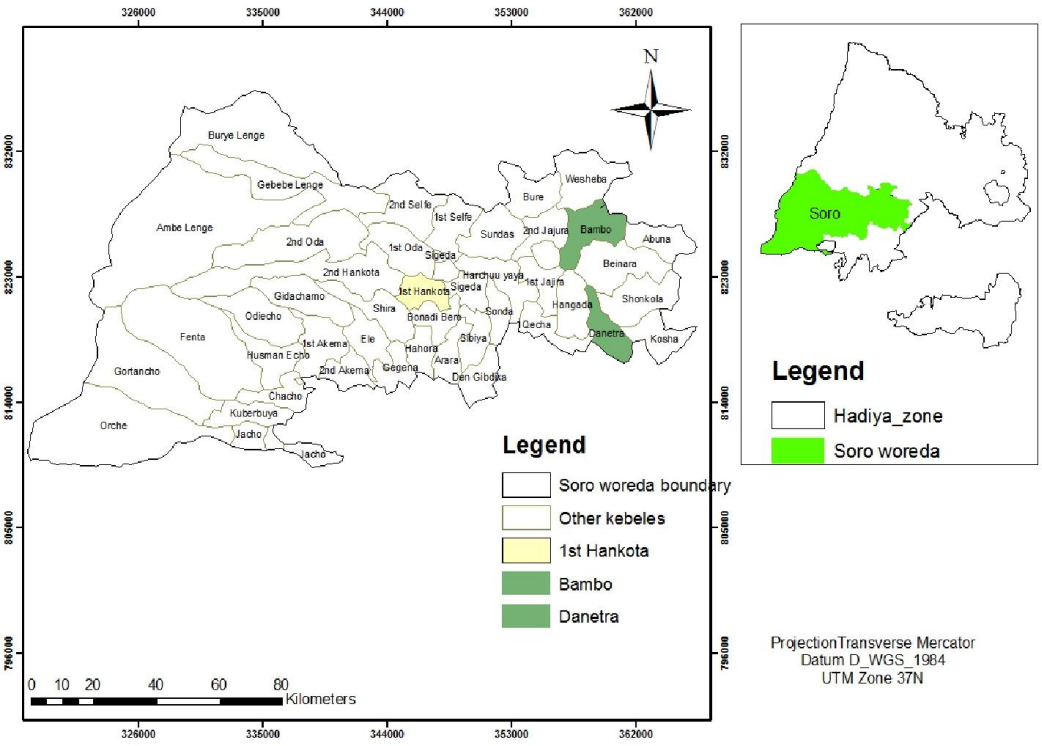

Figure.3.1. Administrative map of soro woreda. Source CSA ;(2014).

Demography and Socio-economic Setting

The total population of the district was about 196,693; with 98,229 males and 98,464 females. The population density of the area is about 338 persons per square kilometer. According to the district Finance office and population and housing annual report, the population for the year 2009/10 was 217,452. Male Populations account about 108,271 (49.8%) and females were about 109,181(50.2%). About 95.9% of population of Soro District is involved in agriculture and reside in rural areas experiencing declining food security (Kibemo, 2011).

Bio-Physical Conditions

Topographically the study area is characterized by steep slopes, moderately gentle lands and flat plains in certain areas. The altitude of the district ranges from 1454 to 2850m above sea level, (Soro woreda Agricultural and Rural Development Office, 2010).

Soro Woreda Land Cover and Soil Types

The study area has an old history of land use with high erosion damages especially with increasing slopes. As the remnants of the trees depict, the area has once been covered by dense indigenous forests. However, the vegetation cover has been removed partly for cultivation and it has also been replaced by some exotic species such as eucalyptus tree. Between 1974 and 1991, the forest coverage declined to 32% and rapidly went down to 15% between 1991 and 2008. Major reason for this rapid decline of forest coverage was extensive deforestation due to the population growth and expansion of cultivation land. Thus, like other parts of the country, natural vegetation of the area has been influenced by human activities. Like forestland, grassland and bush land is also overgrazed and then gradually changed into farmland. Because of this shortage of grazing field, farmers have owned small numbers of animals. As result, accelerated soil erosion and fertility decline become the main problem of the area once the forest cover was lost, (Kibamo, 2011).

The wide diversity in climate, topography and vegetation cover in the study area has given rise to marked variations in soils, even within relatively small area. As farmers' classification, the dominant soil types are red-brown to red clayey soils on undulating land to steeping lands including the rolling plateau. These soils are relatively fertile and productive than grayish soil types which dominated the flat to undulating lands. The common soil types are Vertisol, Cambisol, Rigosol, (SWARD, 2007).

Rainfall and Water Resource

Soro woreda is a typical of the moist *weyine-dega* agro-ecological zone (8%dega, 55%weyna-dega and 37% kola). The mean annual total rainfall is about1260mm and has has two rainy seasons, *Belg* and *Kiremt*. Belg is the short rainy season and lasts between March and May. The *Kiremt* season, which is the longest rainy season, lasts between June and September. More than 75% of the total rain falls during this season and the highest rainfall occurs in July and August. Rain that occurs during the *Kiremt season* is very intensive and, hence, the severity of soil erosion is high during these two months. Most of the crop production also takes place during the *Kiremt* season. Even though there were some variations with respect to cessation, amount and distribution, the *belg* rains were by large favorable in most areas of the district. For example, onset of the rain was timely in almost all Belg producing kebeles of the district and most districts of the Hadiya zone (kibemo, 2011).

Livelihood System of Soro Woreda

The livelihood of the people in the district depends mainly on mixed farming (crop-livestock production). Dominantly growing crops in the study area include wheat, teff, sorghum, bean and pea, barley, maize, potato and Enset. None of these crops could be grown without chemical fertilizer application since natural fertilizer of the soil is insufficient, except Inset. Enset is the staple food in the area and almost always grown for consumption and also for sale. Fruits such as avocado, banana, mango, papaya and citrus species are also cultivated for household consumption and to some extent income generation. Major crops such as teff and wheat and others are grown once in a year

during the long rainy season. Some crops such as maize, barely, Inset, and potato are also grown during the small rainy season. Crop productivity is declining from year to year. Economically, agriculture serves as the main economic foot and means of livelihood to the majority of the people and characterized by traditional mixed farming as it includes both crop and livestock production. More of it is rain-fed with gradual prevalence of drought and crop failures.

Cattle production is the major part of all production systems in Ethiopia. There is a wide range of reasons for which households keep cattle. The reasons vary across ethnic groups, agro-ecological and socio-economic conditions. If the household keeps cattle for several reasons like the pastoralists, livestock can be regarded as means towards the realization of several needs (Musemuwa *et al*., 2007 cited in misginew). Traditionally the Hadiya pastoralists have something special with their cattle both culturally and from religious point of view (the belief that the spirit of traditional god (''wa'a") dwells in cattle. This tradition is hitherto being mainly practiced by the 'Soro' clans (occupy three districts) and yet the motive behind the pastoralists is to secure the cultural title of '*Tibima/Abegaz/Gerad and Kumima*' which is attained in ascending order after achieving the first stage i.e. possession of at least 100 cattle would be "*Tibima /Garad*" and the second, in which single individual can own more than 1000 cattle and hold the *kuma* title. According to Misginaw (2011) ,thirty percent of the households kept cattle for prestige as their first reason, 29% kept for as source of income (livelihoods), 18 % for social functions 15% for they have no land, and the remaining 3% for cattle production.

Table.3.1 Livestock composition of Soro Woreda in 2013

Animal types***(species)***	*Animal population in number in 2012/2013*
Cows	145 695
Sheep	26106
Goats	21876
Mules	1428
Horses	1861
Donkeys	5956
Hens	78304

Source; soro woreda agriculture and rural development office ; (2014).

3.2. Data Sources and Instruments

In order to generate the necessary data for the research work, both primary and secondary sources of data have been used.

Primary data was collected from household surveys using structured questionnaires, FGDs (ocus group discussions), and key informant interview.

In addition to aforementioned primary sources, secondary sources such as Published and unpublished literatures were collected from different government offices. Data on crop production were collected from District's (*woreda*) Agriculture and rural development office. Precipitation and temperature values (data) were collected from NMSA, Monthly total precipitation and Temperature values were computed.

The study involved a range of data collection methods. Data was collected from interview which was made with different officials and experts of SWARDO, DAs and some notable farmers, Focus group discussion and structured questionnaire has been administered from the three selected *kebeles*. Structured survey questionnaire was administered so as to get

detailed information with regards to the three kry methodologies such as impact assessment, vulnerability assessment and coping and adaptation methods assessments.

Key Informant Interview

Primary information about the local indicators of climate change, its possible impacts on the livelihoods of the smallholder farmers and the adaptation methods were obtained through different data collection methods. Then, key informant interview as one of data collection methods was carried out with knowledgeable and experience rich experts from the *woreda's* agricultural office and DA agents. Accordingly, three experts from ARDO and five DAs were interviewed once and semi structured check list was employed to conduct interview with both experts from agriculture and rural development office and development agents.

Focus Group Discussion

Focus group discussion (FGD) was conducted in the three *kebeles* of the study area, and in each *kebele* one focus group discussion had been conducted. Each focus group discussion was composed of 6 individuals who were selected based on the following parameters such as, age groups, sex and socio economic status .During the focus group discussion, the perception of farmers about climate change in the area, indicators of climate change particularly rain fall variability, pattern and reliability and the change in temperature and occurrence of extreme events were given an emphasis. Participants of focus group discussions have also discussed on coping mechanisms and adaptation strategies (which encompassed communal properties and community based adaptation) being undertaken by households to the existing climate variability and change including the main challenges of the society to cope up and adapt well to the changing climate of their locality.

3.2. 1. Sampling Procedure

In order to select sample *kebeles and household heads,* multi stage sampling techniques have been employed. In the first stage the woreda was divided in to three distinct agro ecologic conditions such as *Dega, woyine Dega and kola. In the second stage* three *kebeles* (lowest administrative unit) namely Danatora, bamboo and 1st hanqota were selected based on the agro-ecologic condition they are situated using stratified random sampling method. Then from the three *kebeles* with a total of 1464 HHs, about 5-10% i.e. 96(7%) of HHHs were selected based on judgmental (purposive) method for questionnaire survey.

The sampling procedure considered different parameters such as wealth status, male and females headed households. And another 18 persons from the three *kebeles* were selected for focus group discussion (FGD). And finally 5 DAs and 3 officials (experts) from the *woreda's* agricultural and rural development office were selected for in depth interview as key informants. Accordingly the semi-structured check lists have been used for interview.

Table.3.2. Distribution of sample households

Kebeles	Agro ecology	No HHs	Sample HHs		total
			Male	Female	
Danatora	Dega	512	20	8	28
Bambo	Woyine dega	542	23	13	36
1st Hanqota	Kolla	410	22	10	32
		1464	65	31	96

3.2.2. Methods of Data Analysis and Interpretation

The data collected from both primary and secondary sources was analyzed using qualitative and quantitative techniques. Structured questionnaire was conducted to generate analytical information regarding socio economic condition of the community, perception of farmers towards climate change and variability in their locality, adverse effects of climate change on farmers' livelihoods, coping mechanisms and adaptation

strategies of farmers to the changing climate and existing variability and finally challenges that hinder farmer's adaptation was also collected. Quantitative data generated from questionnaire was analyzed by using SPSS data editor. Descriptive statistical methods such as (frequency and cross tabulation and descriptive statistics) were used for multiple responses. Thus, frequencies, percentiles, means and standard deviations and histograms and tables were used to summarize and present the result. In order to confirm whether there is significant difference of perception towards climate change and variability among farmers who are living at different ecological conditions and age of farmers and their application of various adaptation strategies, chi-square test has been computed and used. Meteorological data was calculated by excel and presented in graphs and charts. The qualitative information gathered using; focus group discussion, open-ended questions, and key informant interview were analyzed and interpreted using qualitative techniques.

CHAPTER FOUR

4. Results and Discussion

This chapter deals with the presentation of results of the collected data and discussion. The result is divided into four major parts. The 1st part presents the socio economic data in relation to HHs adaptive capacity and resilience to climate change and variability. The second part describes the discussion of rainfall and temperature pattern, the third section discusses the effect of climate change and vulnerability to CC and variability and the last part discusses farmers' perception and adaptation responses to climate change variability.

4.1. Socio-economic profile of Respondents

4.1.1. Sex, Age and Marital Status of respondents

As shown on table 4.1.out of the total 96 HHs 36(37.5%) house hold heads were from Bambo which is situated in *woyine-Dega* agro-ecologic condition, 32(33.5%) of them from 1st Hanqota which is *kola* and the remaining 28(29.2%) respondents were from Danetora *keble* (PA), which has *Dega* agro-ecologic condition. As the sex composition of the survey indicates, from Danatora (71.4%) were male and (28. 57%) were female headed households. The remaining two *kebeles,* Bambo and 1st Hanqota took 63.8% and 68.7% of male and 36.1% and 31.2% of female household heads respectively. And Danatora shared relatively the largest share of male headed households and the smallest share of female headed households. The result of the survey reveals that, age composition between 30-39, 40-49 and 50- 59 covered 29.2%, 34.4% and 29.2% respectively. The remaining 6.3% and only 1% of age groups belong to >60 and 20-29 age groups. According to the survey, most of the HHs were between the age of 30-39 to 40- 49, which is followed by age group of 50-59. This entails most of surveyed HHHs are economically active and it can be assumed that they are well aware of their area and prevailing environmental problems very well.

Table.4.1. Sex, age, marital status and HH size of respondents

Variables		Danatora		Bambo		1st Hanqota		total	
		N	%	N	%	N	%	N	%
sex	male	20	71.4	23	63.9	22	68.8	65	67.7
	female	8	28.6	13	36.1	10	31.3	31	32.3
	total	28	100	36	100	32	100	96	100
age	20-29	-	-	1	2.8	-	-	1	1
	30-39	8	28.6	11	30.5	9	28.1	28	29.2
	40-49	7	25	14	38.9	12	37.5	33	34.4
	50-59	12	42.8	9	25	7	21.8	28	29.2
	>60	1	3.6	1	2.8	4	12.5	6	6.2
total	total	28	100	36	100	32	100	96	100
Marital status	Single	-	-	1	2.7	1	3.1	2	2.1
	Married	21	75	26	72.2	24	75	71	74
	Divorced	2	7.1	4	11.1	2	6.2	8	8.3
	Widowed	5	17.8	5	17.8	5	15.6	15	15.3
	total	28	100	36	100	32	100	96	100
HH size	1	1	3.6	1	2.8	1	3.1	3	3.1
	1-2	1	3.6	1	2.8	1	3.1	3	3.1
	3-5	6	21.4	10	27.8	11	34.4	27	28.1
	6-8	8	28.6	18	50	15	46.9	41	42.7
	9-10	11	39.3	6	17.6	4	12.5	21	21.9
	>10	1	3.6	-	-	-	-	1	1
total		28	100	36	100	32	100	96	100

Source: Field survey; 2014.

As the survey result indicates, from the total respondents, 74% married, 15.6% widowed, 8.3% divorced and only 2% are single. When it comes to the *kebele* level, at Danatora *keble(*7,5%) married (17.8%)widowed, and (7%)divorced. And from Bambo (2.7%) single (72.2%) married and (11%) and 13.8% are divorced and widowed respectively. In the case of 1st Hanqota (3%) single (75%) married, (6.2%) divorced and (15.6%) widowed. This shows that majority of the household heads in the three *kebeles* are married. There is no difference in the proportion of divorced and widowed HH, but the frequency of divorced HHs is relatively high in bamboo and widowed is greater in Donatora. In order to assess whether there is association between age and adaptation strategies, chi-square test has been employed. Accordingly Ho is stated as there is no significant difference of adaptation to climate change among different age groups.

Table.4.2. Chi-square test for age * adaptation to climate change

adaptation to cc * age of respondents Cross tabulation

Count

		age of respondents					Total
		20-29	30-39	40-49	50-59	> or = 60	
adaptation to cc	1	1	16	18	16	2	53
	2	0	6	10	7	2	25
	3	0	4	1	2	0	7
	4	0	2	4	3	0	9
	5	0	0	0	0	2	2
Total		1	28	33	28	6	96

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	36.113[a]	16	.003
Likelihood Ratio	18.447	16	.298
Linear-by-Linear Association	1.588	1	.208
N of Valid Cases	96		

a. 19 cells (76.0%) have expected count less than 5. The minimum expected count is .02. Source; Field Survey ;(2014).

As it is shown in Table, 4.2.the calculated chi-square test reveals that P=.003 and 95% or 0.05 was determined as significance level to accept or reject Ho. Accordingly, null hypothesis would be rejected as (.003<0.05). Therefore, the computed test statistics

shows a significant difference between adaptation to climate change and age of respondents. This implies age farmers and adaptation to climate change are not independent.

4.1.2. Educational status

Table.4.3 Educational status of household heads

Variables								total	
		Danatora		Bambo		1st Hanqota			
		Freq	%	freq	%	Freq	%	Freq	%
Educational Status	illiterate	3	10.7	9	25	12	37.5	24	25
	Write& read	1	3.6	4	11.1	9	28.1	14	14.6
	Primary level	9	32.1	11	30.6	9	28.1	29	30.20
	Secondary level	13	46.4	11	30.6	2	6.2	26	27.1
	>12	2	7.1	1	2.8	0	0	3	3.1
	Total	27	100 %	36	100 %	32	100%	96	100

Source: Field survey, (2014).

A number of studies (Temesgen *et al*, 2008) for example, reported that education increases the probability of adapting to climate change. This is because education is an indispensable tool to easily understand climate information to adjust and develop adaptive capacity to the changing climate. In spite of the great importance of literacy on adaptation to climate change, the survey data on table 4.3, shows (46%) of the respondents achieved primary level followed by secondary level which is (30.2%) of respondents. And from the total respondents (25%) or ¼ samples HHs are illiterate, while (14.6%) can write and read and only 3% achieved above grade twelve. This entails there is illiteracy amongst the sampled HHs though its degree is not high.

4.1.3. Means of Livelihood

When respondents were asked whether they have agricultural land, majority (97.9%) of them replied yes and only 2.1% said no. Land is the major determinant factor for applying adaptation strategies. Therefore, farmers' adaptive capacity also differs with average land holding they own. According to the survey data, the size of land is very fragmented and it differs among individual farmers. As shown in the table.4.4.approximately half of (43.8%) of HHs have less than (0.75) ha , and ¼ of HHs have land holding size of (0.75) hh, which is followed by (16.7%) and (10.4%) of HHs who possessed 1.5ha(1.75) ha and 2ha-2.5ha respectively. Only 2.1% of HHHs owned 3-3.5ha of agricultural lands.

Table 4.4, Land holding size of Respondents

NO	Land holding in ha	frequency	Percent (%)	Cumulative %
1	Landless	2	2.1	2.1
2	0.25-0.5h	42	43.8	45.8
3	0.75-1h	24	25	70.8
4	1.5.1.75h	16	16.7	87.5
5	2h-2.5h	10	10.4	97.9
6	3-3.5h	2	2.1	100

Source: field survey (2014)

Household heads were also asked about their major source of livelihood and based on this, principal livelihood components were grouped using clustering techniques where the majority (64.6%) of HHs were dependent on crop production, (19.8%) of respondents depend on livestock rearing and other off-farm activates like daily labor, land renting, petty trade are practiced by (5.2%), (4.2%), (5.2%) of respondents respectively.

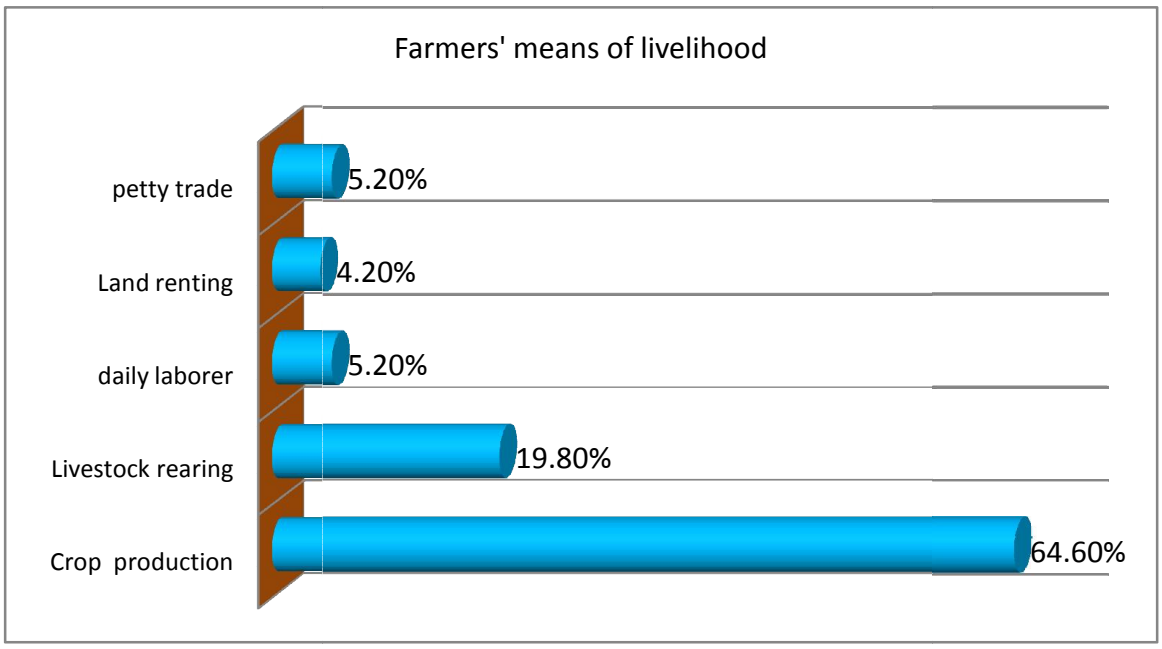

Figure .4.1. Farmers' means of livelihood (Source of income).

Source: Field survey (2014).

Livestock possession of HHs

Studies on livestock production (Abate, 2009) for instance, indicated that climate change and variability has adverse impact on the livestock composition and compromise the return from livestock as the availability and quality of pasture and water are highly affected by climate variability. Moreover, recurrent droughts and heat spells would create favorable condition for the spread of infectious diseases that would eventually increase loss of livestock. As the data on the table shows before some ten years, the highest livestock possession of Danatora, Bambo and 1st Hanqota is (35.7%) of (52.8%) and (21.9%) of animals (>3-5) of livestock number. While for the year 2013(after 10 years), (82.1%), (77.8%) and (62.5%) of the surveyed households possess between (1-2) and (3-5) livestock possessions. And the mean livestock possession of the respondents before ten years is 3.7, while in the year 2013, it declined to 2.02. Therefore, this indicates there is a decline in livestock number.

Table.4.5. Change in livestock distribution between 2003- 2013.

No, of livestock	year	*Kebeles*						total	
		Danatora		Bambo		1st Hanqota			
		Freq	%	Freq	%	Freq	%	Freq	%
0 or < 1	2003	2	7.1	6	16.7	5	15.6	13	13.5
	2013	3	10.7	5	13.9	5	15.6	13	13.5
1-2	2003	6	21.4	5	13.9	7	21.9	18	18.8
	2013	23	82.1	28	77.8	20	62.5	71	73.9
3-5	2003	10	35.7	19	52.8	5	15.6	34	35.4
	2013	2	7.1	3	8.3	5	15.6	10	10.4
6-10	2003	6	21.4	5	13.9	7	21.9	18	18.8
	2013	-	-	-	-	1	3.1	1	1.04
11-15	2003	3	10.7	1	2.8	6	18.8	10	10.4
	2013	-	-	-	-	1	3.1	1	1.04
>15	2003	1	3.6	-	-	-	-	-	1.04
	2013	-	-	-	-	-	-	-	-

Source Field Survey;(2014)

4.2. Rainfall and Temperature Pattern of Soro

4.2.1. Average Rainfall Pattern

Rainfall and temperature are important meteorological variables that determine water availability, and production of crops and livestock rearing or food production processes in countries where agriculture is more dependent on rainfall, (Abebe, 2013). The average annual rain fall of Soro Woreda in the years 1980-2013, ranges from 800.2mm to 1626.8mm. The mean annual rain fall of those years is about 1075.7 mm. As shown in the Figure 4.2 .below, the rain fall of the woreda has shown inter annual variability and erraticenes over the past years. This variability has also been indicated as

a major problem to crop production by HHs. The driest year was 2010, which contains the minimum rain fall of all years and the wettest year was 1982. Annual rain fall is below average in the years 1981, 1983, 1984, 1985, 1990, 1991, 1994, 2000, 2004,2 010, 2011, 2012 and 2013.Thus, the woreda had been suffering from shortage of rainfall in the above thirteen years, while the remaining years demonstrated heavy and erratic rainfall. Therefore, agricultural production in the area was adversely affected by the inter annual variability of the area in the last three decades in the study area. This idea was also supplemented by the information of FGD participants.

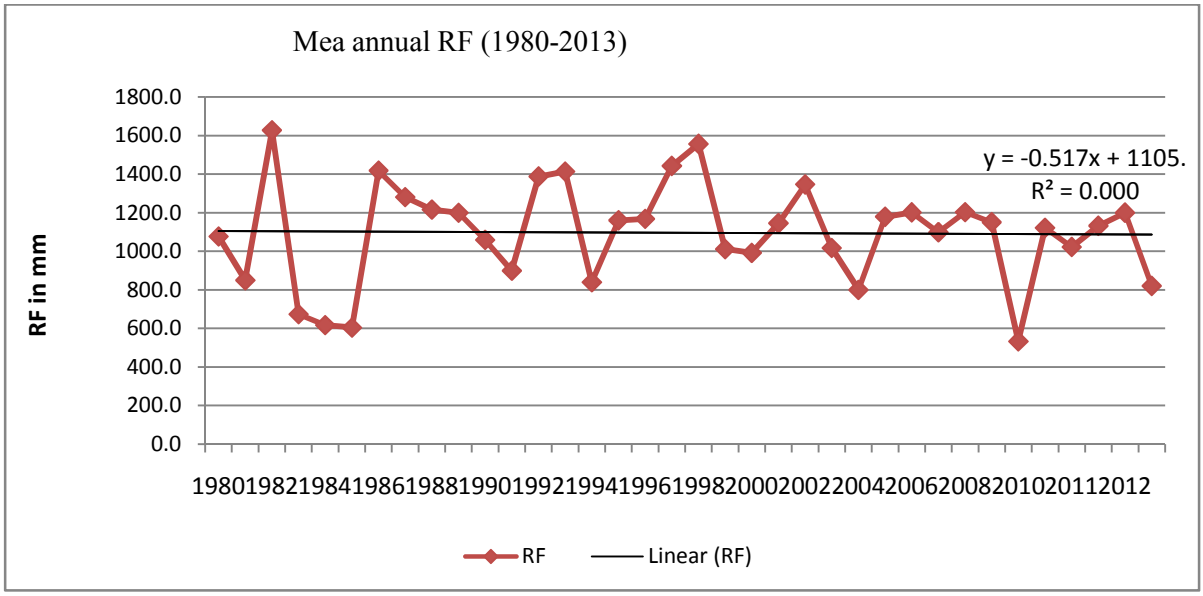

Figure 4.2 Mean annual rainfall of Soro Woreda. Source; NMSA ;(2014)

4.2.1.1. Seasonal Rainfall Variability

The study are receives bimodal rainfall i.e. *Meher season*, the main rainy season from (June to August) and Belg, smaller rainy which falls from (March to May) and the mean Belg rainfall is 359mm and mean *Meher* rainfall is 420mm.The standard deviation of *belg* rain was 142.56 and *Meher* rain was 102.9.There fore, coefficient of variation (CV) of the *belg* and *meher* rain in the study area shows 39.7% and 24.5% respectively.

.As shown in figure .4.3, the *Belg* rain shows a high seasonal variability between the years 1980-2013 and Similarly, the *Meher* rain shows relatively high seasonal variability in the same years and decreasing trend of 0.036 mm per a year and 0.18 mm per a decade. Therefore, the variable and reduced *belg* and *meher* precipitation has a critical implication on rural livelihoods. Traditional and indigenous seeds or fruits are disappearing due to decreased precipitation and increasing temperature.

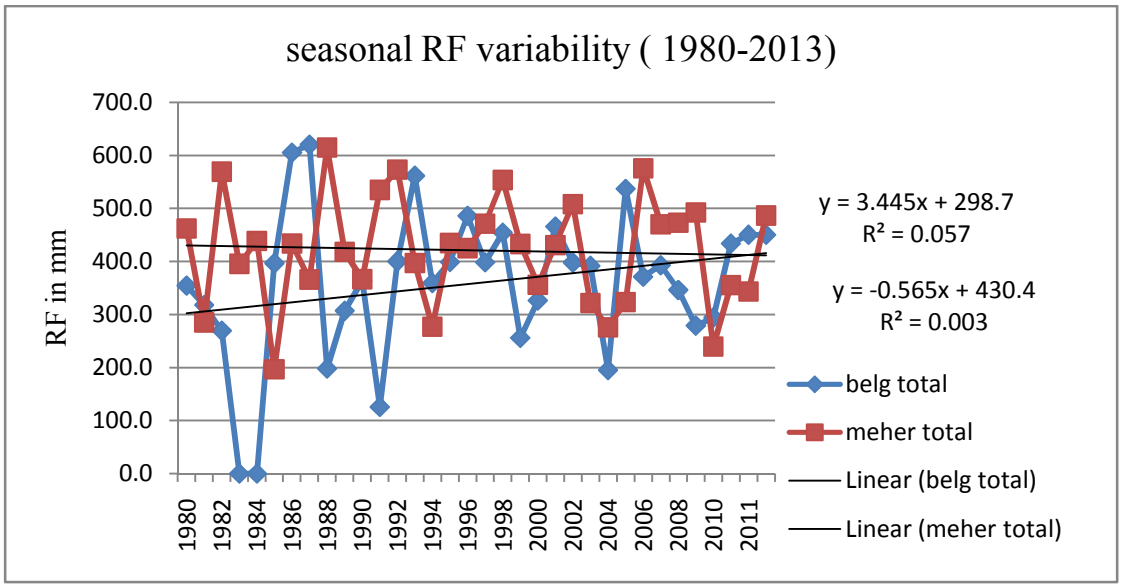

Figure.4.3. Seasonal Rainfall variability,(1980-2013).Source; NMSA;(2014).

4.2.2. Average temperature pattern

According to EPA report on CRGE, Ethiopia has become warmer over the past century and human induced climate change will bring further warming over the next century at unprecedented rates. Climate models suggest that Ethiopia will see further warming in all seasons of between 0.7°C and 2.3°C by the 2020's and of between 1.4°C and 2.9°C by the 2050s.Similarly, increase in inter annual temperature is observed in the study area. The average yearly maximum temperature of the woreda was 22.8^0, while the average minimum temperature of 10.8^0. As indicated in Figure 4.3, the average maximum temperature of soro woreda over the past 33 years increased by about 0.7^0 annually, while average minimum temperature is decreasing by 0.33^0 degree centigrade. Therefore, trend

shows that the maximum temperature of the woreda is increasing and will continue in its increasing trend in the future.

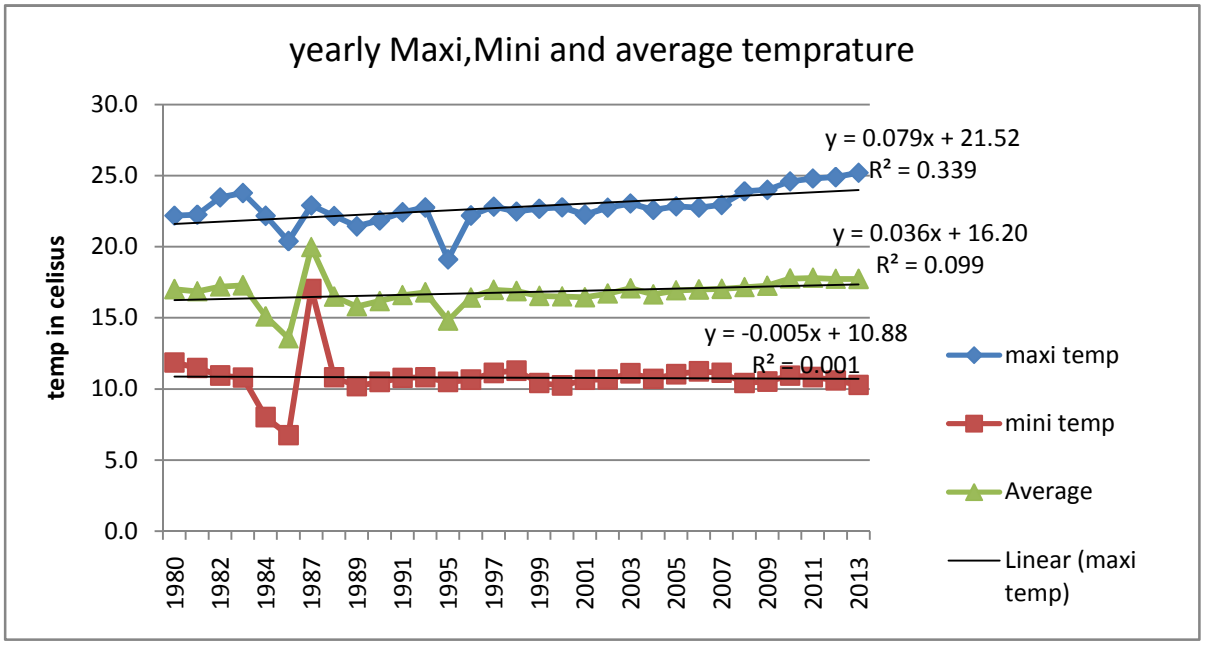

Figure .4.4. The maximum, Minimum and average temperature pattern of soro.

Source;NMSA,(2014).

The trend resulton (Figure 4.2 and Figure 4.3) shows decline in amount of precipitation and increase in average annual maximum temperature. So overall of the analysis of rainfall and temperature from the station indicates that, rainfall will be expected to decrease and temperature on the contrary expected to increase. Together with temperature variability and shortening rainfall seasons and amount, these changes pose major challenges on the rural populations' livelihood especially on agriculture.

4.2.3. Local Indicators of Climate Change/ Variability

Indication of climate change can be assessed mainly in terms of variations in temperature, and precipitation (Shrestha *et al*. 2000; IPCC 2007c). Accordingly, from the total surveyed HHs, (42.7%) of the respondents perceived *increase in temperature as an indicator*, and this is followed by (33.3%) HHs, who responded the unpredictable rainfall

as the major indicator of climate change. While (12.5%), (4.2%) and another (4.2%) of the HHHs claimed recurrent droughts, erratic rainfall and decrease of river volume respectively. The remaining 3.1% of the HHHs assumed other indicators of climate change and variability (See, Figure.4.5).

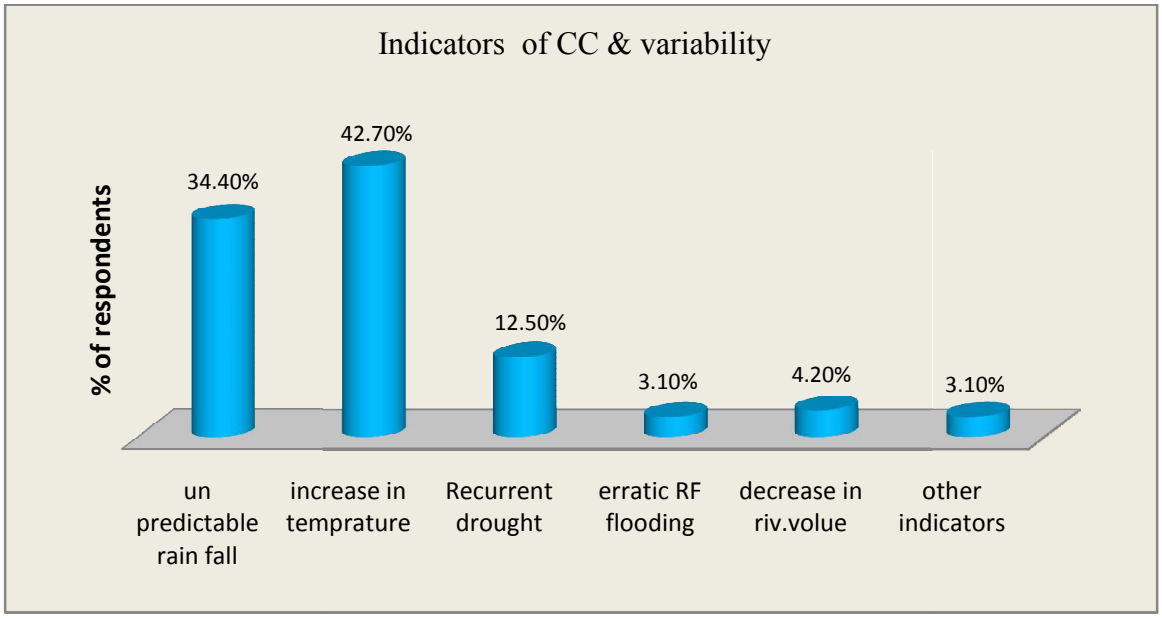

Figure.4.5 Local indicators of climate change and variability

Source: Field survey: (2014).

FGD participant in Bambo reported that:

> "*Some years before, the Belg rainy season used to start in March, but now it starts late in April, and even some years with no Belg rain. It has no longer been reliable - it comes once in four years. The main rainy season (Mehere) used to end late September and sometimes extends to first week of October, but now it stops in pagume or first week of September, and it becomes difficult to live with our existing crop types and varieties".*

4.3. Effects of Climate Change /Variability on Livelihoods and Vulnerability

4.3.1. Effects on rural livelihood

Climate change is likely to impact crop productivity directly through changes in the growing environment, but also indirectly through shifts in the geography and prevalence of agricultural pests and diseases, associated impacts on soil fertility and biological function, and associated agricultural biodiversity. The rain fed yield changes are driven by both precipitation and temperature changes; the irrigated yield effects are from temperature changes alone. As IPCC (2007) concluded, slight warming decreases yields in seasonally dry and low-latitude regions. Climate variability affects virtually all aspects of agricultural and other water-intensive activities and has impact on a large proportion of households, with far-reaching consequences throughout the economy.

Like in most rural parts of Ethiopia, the source of livelihood in the study area (*soro woreda*), is agriculture. However, as indicated in the previous section, the area, particularly the *dega* and *woyinedega* part of the woreda is characterized by unreliable and erratic rainfall. Therefore, unreliable and erratic rainfall during the rainy season results in loss of upper most and fertile soil and decrease soil fertility through soil erosion and this eventually leads to decrease in crop yield and food insecurity.

Respondents in the household questionnaire were asked to say how in their experience climate changes had affected crop production. They were required to select one response from four options pertaining to crop yield, such as 'Increase in crop yield', 'decrease in crop yield', 'no change in crop yield' and 'decrease in long cycled crops'. Accordingly from the surveyed HHHs, a large number (75%) of respondents perceived the effects of climate change/ variability as a major cause for crop yield reduction, around (17.7%) of the respondents said the change/ variability of the climate system has an adverse effect on long season crops. While (6.3%) of the surveyed HHHs responded that there is an increase in crop yield due to climate change or variability. Only (1%) of the respondents assumed that there is no change in crop yield due to CC.

4.3.1.1. Timing of Rainfall and Variability

As most studies demonstrated, changes in precipitation patterns increase the likelihood of short-run crop failure and long-run production declines. (Nelson.,G, 2009). As rainfall patterns become more unpredictable as climate changes, plants will be subjected to increasing fluctuations in soil moisture availability. These fluctuations are likely to have substantial impacts on plants in natural communities and on crop plants in agriculture, (Davies,.J.,2006).

The timing and reliability of rain fall in the study area has been significantly unpredictable. In the old days, the *belg* rain used start in late March and extends up to late May, farmers use this rain to cultivate crops like barely, maize and root crops like potato. Apart from the cultivation of the aforementioned crops, the *dega* and *woyine-dega kebeles* use the *belg* rain to plant Inset plant. Then these crops are harvested starting from May to June leaving the field for *meher* cultivation (the main rain season) cultivation of mainly wheat, *teff* and other crops.

As it has been depicted on Figure.4.6. Majority (70%) of the surveyed household heads agreed that the *belg* rain comes very late and the main *meher,* rain goes early in October increasing moisture stress and making cultivation difficult and eventually causes crop failure, while (23.5%) of the respondents said that the rain comes early and goes vey late. Only 3.1% of household heads responded that the rain comes and goes early.

As one farmer from FGD noted;

> *" Even if we want to plant, it is now very difficult to know how to do it because it is now unpredictable, if you try to plant in March, that might be how you perish all your work and perhaps those that started early in April, might get something…".*

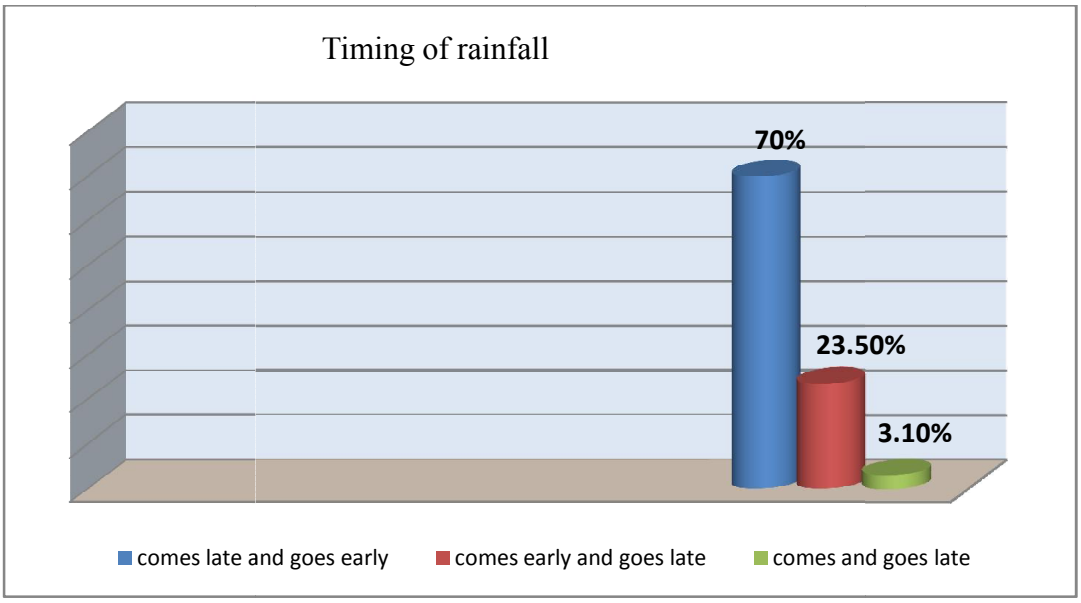

Figure.4.6. Timing of Rainfall in Soro Woreda. Source: Field survey;2014.

4.3.1.2. Timing of Rainfall and its Effect on Croping Pattern

According to FAO, (2008) prediction, the wet areas are expected to be wetter and the dry areas in the tropics are expected to be drier as a result of climate change. The intensity of rain storms could increase in some areas and rain becomes more unreliable and unpredictable.

In agreement with this prediction, almost all of the respondents reported that there is a change in the amount and timing of rain fall in the study area and it is adversely impacting crop production. It was clear to farmers that rains are becoming both more erratic and coming later and going earlier in the cropping seasons.

The focus group (FGD) participants reported that:

> "*The rains are normally now starting late in March or April and ending early before the crops could mature. They noted that in the past, rains would normally begin sometime in February. However, the seasons appeared to have shifted as the rains could now start as late as March. We have a general feeling of uncertainty about when the best time to plant would be. Therefore, we needed an efficient weather forecasting system if we*

were to remain effective in farming. The unpredictability of rainfall patterns made faming a high risk business"

All of the members of FGD in the three *kebeles* unanimously agreed that change in timing of precipitation is adversely affecting the whole process of cultivation. The following are some of the problems rised during FGD about the impacts of the change in timing of rain fall*:*

- The delayed *belg* rain hampers sowing so that they could not prepare the land timely to grow crops using *belg,* (small rainy season which covers from march to may), rain. When delayed rain comes, it is becoming so erratic and causes erosion and flooding on our agricultural fields.
- Before some 10 years farmers in the *Dega* and *woyine- daga* areas used to grow crops like sorghum and maize which require lengthy rainy season to attain maturity, however, since recent past, these crops are not grown in these a*kebeles* because of the change in the timing and decreased precipitation, as the main *meher* rains goes so early these crops face moisture stress to get matured.
- In kola *kebeles*, the delayed precipitation is resulted in shortage of water and fodder for livestock and increases heat spells that results in loss of livestock and decreases the quality of livestock and returns from livestock as well.

4.3.1.3. Effects on Crop Yield

Climate change is likely to impact crop productivity directly through changes in the growing environment, but also indirectly through shifts in the geography and prevalence of agricultural pests and diseases, associated impacts on soil fertility and biological function, and associated agricultural biodiversity. The rain fed yield changes are driven by both precipitation and temperature changes; the irrigated yield effects are from temperature changes alone. As IPCC,(2007),concluded, slight warming decreases yields in seasonally dry and low-latitude regions. Climate variability affects virtually all aspects of agricultural and other water-intensive activities and has impact on a

large proportion of households, with far-reaching consequences throughout the economy.

Like in most rural parts of Ethiopia, the source of livelihood in the study area (*soro woreda*), is agriculture. However, as indicated in the previous section, the area, particularly the *dega* and *woyinedega* part of the woreda is characterized by unreliable and erratic rainfall. Therefore, the lesser rainfall or decreased rain fall in harvest season impedes crops maturity and caused reduction in crop yield as a result of loss of soil fertility by soil erosion and moisture stress as weeks delay in the onset of rain is said to have significant difference on the harvest and has deprivation of households' livelihood.

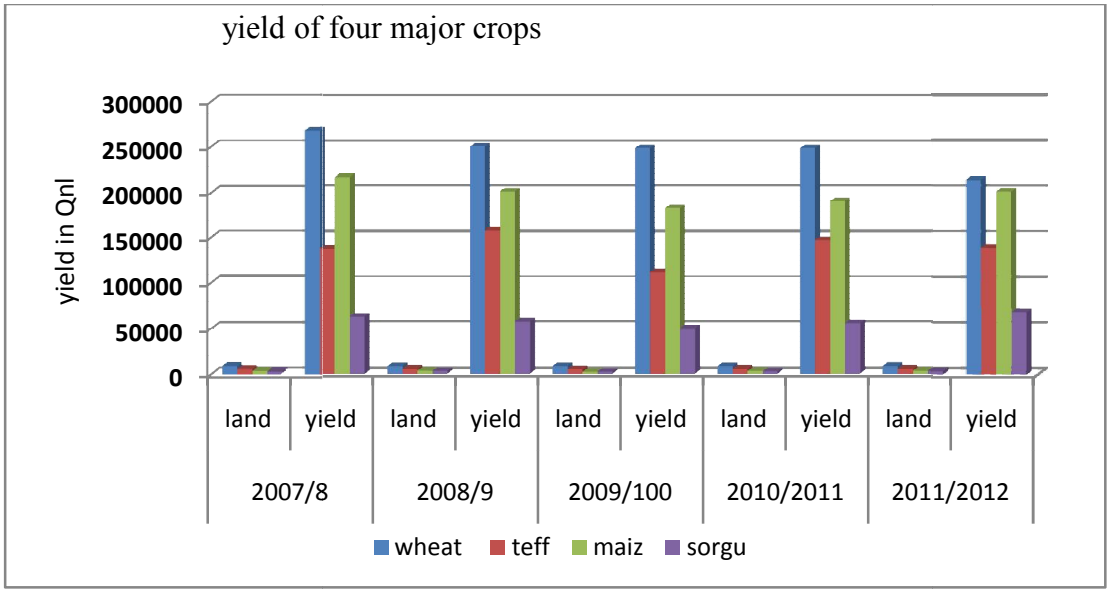

Figure4.7. Soro Woreda Crop Production from (2007-20120).

Source: Soro Agriculture and Rural Development Office.

Respondents in the household questionnaire were asked to say how in their experience climate changes had affected crop production. They were required to select one response from four options pertaining to crop yield, such as '*Increase in crop yield*', '*decrease in crop yield*', '*no change in crop yield*' and '*decrease in long cycled crops*'. Accordingly from the surveyed HHHs, overwhelming number (75%) of respondents

reported the effects of climate change/ variability as a major cause for crop yield reduction, around (17.7%) of the respondents said the change/ variability of the climate system has an adverse effect on long season crops. While (6.3%) of the surveyed HHHs responded that there is an increase in crop yield due to climate change or variability. Only (1%) of the respondents assumed that there is no change in crop yield due to climate change/ variability. As shown on figure.4.7.the yield of major crops in the woreda indicates fluctuating growth, in spite of the increasing agricultural land from year to year.

4.3.2. Socio-Economic Effects of Climate Change & Variability

4.3.2.1. Effects on Water Availability

According to the information obtained from soro woreda water resource development office, the woreda is endowed with all types of water resources, such as rivers, springs ponds and ground water. However, the efforts of water sector to develop HH water supply is being constrained by climate variability in the area.

House hold heads were supplied with two types of questions with regard to HHs water supply. The first question was stated as" Do your household get sufficient water throughout the year?" Accordingly, majority of the respondents replied 'No', while the remaining (31.3%) of the respondents said 'Yes'. This implies most of the HHs in the area are suffering from shortage of water. The second question was about source of water for rural households. The response of HHHs is summarized as follows; (50%) is river water,(25%) is springs , (11.5%) is ponds and only (8.3%) of the respondents get pipe line water.

In agreement with survey data, participants of FGD in the three *kebeles* unanimously agreed that most of the HHs in the area get water from rivers to drink. However, the amount of water in the rivers is decreasing from year to year with the decreasing rainfall amount. Household members, mainly women and children, travel long distances to fetch water for livestock and household consumption. In addition to this, members of FGD from Danatora and Bambo (*dega* and *woyine- dega kebeles*) said that, their source of

drinking water is springs and pipe lines developed by the woreda in very few *kebeles*. But most of the springs are unprotected and they are already drying up due to drought.

4.3.2.2. Effects on Livestock

Most of the households used livestock as source of livelihood in addition to crop cultivation. In 1st Hanqota (*kola kebele*) majority of HHs are agro-pastoralists. Focus group discussion participants pointed out that some people had lost all their cattle to drought. Very few cattle that survived the dry season are sent away to pastures in *Dega and Woyine dega woredas* until the end of dry seasons. Some are sent several hundreds of kilometers away to areas with better pasture. Other strategies used by local communities to save their cattle involved selling some of the cattle which are old and weak, but cannot substitute them with other livestock, because these cattle are sold with low price. Therefore, the number and types of cattle is decreasing from year to year. Since much of the requirements for household consumption are derived from livestock or exchange with livestock products, the loss of livestock is serious risk for the livelihoods. For the change of cattle and potential causes for the decrease of livestock number (see table 4.7)

Table 4.6 .Change in livestock production

variables	Kebele of respondents						total	
	Danetora		Bambo		1st Hanqota			
Decrease/ increase of livestock	count	%	count	%	count	%	count	%
Increased	1	3.6	-	-	3	9.4	4	4.1
Decreased	27	96.4	36	100	29	90.6	92	95.8
reason for decrease of livestock	count	**%**	count	**%**	count	**%**	Count	**%**
Shortage of grazing land	21	75	31	86.1	16	50	68	70.8
Livestock disease	2	7.1	4	11.1	12	37.5	18	18.8
Shortage of water	5	17.9	1	2.8	1	3.1	7	7.3
High temperature	-	-	-	-		9.4	3	3.1

Source: Field survey (2014).

Effects on Livestock Feeding

Drought and delay in the onset of rain fall led to poor grass regeneration/forage deficit, water shortage and heat stress on livestock, and consequently increased the mortality of the livestock, vulnerability to diseases and physical deterioration due to long distance travel for water and pastures(Abate,2009).

According to the survey data, majority (89.6%) of the household heads said that the source of cattle feed before some 10 years was pasture, while only (10.4%) responded that crop residue. Showing the change in livestock feeding, however, majority (60.4%) replied that the feeding for their cattle now is, crop residue, while (26%) and (6.3%) of them responded steam of Inset and pasture respectively. The remaining (7.3%0 replied that they feed their livestock with other forages. Members of FGD also pointed out that, shortage of adequate fodder and underfeeding of livestock have increased the vulnerability of livestock to disease risks and death associated with drought and climate stress.

Figure 4.8. A Photo showing livestock feeding crop residue in soro woreda

Generally cattle population in the woreda has feed grass for a few months when there is rainfall but during the dry season they use crop residues and Inset feeding. Water (watering) problem in the woreda has become more acute in recent years; some rivers have dried up and the existing ponds become empty.

4.3.2.3. Vulnerability of the Community & Their Concerned shocks

As studies indicate the vulnerability of the community to the adverse effects of climate change and variability depends not only to the exposure of the biophysical environment but also the socio economic and demographic characteristics of a given society such as age, sex, wealth status etc. And a given portion of a society could be more vulnerable to the impacts of climate related shocks.

4.3.2.3.1. Vulnerability to Economic, Health and Price Fluctuation

As noted by different studies and researchers, CC/ variability are posing a serious threat on the health and socio economic condition of the societies. For example, Kovats*, et al,* (2003), stated that climate change is likely to have major effects on human health via changes in the magnitude and frequency of extreme events, floods, wind storms and droughts. In order to obtain information regarding the adverse effects of climate change and variability on the communities' health, HHHs were asked two types of questions. The first question was to assess the perception of household heads to vulnerability to climatic change and variability. Accordingly, almost all (99%) of the respondents agreed that climate change is adversely affecting their health, economic and price condition of commodities. while only,(1%) of respondents replied that climate change and variability has no effect on the health, price and economic condition of their families.

Similarly participants of FGD highlighted that climate change and variability is posing negative effects on health of their families. In this regard, members of the FGD reported that flooding and high temperature are the main drivers of health problems of their families. They noted that water and vector born diseases get favorable conditions for the presence and transmission of diseases. In addition to this, they pointed out that due to

shortage of food and milk, babies and elderly are being affected by diseases. Communities 'current vulnerability to climate extreme

Table 4.7.climate related shocks among the three kebeles.

Kebles	Types of shocks									
	drought		flooding		Pests& diseases		Rain variability		total	
	count	%	count	%	Count	%	count	%	count	%
Danatora	2	7.1	6	21.4	6	21.4	14	50	28	100
Bambo	3	8.3	8	22.2	3	8.3	22	51.2	36	100
1st Hanqota	14	43.8	7	21.9	4	12.5	7	21.9	32	100
total	19	59.2	21	65.5	13	42.2	43	123.1	96	100

Source: Field survey (2014).

As shown on the table 4.7.above, the shocks experienced by communities vary among the sampled *kebeles* in terms of frequency and intensity. Accordingly, a large number of respondents i.e (51.2% and 50%) claimed that rain variability is the major concern in both Bambo and Danetora *kebeles* respectively. But in 1st Hanqota (*kola kebele*) about (43.8%) the respondents were concerned to drought .This was followed by flooding (65.5%) in all *kebeles*. And drought and the prevalence of pests and diseases take (59.2%) and (42.2%) respectively. This implies that vulnerability to climate extremes greatly vary across different agro-ecologic environments. Accordingly, rain variability is the major concern in all agro ecologic conditions with far reaching adverse effects on rural livelihoods in general and agriculture in particular. In kola *keble* re-current drought resulted in loss of livestock.

According to the information obtained from interview of farmers and DAs, those poor households with limited financial assets are suffering from increase of price commodities. Furthermore, the price of crop yield is not consistent whereas the price of inorganic fertilizer is consistently increasing from time to time and government's intervention is not sufficient. Unless the government could take better supportive intervention, climate change would put our food security at risk.

Potential causes of shocks

The survey data reveals that deforestation (70.8) is the leading driving cause, followed by low fertility of agricultural land which worsened the negative effects climate change and variability. Land use and land cover change and absence of sustainable agricultural practice account (7.3%) and (2.1%) of the responses. Members of the FGD also unanimously agreed that the climate is becoming much more unpredictable since recent past. They reported that this may probably due to deforestation and over cultivation due to the ever increasing demand of agricultural land.

Figure.4.9.A Photo showing deforested and highly degraded area

One of the members of FGD reported that;

> *"I have lived in this area for more than 40 years. Before some 20 years, the area you see here was covered by dense indigenous forest. The area was deforested since 1983 EC. Following the fall of Derg government in the country, the ex-Derg soldiers returned to their home and began clearing and burning the forest, primarily to get agricultural land. This was coupled with increasing demand of fire wood. Furthermore, the area which is not suitable for agriculture was partly planted by some exotic trees like eucalyptus while the remaining area left un planted exposed to erosion".*

Who is most vulnerable to CC and variability effects?

It is concluded that the Woreda is vulnerable to the impacts of climate change and variability. But still there is a difference on the capacity to adapt to those impacts among the households. Therefore, some socio economic indicators are selected to expose who the most vulnerable is. In this study male or female headed HHs, economic status, physical assets, age and family size are chosen to assess the rate of vulnerability.

Table .4.8.Most vulnerable groups of the society

Vulnerable groups	Danatora		Bambo		1st Hanqota	
	Count	%	count	%	count	%
Female headed HHs	7	25	7	19.4	14	43.8
Male headed HHs	5	17.9	4	11.1	1	3.1
HHs with no additional income	3	10.7	4	11.1	1	3.1
HHs with large family size	2	7.1	3	8.3	5	15.6
Land less & the poor	2	7.1	5	13.9	-	-
Children & elderly	9	32.	13	36.1	11	34.4
Total	28	100	36	100	32	100

Source: Field survey (2014).

As shown in the table. 4.8, (43.8) of the respondents from 1st Hanqota responded female headed HHs, (36.1%) from Bambo replied that children and elderly are the most vulnerable to CC (8.2%) of the HHs are land less and with HHs no additional income. And (34.2%) of the respondents replied children and elderly are most vulnerable to the adverse effects of climate change and variability.

The information from key informants interview (officials of SWARDO and Das), indicates that women, children and elderly are the most vulnerable section of the society, this mainly because they cannot easily leave their home or migrate in time of extreme events and the occurrence of disaster. On the contrary men can migrate to other areas in time of the occurrence of extreme events such as drought and famine. In addition to this, children and older people cannot escape when flooding occurs mainly in highland areas so that they could be victim of the subsequent hazards. 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 women take all responsibility of taking care of household. Specially, if she is land less & have many dependants, the situation become difficult and she face socio-economic pains of the situations. The men's vulnerability was explained from their prime responsibility of income generation. In cases of no agriculture work (labor) or animal death they are supposed search other off-farm and non-farm activities income sources, take credit and pay it off.

Large Family Size

Large family size independently is not direct indicator of vulnerability but it is directly related with the income of the household. As indicated on table 9.6. (29.6 %) of the respondents reported that families with large family size are more vulnerable because of their limited adaptive capacity. Therefore, vulnerability of the local people can be proportional to the family size.

The Poor and Landless

As noted by several studies, Ethiopia is especially vulnerable to climate variability and change because large segments of the population are poor. Most have low access to education, information, technology, and basic social and support services, and, as a result, have low adaptive capacity to deal with the consequences of climate variability and change (Oxfam 2010; The World Bank Group 2010; Regassa *et al*, 2010, cited in Bishaw, *et al*., and 2013).According to the information of key informants (officials of agriculture office), poor HHs specially, if they do not have additional income , would be vulnerable due to shortage of money to practice capital intensive agriculture to adapt to changing climate. In addition to this, HHs with low land holding and limited physical assets would bear the brunt of climate change and variability.

Survey data regarding the reason of vulnerability of HHs to climate change reported that (52.1%) respondents replied that it is because of inability to cope shocks, (27.1%) said that due to lack of adequate climate information, (12.5%) of them replied because of poor administration. The remaining (4.2%) and (3.1%) of the respondents reported that weak social capital and other drivers are responsible causes of vulnerability.

4.4. Farmers' Perception and Adaptation to CC and Variability.

4.4.1. Farmers' Perception to Climate change & Variability

Community perception, views and opinions regarding climate change and variability matters both in designing mitigation policies as well as formulating adaptation strategies. If the public perception of risk differs from policy makers perception, implementation will be misunderstood neglected or even opposed, (Maharjan and Joshi, 2013). Besides, the degree to which an environment is affected by climate change depends on one hand on the level of perception by individuals and the other on mitigation and adaptive capacity to the change phenomenon (Gbetibouo, 2009). Cognizant of this importance, farmers were asked whether they perceived long term climate change and variability in their area and its impact on livelihood. Accordingly majority of (75%)t hem replied that

there is climate change and variability in their locality (16.7%) responded that the climate is totally changed and only (8.3%) said that there is no observable climate change or variability in their locality.

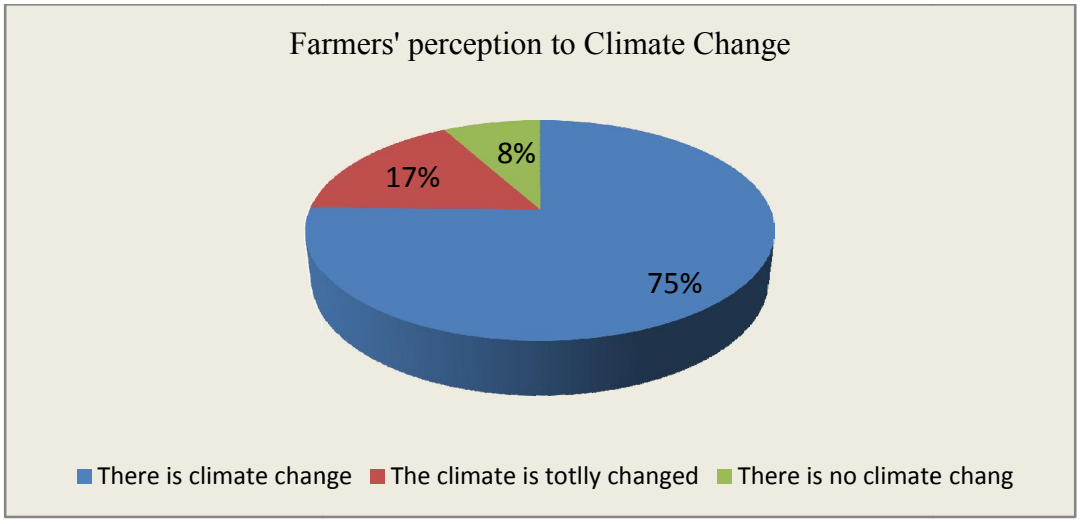

Figure .4.10. Farmers' Perception towards CC and Variability. Source; Field Survey ;(2014).

In order to confirm whether there is association between farmers' perception to CC and their environment, chi-square test was employed. Accordingly, null hypothesis was stated as, there is no significant difference of perception towards CC and their living environment.

Table.4.9. Chi-square test to keble of respondents* perception about climate change

Count

		kebele of respondents			Total
		danatora	bambo	1st hanqota	
perception to CC	There is clmate change	22	29	21	72
	The climate is totaly changed	3	5	8	16
	There is no observable CC	3	2	3	8
Total		28	36	32	96

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.231[a]	4	.520
Likelihood Ratio	3.189	4	.527
Linear-by-Linear Association	.572	1	.450
N of Valid Cases	96		

a. 4 cells (44.4%) have expected count less than 5. The minimum expected count is 2.33.Source; Field survey;(2014).

The chi-square test employed to analyze association between perception and living environment (*kebeles*), reveals that p= .520, df=4 and 0.05 is determined to accept or reject the null hypothesis. Accordingly, the null hypothesis is accepted because as .520>0.05. Therefore, it could be concluded that there is no significant difference of perception towards climate change and variability among farmers who are living at different environments (agro-ecologic conditions). This implies the climate change and variability is becoming the problem of all environmental conditions.

4.4.2. Coping & Adaptation Strategies to CC and Variability

One of the intended objectives of this study was to assess some of coping and adaptation methods being practiced by farmers along with community based adaptation strategies in response to negative effects of climate change and variability. Coping strategies are actual responses to crises on livelihood systems in the face of unwelcome situation, therefore they are termed as short term responses (Berkes and Jolly, 2001). Generally, the local communities are already undertaking various coping and adaptation mechanisms in response to the adverse impacts of CC and variability. Thus, to assess the types of adaptation a.. nd coping strategies they are using the surveyed household heads were asked two types of question.

Table.4.10.The existing coping mechanisms to CC and variability

Coping mechanisms	Sample *kebeles*		
	Danetora	Bambo	1st Hanqota
Reducing number of meals per a day	50%	69.4%	46.4%
Taking loan	15.9%	2.8%	3.6%
Remittance from relatives	21.9%	13.9%	17.9 %
Sale of live stock	6.2	11.1%	28.6 %
Receiving food aid	6.2%	2.8%	3.6 %
Total	100 %	100 %	100 %

Source: Field Survey (2014).

As shown on table 4.10, the main coping mechanisms are reducing the number of meals per a day, taking loan from relatives, remittance from relatives, sale of livestock, others etc. Accordingly, the surveyed HHHs replied for the first question, which is stated as "How do you manage to cope with some of your problems related with vulnerability to CC and variability?" as follows: reducing the number of meals has been the most widely used coping mechanism comprising (69.4%), (50%) and (46.4%) in the three *kebeles* such as Bambo, Danetora and 1st Hanqota respectively. This is followed by receiving remittance from relatives which also comprised (21.9%), in Danetora, (17.9%) in 1st Hanqota and (13.9%) in Bambo *kebeles*. The remaining coping mechanisms such as taking loan from cooperatives, sale of livestock and food aid account on average (7.3%), (6.6%) and (4.2%) respectively.

The second question regarding coping mechanism was state as "what are major coping strategies you used *to overcome* climate change / variability impacts on livestock production?. Accordingly, in Danetora and Bambo (*Dega* and *woyine dega kebeles*), an overwhelming number(75%) and (63.9%) of respondents replied decreasing the number of livestock as the major coping mechanism to climate change and variability related vulnerability, while in 1st Hanqota, which is *kola keble*, there is no significant difference in the use of coping mechanisms, nevertheless, the sale of old and weak animals to takes the lead. The remaining coping mechanisms namely livestock diversification, seasonal migration with cattle in search of pasture and water , sale of older animals and cattle fattening are being practiced in very limited bases in both Dantora and Bambo *kebeles.*

Members of FGD in 1st Hanqota (warmest *kebles*), particularly, reported that the above coping mechanisms were being practiced for several decades in this area, but it did not bring any change. The reason they suggested for this problem is that, the ever decreasing grazing land and decreasing availability of water coupled with absence of sufficient medication for their cattle. Therefore, the occurrence of a single extreme event subsequently results in heavy loss of cattle.

4.4.2.1. Individuals' Responses to CC and Variability

Studies have confirmed that climate change is happening, and societies must take the necessary adaptation strategies to the impacts of climate change and variability. For poor countries like most African nations, adaptation is not an option rather it is a necessity,(Boko, *et al*, 2007).Adaptation to vulnerability is also largely affected by social, economic and institutional factors (Saldana-Zorrilla,2008) like land tenure system, level of irrigation, availability of cheap credit etc.

Farmers' Initiated adaptation to CC and variability

The most widely cited adaptation strategies in cc literature related with crop production, such as new varieties of seeds like, early maturing seeds with higher yields per a plot, drought resistant crops that are suitable in drought prone areas of kola *kebeles*, use of inter cropping, practicing irrigation farming in areas where water is available, wise storage of seeds and receiving food aid from government and NGOs are used to as assess whether farmers are practicing adaptation strategies not. Accordingly, the survey data obtained from HHHs indicates that, (42.3%) of respondents were using new varieties of crops, followed by (19.6%) of respondents who replied intensive irrigation as their major adaptation method. While the remaining three adaptation strategies namely inter cropping, receiving food aids and wise storage of seeds until cultivation season are equally chosen by (12.4%) of household heads. This implies farmers in all agro ecologic conditions are already undertaking all types of adaptation strategies with more tendencies to use new varieties of seeds.

Key informants from the woreda agriculture office suggested that the government is supplying new varieties of crop seeds and inorganic fertilizer. Nevertheless, the high price of seeds and fertilizer coupled with low awareness of farmers in the use of agricultural technologies is impeding the expected high yield per a plot in some parts of the woreda

Table 4.11.Farmers adaptation strategies related with crop production

Adaptation strategies	Sample *kebeles*		
	Danetora	Bambo	1st Hanqota
Use of new varieties of seeds	46.9%	47.2	32.1 %
Inter cropping	3.1%	11.1	25 %
Use of irrigation	25%	16.7	17.9 %
Receiving aid from safety net	9.4 %	16.7	10.7 %
Storage of crops	15.6 %	8.3	14.3 %
total	100%	100 %	100 %

Source; Field Survey ;(2014).

Farmers' Adaptation strategies Related to Shortage of Water

As indicated in table 4.12, below, the result of survey questionnaire of HHs summarized farmers' their adaptation strategies related with water problem. Accordingly from the total 32 HHHs (28.1%) of them used rain water harvesting in response to CC and variability effects on water resources, (21.9%) irrigation, (28.1%) used recharging ground water , (12.5%) used water from ponds , (9.4%) of respondents replied others sources of water in Danetora kebele, in Bambo, a large number of respondents(44.4%) used rain water harvesting , (22.2) used ground water, and the remaining adaptation methods such as use of water from ponds, use of irrigation and others sources equally account (11.1%).

The last but not the least , in 1st Hanqota (which is *kola kebele*), majority of HHs (35.7%) used water from ponds , (21.4%) of them used rain water harvesting, then this is followed by use of irrigation(17.9%), recharging ground water(14.3%) and other sources of water (10.7%).

Table.4.12 Farmers Adaptation strategies related to water

kebeles	Farmers Adaptation strategies related to water problem										Total	
	Rain water harvesting		Use of irrigation		Use of ground water		Use of water from ponds		Other sources			
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Danetora	9	28.1	7	21.9	9	28.1	4	12.5	3	9.4	32	100
Bambo	16	44.4	4	11.1	8	22.2	4	11.1	4	11.1	36	100
1st Hanqota	6	21.1	5	17.9	4	14.3	10	35.7	3	10.7	28	100

Source: Field survey (2014)

Focus group discussion participants unanimously agreed that water availability is generally decreasing as a result of reduced rainfall amounts. They noted that several water points that used to provide water for animals and people had dried up. A specific mention was made of springs and pools in local rivers. Members of the FGD were able to observe some of the springs that previously used to supply water to the communities but had since dried up.

Obstacles of farmers Adaptation to climate change/variability

Despite all efforts to minimize the changes in climate, the world needs to adapt to the upcoming changes as well. This adaptation to climate change is necessary to prevent societies from disasters and disruption (Roggema, 2009). However, several socio economic obstacles have been hindering farmers' effort to undertake various adaptation mechanisms to in response to the existing climate change and variability effects on their livelihoods. The data from survey questionnaire reveals that the major factor(obstacles) that impeded farmers' endeavor to adjust themselves and their livelihood to climate change and variability include;(38.1%) poverty(shortage of money), (21.6%) lack of awareness of the local population about climate change and its impacts,(17.5%) is

fluctuation of price of agricultural products while increasing cost of fertilizers and other commodities to be bought from markets, (15.5%) shortage of infrastructure(FTC, veterinary services, roads and markets and health centers etc) , (5.2%) absence of markets in the nearby areas to sell our agricultural products and the remaining (1%) is other reasons such as poor management of resources, lack of institutional capacity as mentioned by respondents.

4.4.2.2. Community Responses to CC and Variability

Communities have always adapted to climate variations by making preparations based on their resources and knowledge accumulated through experience of past weather pattern. Community based adaptation to CC and variability emerged out of the growing recognition in the developing community that those most vulnerable to climate change are the poorest people in the world's poorest regions. Many are marginalized, and live in remote regions out of reach of government services. CBA may foster the resilience of rural communities, but also the resilience of the ecosystems on which these communities rely for a living.

While the international community has increasingly emphasized the need for adaptation in recent years and more funding has been made available for adaptation, most efforts to help countries adapt have centered on top–down approaches and policy solutions (Wilbanks and Kates 1999; Reid et al. 2009). However, given that climate change impacts, appropriate responses, and, to some extent, adaptive capacity, are location–specific, adaptation at the community level is critical to the process of adaptation.

Community organizing for adaptation to climate change in itself also increases resilience to climate risks by strengthening and expanding social networks and links with supporting institutions (Adger 2003; Tompkins and Adger 2004) cited in Bryan and Behrman, 2013). The evaluation made by Boko *et al*. (2007, p. 453), provides the conceptual framework, characterizing the initiatives, i.e. adaptation actions, according to their social or economic resilience focus. According to Boko, sub-themes within the social or economic resilience dimension relate to the following:

- Social networks and social capital, e.g. perceptions of risk by rural communities or local saving schemes which determine behavior towards adaptation.
- Institutions, e.g. design, function and governance of institutions which enhance or constrain adaptive capacity.

Economic Resilience

- Equity, e.g. ability to access external funding sources or donor aid on various levels.
- Diversification of livelihoods, e.g. agricultural intensification or income diversification to strengthen resilience to shocks.
- Technology, e.g. seasonal forecasts or improvements of rain-fed systems through water harvesting and conservation techniques, use of new crop varieties to enhance resilience to shocks.
- Infrastructure, e.g. communication lines, road networks and other physical infrastructure to improve adaptive capacity.

4.4.2.3. Shared Resources and Community Responses to CC/Variability

According to the data obtained from HHs survey, majority (66.%) of respondents replied water as their shared resource, and it is followed by grazing land (20.6%), (10.3) is forest and the remaining (1%) is other shared resources. This implies in most parts of the woreda there are various types of shared resources and water is the major one. As far as the adverse effects of climate change and variability is concerned, almost all, (95%) of respondents agreed that climate change and variability has been impacting the shared resources, while only (3.1%) of the respondents did not agree. As it is indicated on the figure 4.10, the negative effects of climate change and variability on major shared resources include; drying up of streams, decrease of grazing land, forest fire, and disintegration of infrastructure.

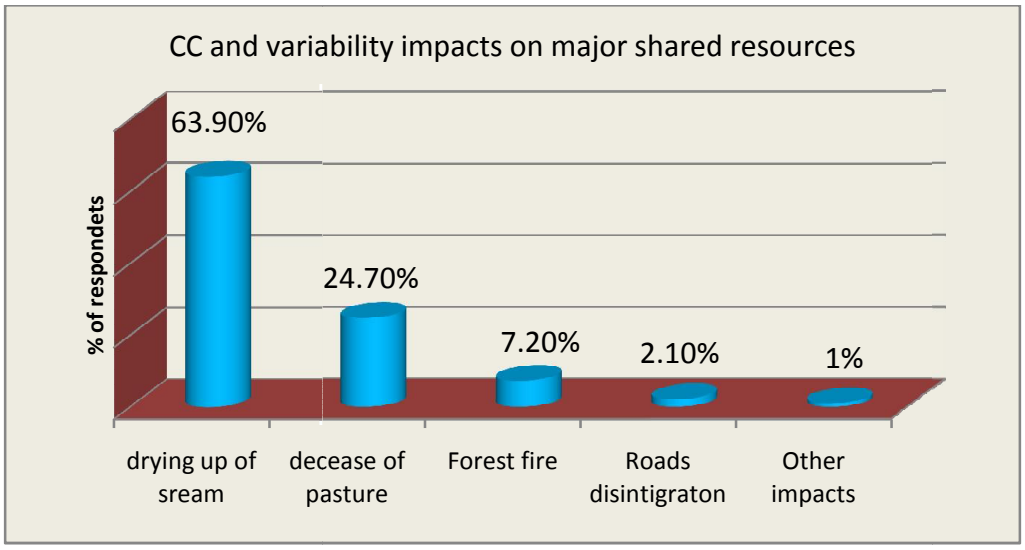

Figure. 4.11 Climate change impacts on shared resource.

Sources: Field survey (2014)

Members of the FGD were unanimous regarding the decreasing amount of shared resources. They confirmed that the changing climate is impacting the shared resources of their locality. They noted that before some 25 years there were lots of shared resources in their locality such as a thick indigenous forest from which we used to collect wild fruits, fire wood etc , a wider area of grazing field ,which was communally grazed , streams and rivers . But at the present time, except big rivers and grazing lands in some limited areas, shared resources are disappearing due to climate variability and change.

Household questionnaire respondents were asked the question 'Did you take any community based measure to overcome the observed climate change/ variability impacts?'And they were required to select an answer from two options, 'yes' or 'no'. Accordingly a huge number (90.7%) of the respondents replied yes, while only (8.2%) of the respondents answered 'no' The survey data reveals that more than half (52.6%) of respondents involved in planting trees,(24.7%) of them built flood protection ditches , (9.3%) participated in preparing and fencing communal water reservoirs and the remaining(2.1%) used other adaptation methods such as construction of roads, awareness creation etc in their respective *kebeles.*

4.4.2.4. Institutional / Government Responses to CC & Variability

Over the last two decades, the government of Ethiopia has put in place a number of policies, strategies and laws that are designed to support sustainable development, and the country is set to move for wards to a greener economy. Thus, to achieve the green economy plan, the most important environmental problems have to be identified and reduced. Therefore, the following environmental problems such as climate change, land degradation, over grazing and deforestation, indoor air pollution and water pollution, loss of biodiversity and ecosystem services, spread of invasive species etc are identified as a serious obstacles to achieve the county's green economy plan,(Cesar and Ekbom, 2013).

According to the information obtained from officials of SWARDO and DAs, a number of woreda initiated adaptation strategies are being undertaken as part of the federal government's efforts to increase community's resilience to climate change and variability. Some of the activities that are already taking place currently include, soil and water conservation activities, a forestation and spring development and road construction are some of the major ones. Productive Safety Net Program is also one of government induced adaptation strategies. The main objective is to fill food gap of the chronically food insecure farmers by assist crop (wheat) so that the farmers may not to sell their remaining assets. The programmed aims to provide households with enough income, in the form of either cash or food, to meet the food gap. The combination of cash and food transfers is based on season and need, with food given primarily in the lean season between June and August. Introduction of early maturing crop varieties is another government strategy. Many varieties are being introduced out of which wheat varieties are widely accepted.

Participants of FGD have noted that, PSNP has had a positive impact on the livelihoods of households. Public works and projects have increased food security by rehabilitating degraded land and creating productive community assets such as terraced fields, and small-scale irrigation systems. At the household level, families are experiencing improved food security, increased asset creation and protection, increased utilization of education and health services and improved agricultural productivity.

Rehabilitation of Environmental Resources

Many of the biophysical improvements to increase resilience and mitigation in smallholder agricultural production systems require action and coordination among many stakeholders in the rural landscape. Restoration of degraded areas to improve soil quality, improved management of communal water and pasture resources, and informal seed systems to facilitate the exchange of plant genetic resources are all examples of collective resource management activities that are likely to become more important under climate change (Thornton and Lipper, 2014).

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. Intense natural resources rehabilitation on degraded farmland and grazing areas are being implemented using different Soil and Water Conservation (SWC) techniques to reduce soil erosion and increase vegetation cover. As the information from Key informants interview reported, the following government initiated intervention works are already taking place to increase the small holder farmers adaptive capacity and resilience of their livelihoods,(agriculture).The intervention measures include:

- Construction of rain water harvesting and check dams.
- Digging SWC features such as terraces, soil bands on both private and communal land.
- Prohibiting degraded pasture and forest lands from any use by people in the area. This is in order to rehabilitate the land and generate natural forest.

Institutional responses to shortage of water

Ethiopia has essentially rain fed agriculture system, where more than 83% of the population depends on subsistence agriculture. While rain fall plays a major role as vital water source for securing nearly the entire food production of the country, the temporal and spatial distribution over the country varies above 2000 mm over some pocket areas in

the south west to less than 250 mm over the vast areas of afar and Ogaden low lands (NAMSA, 2001).

However, as it is noted in the previous section, the water resource of the country is being adversely impacted by decreasing precipitation and heat/ dry spells due to cc and variability. As studies indicated, the country has been experiencing recurring droughts and flashes and seasonal river floods. Therefore, 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). Accordingly in an effort to address the problems of recurring climate variability conditions and food insecurity, the woreda office of agriculture engaged in variety of water harvesting programs to supplement the rain fed agriculture and there by address drought and food shortages.

According to the information from experts of the woreda agricultural office, the office has been trying to introduce and accomplish various adaptation strategies in response to water shortage due to climate change and variability. Some of these are, constructing rain water harvesting pools, localized pumping, either from a surface water source (river, stream, lake or dam or groundwater (borehole/shallow wells/springs), using manual or motorized pumps and various on-farm water application methods), Gravity schemes using water diverted from upstream rivers / streams/ dams and delivered to cropped area either through open canals or pipes, and applied either by surface irrigation or pressurized systems .

The information from key informant interview,(experts from the woreda's ARDO) noted that farmers are not aware of the benefit they could earn if they used various agricultural technologies , inputs and varieties of crop seeds to enhance yield per a plot of land. So that, they simply complain as if there is no profit even if they used all technologies and inputs.

Figure .4.12. A photo Showing farm pond in one of surveyed kebeles.

4.4.3. CBA and Related Issues

As it has been noted in the previous section, CBA, as new adaptation approach comprises various socio-economic aspects and adaptation strategies to enhance pro-poor policy formulation and implementation. Many studies indicated that, there are two major themes of CBA to CC and variability, i.e., increasing social and economic resilience of communities.

Social Resilience of Communities

As far as social resilience is concerned, members of the FGD reported that, the woreda's office of agriculture and rural developments is trying to provide climate information, but this is minimal when compared with the adverse effect that they are suffering from the existing CC and variability.

One of the FGD participants reported that:

> *"If societies are to build adaptive capacity and climate resilient livelihood, it is imperative to create institutional connection and provide awareness creation trainings to local community and development agents so as to bring behavioral changes to wars adaptation".*

Economic resilience

The second major theme of community based adaptation to climate change / variability is building economic resilience of communities in response to the existing local climate change and variability effects on their livelihoods. Thus, economic resilience intends to enhance the following themes such as equity, diversification of livelihoods, availability of modern technologies and infrastructure to build resilience and adaptive capacity in the face of climate change and variability.

Technology

The introduction of new technologies resulting for example in more sustainable production methods, improved soil and water management practices or increased diversification suggested that technological adaptations are key when it comes to risk reduction and food security. With respect to technological services, HHHs were asked whether they get early warning climate forecast by SWoARD. Accordingly (72%) of them responded that they are receiving early warning information, while (28%) them replied 'no'. According to the information of SWARDO, the office is working to provide new agricultural technologies which enable farmers to practice sustainable production and it bore a good fruit in some kebeles such as Benara, where farmers were able to use improved soil and water management practices and produced encouraging yields of various crops, fruits, vegetables for the first time.

Access to Credit services

According to the survey data, almost all (88.5%) of the HHHs replied 'NO' and (28%) of them responded 'Yes' for the question which was stated "Do you have access to get credits from institutions to deal with climate related shocks or hazards?". This clearly shows that farmers' adaptation efforts to the changing climatic is being constrained by shortage of access to credit services in the woreda.

Equity

Equity and justice, or 'fairness' (Beg et al., 2002), in climate change can be considered in terms of processes, which largely relate to emissions issues, and outcomes, that relate to impacts, vulnerability and adaptation. Justice can also be considered to have distributive and procedural (Pavola and Adger, 2002), where the former relates to the distribution of benefits and adverse affects of climate change across society. In this respect , the information (response) of DAs is contrary to that of farmers ,(women and elderly) whom I interviewed , as they have complained as if there is no equity Not only in the distribution of food aids but also in the selection for safety net projects.

Governance

Many studies on climate policy highlight a strong interrelation of adaptive capacity and governance as an innovative form of government: "Interventions in social–ecological systems immediately confront issues of governance" (Lebel *et al*, 2006: 19). Adaptation policy has to handle questions such as: Who decides what should be adapted? For whom is adaptation to be managed, and for what purpose?

With respect to the interrelation between governance and adaptive capacity, experts, officials from soro woreda agricultural and rural development office and development agents as well, reported similar views. They noted out that, previously every community based work had been under taken by the sole directives and order of the woreda (top-bottom). But now, it is both top to bottom and bottom – top approach, peasants are also participating in planning, implementing and decision making.

CHAPTER FIVE

5. Summary, Conclusion and Recommendation

5.1. Summary

The international consensus of the scientific society led by IPCC, agreed that the global temperature is increasing and the main cause of this is the accumulation of CO2 and other GHGs. The negative effects of CC and variability are threatening to reverse development strives in many parts of the world, especially in SSA. In the coming decades, global CC will have a serious threat on food and water security.

Ethiopia's agricultural sector is heavily dependent on natural rain fall (rain fed agriculture).Though agriculture is the back bone of Ethiopia's economy; it has been adversely impacted by various extreme weather events. In the past he country experienced several drought and flooding due to climate change and variability. Thus this study intended to assess the effects of climate change on rural livelihood and their adaptation methods in Soro Woreda, Hadiya zone, in SNNPR of Ethiopia. The main findings of the research are summarized below.

- From the whole surveyed HHHs, 64.6% depend on crop production, 19% on livestock production and few of them practice other off-farm activities. However, majority of the respondents posses a land size which extends from 0-0.5 ha to 1hh, while very few of the respondents posses a land holding of 0.75ha to 3ha.

- Increase in temperature, uncertain rain fall, droughts, erratic rain fall and flooding and decrease in river volume are mentioned as the major indicators of cc and variability. Crop yield reduction, shortage of grazing land, hailstorms and loss of livestock are mentioned as the most frequently affecting negative effects of climate change and variability. The decrease in crop yield and livestock production are attributed to highly un predictable rain fall , late onset and early offset of rain fall, low fertility of the land, absence modern technology and

agricultural inputs apart from this, shortage of water, loss of livestock due to lack of fodder, pests and diseases , dry spells are mentioned.

According to the survey data, drought, flooding, pests and diseases and rain variability are main drivers of vulnerability of the community to CC. Other factors such as sex, age and wealth status also contribute to vulnerability. And the major causes for the above shock have also been suggested by respondents.

These causes include, deforestation, less fertility of the farm lands, land use change / land cover and absence of sustainable agricultural practices.

- The major coping mechanisms used by respondents include; eating less,(reducing frequency of meal), borrowing from relatives, sale of livestock, receiving food aid etc. With regard to livestock production, HHHs have listed out various coping mechanisms following agro ecologic condition of their respective kebeles. Accordingly, Danetora and Bambo kebeles, majority of the respondents used decreasing the number of livestock, while in 1st Hanqota, sale of old animals and herd mobility account the highest share. Other coping mechanisms such as livestock diversification, seasonal migration, herd mobility cattle fattening are practiced in a limited basis.

- According to the finding of the study, adaptation in the woreda is taking place in house hold community and institutional level. At house hold level, use of new varieties of seeds, irrigation in a very limited basis, inter cropping, receiving aid are practiced. At the community level, various woreda initiated adaptation actions are being practiced. Some of these are SWC activities, a forestation, developing springs and construction of roads etc. To fill food gap of chronically food insecure families, the woreda government is employing productive safety net programme. In response to water shortage, the woreda agricultural office has been implementing adaptation strategies such as water harvesting pools, localized and motorized pumps.

As the major themes of CBA to CC/ variability, key informants were asked about the presence and application of social and economic resilience of the community, technology, equity and governance issues etc. Therefore, they noted that previously all the above themes were not implemented, but since recent past, even though it is not in its significant level there are improvements in the inclusion of all themes of CBA.

- Poverty (shortage of money), lack of awareness, volatility of price, shortage of infrastructure, absence of markets in nearby areas are considered as the major problems of farmers adaptation to CC/ variability.

5.2. Conclusion

The result of the study shows that, climate variability (Rainfall) is a major driver of vulnerability in the woreda .The amount and timing of the rain fall in the area is very variable, both maximum and minimum temperature consistently increasing from year to year. This is affecting agricultural practices (crop production and livestock rearing) which are very sensitive to climate change and variability.

The livelihood problem in the study area is exacerbated by ever increasing population number, shortage of agricultural land, degraded environment, (decreasing fertility of soil, high poverty of the communities.

Because of climate variability induced shocks and population growth the vegetation cover and grazing areas of the woreda has deteriorated and finally it caused shortage in livestock feeding and decrease in cattle production. There is irregularity in the timing of rainfall which in turn affecting the cropping pattern and the whole process of crop production.

Generally farmers in the study area are very vulnerable due to climate induced shocks and low adaptive capacity of the community to CC and variability. Other variables like poorness, landlessness or having infertile land, large family size, and the like increased the vulnerability of households among the society.

The current adaptation strategies that the local people used are not planned, coordinated and not sufficient to. So that it could not fully support the local people to sustain their life. Even though the woreda government institutions are trying to take some intervention measures, it faces several short comings like institutional inter- connectedness, equity, efficient governance etc. Therefore it is not as such efficient to overcome the existing climate related problem in the area.

5.3. Recommendation

Based on the nature and finding of the study, the following intervention measures are recommended so as to enhance resilience and adaptive capacity of the society. These measures include;

- Even though, the local people perceived CC and variability in their locality, their knowledge on how to adapt is not sufficient. Therefore, rising awareness about CC effect and how to use modern agricultural technologies is imperative to increase adaptive capacity of the farmers.

- Maintaining agricultural resilience through agro-forestry

  Agricultural sustainability is often enhanced through eco-system diversity. Therefore, efforts should be made to increase use of inter-cropping and planting Inset, which is the most drought resistant and staple food in the study area. This could help to maintain soil fertility through decomposition of litter and manure.

- Restoring the degraded ecosystem in which the local farmers depend for their livelihoods, by applying various mechanisms such as forestation, reforestation, protection of water bodies from pollution, encouraging local farmers to protect soil erosion using various SWC technologies must be applied if the degraded environment has to be rehabilitated. With respect to shortage of water, various communities based works, such as developing springs, digging water wells, supplying manual and motorized pumps so as to pump recharging underground

water, protecting wet lands from any pollution, building rain water harvesting pools, and like have to be accomplished.

- Distributing Climate risks to different sources of income; this can be achieved through diversifying income of the HHs to different sources. If farmers are depending only on agriculture, they could easily be sensitive to and affected by the adverse effects of climate change and variability. Therefore, encouraging local farmers to get engaged in various occupations which may be under taken low capital such as bee keeping, poultry and other off farm activates other than agriculture is worthwhile to resilience.

- Access to credit and investment is considered as one of the several factors that can affect adaptive capacity of HHs. Thus, to minimize the effects of CC, the young and women should get access to credit to invest in farm and off farm activities.

- As noted by several studies, women headed HHs, the poor, children and elder people are disproportionately affected by climate related extreme events. These people are vulnerable to climate change and its adverse effects, partly because, they reside in areas which are prone to extreme events. Therefore, every development plans need to be designed taking in to account the most vulnerable section of the society and DRR strategies that could minimize the risk related with climate variability.

- Given the shortcomings of individuals (autonomous) and national (top- bottom) adaptation plans, more effective adaptation methods (CBA) that link bottom-up action with top-bottom strategies are required. Therefore, group based approach, which requires collective action and social capital, integrates local knowledge and perception of climate change, emphasizes local decision making, communities' priorities and needs, improves poverty reduction and livelihoods should be implemented and then evaluated against the cited goals.

- Building the capacity of rural community through;
    - Providing effective level of fertilizer with reasonable price.
    - Providing training to practitioner and facilitating modern livestock breeding practices.
    - Maximizing employment opportunities
    - Improving infrastructure (roads, markets, schooling storage and distribution and extension services) and the like.

Finally, further studies which could address the adaptation and coping mechanisms, and the existing challenges in various agro ecological conditions should be conducted so as to provide more options to policy formulation and enhance sustainability of livelihood of rural community in the face of changing environment.

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Appendices

Addis Ababa University

College of social sciences and Humanities

Department of Geography and Environmental Studies

Appendix I: Introduction

My name is Astawsegn zeleke. I am a master's student in Addis Ababa University studying Geography and Environmental studies (climate change and adaptation stream). I am doing my thesis on: the *Effects of climate change and variability on rural livelihoods and responses in soro woreda, Hadiya Zone, SNNPR, Ethiopia.* Thus, I would like to express my appreciation in advance for your cooperation in giving me your time and being committed for the success of this work.

I. General characteristics of respondents

1. *General*

1.1 Name of the *kebele*----------

1.2 Farmer's name ---------- (Not compulsory)

1.3. Date of interview----------

1.4. Enumerator's name ---------- signature----------

Checked by ---------- ----------signature ----------

2 Socio-economic and demographic characters ices

2.1 Sex of household: Male---------- Female----------

2.2 Family size----------

2.3. Marital status: Single…….married----------Divorced----------widowed--------

2.4, What is your educational level?

A. Primary school C. Secondary School

B. Capable to read and write D. Illiterate E. above grade 12

3. What is your means of livelihood or how do you get your livelihood?(multiple response is possible)

A. Livestock rearing C. Renting out land

B. Agriculture (Crop production) D. working as daily laborer,

E. petty trade F. Other (specify).

4. Do you have another source of livelihood other than Agriculture (off farm activity)? Yes----------No……

5. If your answer to Q 7 is 'yes', what could be that activity, Please specify

A. Bee keeping B. Petty trade C. working as laborer

D. working hand crafts E. others specify

6. Do you hold land? Yes ----------No----------

7. If your answer for Q, NO 6, is 'yes', how much is the total size of your land?, Hectare/ ----------Timad,----------

8. Do you have livestock (domestic animals)? Yes ---------- No ---------- if yes, how many livestock do you own?

Animal type	Number of Animals	
	Before 10 years	2006 E.C
Cows		
Oxen		
Donkeys		
Horses		
Sheep		
Goats		
Others (specify)		

Appendix I. (A).Climate change/ variability and community vulnerability

1. What is your perception about climate change/ variability of your *kebele*?

A. There is climate variability C. The climate has not changed (it is stagnant)

B. The climate has totally changed D. I have no idea

2. If your answer to Q No, 1 is 'the climate has changed/ show variability', what are the local indicators of the observed climate change?

A, un predictable rain fall C. Recurrent drought
B. increase in temperature D. Hail storms E, Decrease in river volume. F. Others

3. What are the major challenges that climate change/ variability posed on your livelihood?

A. Shortage of pasture land C. Loss of livestock

B. crop yield reduction D. flooding E. Drought E. Others (specify).

4. How do you perceive the temperature pattern of your locality or Village?

A. Increased B. decreased C. No observable change. D, Other specify.

5. Is there a change in the timing of rain in your area? Yes ☐ No ☐

6. If your answer is 'Yes', how do you characterize it?

A. comes early and goes late. C. Comes and goes early

B. Comes late and goes early

7. If your answer for Q N6, is comes late and goes early, what changes have you observed in crop production?

A. decrease in crop yield C. No change in production

B. Increase in crop yield D. Decrease of long cycle crops

E. Others

8. Are you vulnerable to such problems like economic shocks, health, price fluctuation…..?

Yes---------- NO, ----------

9. If yes, which one of the following affects your life?

1. Drought 2. Disease 3.High price of goods and commodities 4. Food shortage

5. Shortage of water supply 6. Others

10. Do your household get sufficient water in the whole year? Yes----------No----------

11. What is the source of water for your household?

A. Rivers (Stream) C. pounds

B. Protected springs D. Unprotected springs E. pipe lines F. Dams

12. Do you think that livestock production has increased or decreased in your village or locality?

Increased ☐ Decreased ☐

13. If your answer for Q No7 is decreased, what do you think is the reason?

A. Livestock disease C. shortage of water for animals

B. Shortage of grazing land D. high temperature. E. others Wh1at, (specify),

14. Have you ever faced any climate related disaster over the last ten years?

Yes ☐ No ☐

15. If your answer for Question No14, is 'yes', what type of climate shock is your concern?

A. Recurrent drought C. Crop pests and diseases

B. Erratic rain fall & flooding D. Rain fall variability E. others

16. What do you think is the main cause for the climate change related problem that you specified in Q NO, 15?

A. Deforestation C. low fertility of land
B. Change in land use and land cover D. Absence of sustainable farming system E. Others (specify).

17. What was the main source of feed for your livestock before 10 years?

A. grazing pasture C, steam of Inset plant
B. Crop residues D. others,

18. What is your main source of animal feed at the present time?

_____
_____
_____

19. What do you think is the possible adaptation methods to minimize the impacts of climate variability on your livelihood?

A. Applying new cropping system and irrigation C. Safety net program

B. Diversification of crops and Livestock D. Planting grass cover. E. Migration F. Use of early maturing crops G. Others (specify).

20. Which group of the society is most impacted by and vulnerable to climate change and variability?

A. Female headed households B. Male headed house holds

C. Land less and the poor D. elderly and children

21. Based on your answer to question NO 20, why do you think, you are more vulnerable to the impact of climate variability?

A. Lack of information on climate and weather variability C, weak social capital

B. Poverty to cope the shocks easily D. Poor administration

E. Others (specify).

B. Adaptation methods to impacts of climate change and variability

1. What is the shared property of your locality or your area?

A, Pasture land, C. Water resource

B. Forest D. Others.(specify)

2. Have you observed any climate change or variability impacts on resource you mentioned in Question, NO, 2…? Yes, ---------- NO, ----------

3. Which type of impacts did you observe?

A. Drying up of water,(rivers) C. shrinkage of pasture land
B. Forest fire, D. Disintegration of roads E, others.

4. Did you take any community based measure to overcome the observed climate change/ variability impacts?

Yes---------- No, ----------

5. If yes, what is that measure you have taken to overcome climate variability problem?

A. planting trees (aforestation) C. protecting water reservoirs

B. Building flood protection features (ditches) D. constructing roads E. Others

6. What are major coping strategies you used *to overcome* climate change / variability impacts on livestock production?

A. Increase livestock diversification

B. Seasonal migration with your cattle in search of pasture & water

C. Sale of weak and old animals before the dry season.

D. Decreasing the number of livestock

E. cattle fattening F, Others (specify).

7. Adaptation strategies, you used to overcome climate change / variability impacts related with crop production?

A. Receiving aid from safety net B, using new varieties of crops

C. Inter- cropping system D, wise storage of crops (saving).

E, Intensive irrigation F,Others (specify).

8. Adaptation related with shortage of water?

A. Rain water harvesting C. Use of recharging ground water

B. Expanding irrigable farm D. Use of reservoirs and ponds

E. Others (specify).

9, how do you manage to cope with some of your problems related with vulnerability?

A. Reducing number of meals C, by getting remittance from relatives
B. Through loan D. sell of livestock E. Renting of land

F. By membership social institutions G. by getting aid H. Others (specify)

10. Do you have access to get credits from institutions during climate related hazards?
Yes---------- No----------

11. Do you get early warning information before the occurrence of climate related shock?,

'Yes'---------- NO ----------

12. If yes, who do you think is responsible in disseminating information before the occurrence of hazards?

A, local institutions,(Ikub, debo). B. NGOs

C. Local government institutions D. Others(specify)

13. What are the major problems that hinder you to adapt impacts of climate change/ variability on your livelihoods?

A. Lack of accessibility to infrastructure (roads, FTCs, etc) **C.** Low and fluctuation of prices

B. Poor market accessibility D. shortage of money E. lack of awareness

F. Others (multiple answers is possible)

14. What do you think are the locally feasible *coping mechanisms* that should be adopted to reduce climate change / variability impacts on livelihoods?

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15. What must the local GOs must do to reduce impacts of CC and variability on livelihoods, DRR and poverty reduction?

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16 .Are there locally formed social, legal and cultural norms (institutions) that could be used to perceive or distribute climate change impacts across different social groups?

Yes---------- No----------

17. If your answer for question no 16 is yes, please specify the institutions with the service they offer

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Appendix, II

- **Interview Questions for Focus Group discussions (FGD)**

1. What do you think are the local indicators of Climate variability or change in your *kebele*?
2. Do you think climate change or variability posed negative effects on your livelihood? If Yes, Please explain it.
3. What are the more vulnerable livelihood sectors in your *Keble (peasant* association*)*?
4. Is there any change on water, grazing land, the quality of pasture and arable land over the past years in your village? Please
5. What do you think is the major causes for the changes on the resources mentioned above?
6. Do you think any measure to avert climate change or variability? Who should have the main responsibilities to do this?
7. Is there any change on livestock number, composition and feeding of your village?
8. How do you perceive your crop production? Increasing ---------- decreasing ----------
9. How do you cope up or adopt the impacts of impacts of climate change / variability on your livelihood?
10. Have there been climate extremes (drought and flooding)In the last 20 years? Which one is your main concern?
11. Have you ever been participated in community based environmental participation in your Keble?
12. What are the main challenges that hinder your coping mechanisms?
13. What is the role of traditional institutions in coping climate related hazards?

Appendix III

A Check list for Key informant Interviews with experts from SWARD office and DAs

1. Name ----------

2. Position/profession----------

3. Is there any form of climate change or variability in your woreda/district? If, 'Yes', please explain it----------

4. What o you think is the impacts of climate variability on the livelihoods of farmers?

5. Who are more vulnerable to the adverse impacts of climate change and vulnerability?

6. What are the local coping mechanisms used to reduce current climate elated risks and adapt to the future climate change?

7. What is the role of institutions like GOs, NGOs, in facilitating adaptation to climate change in your woreda/

8. are the local GOs working in integration with agencies in Zonal, regional and national adaptation programs(NAPAS)? If, not why?

9. Do local communities take part in making decisions with regard to adaptation mechanisms and how to implement CBA in woreda level? If, yes, how / please explain it. If not why Please explain it.

10. What are the main challenges to undertake CBA to climate change in your woreda, ? And how do you think it can be improved?

Declaration

I , the undersigned declare that this thesis is my genuine work and that all sources of materials used for the thesis have been duly acknowledged and I also seriously declare that this thesis has never been presented to any other Institution anywhere for the award of any academic degree, diploma, or certificate.

Name Astawsegn Zeleke

Signature _____

Advisor: Aklilu Amsalu (PhD)

Signature----------