ADDIS ABABA UNIVERISTY

COLLEGE OF SOCIAL SCIENCE

LOCAL PERCEPTION ON CLIMATE VARIABILITY AND ADAPTATION STRATEGIES: THE CASE OF JAVIE TENAN WOREDA, WESTGOJJAM ZONE

BY

TSEGA GASHU

JUNE, 2013

ADDIS ABABA

LOCAL PERCEPTION ON CLIMATE VARIABLITY AND ADAPTION STRATEGIES: THE CASE OF JAVIE TENAN WOREDA, WEST GOJJAM ZONE

BY

TSEGA GASHU

A THESIS SUBMITTED TO GEOGRAPHY AND ENVIROMENTAL STUDIES OF ADDIS ABABA UNIVERISTY IN PARTIAL FULFILLMENT OF THE REQUIRMENTS FOR THE DEGREE OF MASTERS OF ARTS IN NATURAL RESOURCE MANGEMENT

ADDIS ABABA UNIVERRISTY

COLLEGE OF SOCIAL SCIENCE

JUNE, 2013

Local Perception on climate Variability and Adaptation Strategies: The Case of Javies Tenan Wereda, West Gojjam Zone

By

Tsega Gashu

APPROVED BY BOARD OF EXAMINATION

1._____	_____	_____
Advisor	Signature	Date
2._____	_____	_____
Internal Examiner	Signature	Date
3._____	_____	_____
External Examiner	Signature	Date

_____	_____	_____
Graduate Program Coordinator	Signature	Date

Acknowledgement

Several people have assisted me during my research work. Although it is not possible to mention all these people in a few sentences, I would like to thank those who have been particularly important to my work. I feel great pleasure to express my special thanks to my unlimited technical supports and guidance, throughout the research work, have had played advisor Dr. K.N Singh, for his critical and valuable comments in the course of this study for his uncompromised role for the betterment of the whole work. I am also grateful for his, kindness, patience and warm-welcome he has shown me throughout the research work.

I would also extend my profound and heartfelt gratitude to my families(especially My wife W/ro Meaza) and my friends for their endless support and encouragement throughout the ups and downs of my academic and personal life.

I would like to thank anonymous survey respondents and interviewees for their welcomed responses. I must thank the development agents and experts, especially Mr. Temesgen Mekonnen and for providing me valuable information, coordination of the visits to farmers and assistance in primary data collection. Indeed, there are many people who pretend to be friends, but there also few friends who stick together and understanding than a brother. Thank you all friends!! For your understanding and friendliness!

Table of Contents

Contents **page**

List of Table

List of Figure

List of Acronyms

ADLI	Agriculture Development Led Industrialization
CFDRE	Constitution Federal Democratic Republic of Ethiopia
CSA	Central Statistic's Authority
CVA	Climate variability and Adaptation
DA	Development Agent
ECA	Economic Commission for Africa
EEA	Ethiopian Economic Association
EEPRI	Ethiopian Economic Policy Research Institute
EPRDF	Ethiopian People's Revolutionary Democratic Front
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
ha	hectare
ILRI	International Livestock Research Institute
JTWRDB	Javie Tenan woreda Rural Development Bureau
Km	Kilometer
LMP	Land Management Practices
M	meter
Masl	meters above sea level
MERET	Managing Environmental Resource to Enable Transition
MoARD	Ministry of Agriculture Rural Development
Pas	Peasant Association
RKAU	Rural *kebele* Administration Unit

SLM	Sustainable Land Resource Management
SPSS	Statistical Package for Social Science
SWC	Soil and Water Conservation
UN	United Nation
UNEP	United Nation Environmental Protection
USD	United States Dollar
WCED	World Commission on Environment and Development
WFP	World Food Program

Abstract

The objective of the study was to assess farmer's perceptions on climate variability of rural farming household with their response towards and adaptation mechanisms in Javie Tenan woredas. Primary data for the study were collected through household questionnaire surveys, focus group discussions, key informants interviews and personal observations while secondary data were collected from relevant local authority reports and records. The findings of the research showed that the district is experiencing increasing land degradation, spatially soil erosion, nutrient depilation and deforestation are perceived as impacts of climate variability. Binary regression model results reveal that farmers' household age, sex, marital status, distance of farm land from homestead and their perception on climate variability on their own farmland have significant positive impact on farmers' use of land management practice as an adaptation mechanism. Land tenure security and contact with development agents has significant negative influence on livelihood adaptation mechanisms. Other remaining factors such as farmers' literacy, household size, main occupation, income level, farm size, and access to credit service are found not to have significant influence on livelihood adaptation mechanisms. In addition, the results of qualitative data also showed that low level of income, abject poverty, low level of agricultural production, and depilation of assets, lack of alternative livelihood opportunity; unsustainable rural land use practice and competition aver scanty resources are considered as important factors to be treated. The study concludes that in making interventions in land management as the livelihood adaptation mechanism, there should be active participation of local stakeholders, primarily the farmers. This helps to integrate indigenous livelihood adaptation mechanisms and the new techniques and enhance easy adoption and sustainable use of effective introduced adaptation mechanisms.

Introduction

1.1. Back ground of the study

The Earth's mean surface temperature is doubtlessly warmer than it was 100 years ago (IPCC, 2007), Mounting evidence from around the globe has removed virtually any serious doubt over this fact, and also over whether the main culprit is human emissions of heat-trapping gases such as carbon dioxide (CO2).According to the recent Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC,2001) warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. (IPCC, 2007) has also concluded that more climate change is on the way resulting from past, current, and future greenhouse gas emissions with its potential adverse impacts on socio-economic development of nations.

The challenges are substantial, particularly in the developing world (Olsen, 2006). Developing countries have a high dependence on climate-sensitive natural resource sectors for livelihoods and incomes, and the changes in climate that are projected for the tropics and sub-tropics, where most developing countries are found, are generally adverse for agriculture (IPCC, 2001 and 2007a). Furthermore, the means and capacity in developing countries to adapt to changes are scarce due to low levels of human and economic development and high rates of population growth. These conditions combine to create a state of high vulnerability to climate change in much of the developing world (Olsen, 2006).

Climate change is anticipated to have far reaching effects on the sustainable development of developing countries including their ability to attain the United Nations Millennium Development Goals by 2015 (UN, 2007). Africa's high vulnerability and prone to greater impacts of to various manifestations of climate change and variability has been confirmed in reports of the IPCC and other publications (IPCC, 2007a; FAO, 2007). However, Africa's, total contribution to emissions of greenhouse gases is less than 7% of the world's greenhouse emissions (Olsen, 2006).

1.2. Statement of the Problem

Many research findings indicated that climate change have significant impacts on tropical regions, particularly poor countries are more vulnerable to the harmful effect of climate

change (CLICO, 2011).. The vulnerability of poor countries is due to their technological, resource and institutional constraints (Kurukulasuriya and Rosenthal, 2003).

A large part of Ethiopia is dry sub-humid, semi-arid and arid, which is prone to desertification and drought. The country has also fragile highland ecosystems that are currently under stress due to population pressure and associated socio-economic practices (NAPA, 2007). Ethiopia's history is associated, more often than not, with major natural and man-made hazards that have been affecting the population from time to time. Drought and famine, flood, malaria, land degradation, livestock disease, and insect pests have been the main sources of risk and vulnerability in most parts of the country. Especially, recurrent drought, famine and, recently, flood are the main problems that affects millions of people in the country almost every year. While the causes of most disasters are climate related, the deterioration of the natural environment due to unchecked human activities and poverty has further exacerbated the situation (NAPA, 2007).

These may, in turn, lead to increased conflicts, human right violence, and food and water insecurity for at risk populations, undermining growth. It is estimated that the net balance of changes in the cereal production potential of east African countries resulting from climate change will be negative, with net losses of up to 12%. Overall, approximately 40% of SSA countries specially the eastern parts of the continent and Sahel will be at risk of significant declines in crop and pasture production due to climate variability and change (Fischer et al., 2005; Shah *et al*., 2008).

Ethiopian agriculture is not highly productive in general. Its improvement is constrained mainly because of climatic factors and soil and land degradation (IPCC, 2007a). This is triggered and exacerbated by improper land use such as cultivation of steep slopes, over cultivation and overgrazing, and other socio-economic constraints such as inappropriate policies, subsistence farming and declining farm size mainly due to population growth (Daniel, 2008). Additionally, tenure insecurity, weak agricultural research and extension services, lack of agricultural marketing, inadequate transport network and use of agricultural inputs such as low use of fertilizers, improved seeds and pesticides, poor nutrition of livestock, low level of veterinary care, and livestock diseases are other constraints (Deressa, 2006).

Special interference at certain local levels and environments in the community by making effort to address these adverse conditions and designing coping mechanisms to the climate change and variability is very essential and helps local communities, the government and the donors in decreasing the degree of vulnerability to the hazards and cost of adaptation (NAPA, 2007). In fact, some of these efforts have brought about strategies that have induced changes in the attitude of the affected local communities. Some strategic measures include the development and implementation of national environmental initiatives, as well as policy/ program and project initiatives that directly and/or indirectly address climate variability and change and adaptation strategies. These initiatives could be capitalized for mitigating the undesirable consequences of climate related hazards (CLICO, 2011).

There has been no much research on climate variability and local livelihood adaptation strategies in the study area. A known study for Ethiopia is done by (Deressa, 2006). His study was conducted using sub-regional (agro-ecology) agricultural data, not household-level data. Thus, the scale of his analysis ignores basic household-specific characteristics that are potentially the key to designing effective adaptation strategies.

Thus, this study will assess the perception of rural community toward climate variability and /or change and livelihood adaptation strategies in the wider Javie Tenan woreda. It also explores local views; indigenous knowledge, traditional values and cultures, etc. that have been exercised to adapt climate change in the study area. Finally, recommendations on how to address possible problems associated with the perception of rural communities' toward climate change variability and livelihood adaptation strategies were forwarded.

1.3. Objectives of the Study

1.3.1 General Objectives

The general objective of the study is to assess climate change, variability and adaptation perception of rural communities of Javie Tenan woreda.

1.3.2. Specific Objectives

1. Assess the local perception on the climate Variability.
2. Assess local coping and adaptation strategies on climate variability the study area.
3. Discuss the extent of adaptation mechanisms that are being practiced by the local communities in the study area.

4. Identify socio-economic and demographic factors which influenced the perception of local communities on climate variability and livelihood adaptation mechanisms.

1.4. Research Questions

1. How are the communities' perceptions on climate variability in the study area?
2. What are the local coping and adaptation strategies on climate variability in the study area?
3. To what extent the local coping and adaptation mechanisms are being practiced by the local communities in the study area?
4. Which socio-economic and demographic factors influenced the perception of local communities' on climate change and variability and adaptation mechanisms?

1.6. Conceptual Framework

Rural communities' perception about climate change, variability and adaptation mechanisms practiced is being influenced by their current status of demographic and socio-economic characteristics. The conceptual framework of the factors, which consist of two key concepts of variables, is shown in figure-1. The dependent elements that include the frame work for this study are rural communities' perception about climate change, variability and adaptation mechanisms. The socio-economic factors (age, sex, educational background, and access to information) (IFPRI, 2011) are independent variables which highly determine and ultimately predict the dependent variables.

Rural communities' ability to perceive climate change is a key precondition for their choice to adapt (You and Ringler, 2011). Understanding communities' perceptions has scientifically been viewed as an approach to the preparation for and management of discrete events, that have the potential to overwhelm the capacity of an affected community, province, country or region, and cause severe hardship and loss due to climate change and variability.CCA polices and strategies should take into account variety of factors for their effectiveness. It follows from the above examples that social, institutional, cultural, religious, economic, environmental, hydrologic, geographic, educational and political factors are all important. These factors include aspect such as (You and Ringler, 2011).

1.7. Significance of the Study

Although, the study will be carried out for academic purpose and it is confined to a single Woreda, the findings shall contribute to deepen the knowledge of rural communities' perception and attitudes on climate change and/or variability and adaptation mechanisms in general and the study area in particular. Therefore, the outcomes of the study will be used in formulating future environmental policies and strategies at the local level. As well as it will be used to have a better understanding of the kind of training which is required for local communities in the area. Above all the survey is the first of its kind in the areas that, it may be used to stimulate for further research to refine the conceptual and methodology of the present study.

1.8. Scope of the Study

The scope of this study is to assess the level of local perception towards climate change and/or variability, and livelihood adaptation strategies practiced at local level i.e. Woreda and to assess some of the factors that determine local perception towards climate change and variability and adaptation mechanisms. There are a number of factors that affect local perception towards the climate change and variability and method of adaptation. It constitutes the demographic, socio-economic, political, psychological, cultural experience, exposure to different sources of information. Despite the fact that, those factors are many in number they are interrelated and multiple.

The following list of determining factors such as age, sex, educational status and access to information were taken into account for the sake of these studies. This was due to the time and budget constraints for further study of the rest of the factors. In addition, the study will confine to relatively very large geographical area within which no the same research had been surveyed in Javi Tenan woreda of West Gojjam zone.

CHAPTER TWO

Review of Related Literature

2.1. Climate Variability and Change in Ethiopia

As climate change and variability is global concerns, about its impact on agriculture in developing countries have been increasing (IPCC, 2007) and some attempts have been made to estimate this impact (Wiggins, 2006). Though this effort is growing, not much research has been done in Ethiopia. Climate change could be damaging to countries in south east Asia, Latin America ,Africa, particularly sub-Saharan countries, being dependent on rain-fed agriculture and under heavy pressure from food insecurity and often famine caused by natural disasters such as drought, is likely to be seriously affected (Mendelsohn and Tiwari, 2000).

According to the (MME,1994, Abebe et al, 1999) the global mean temperature is increasing drastically, which would bring an uncontrollable change in socio-economic development of all nations. These events are reported to exist and affect some areas of the world, including the sub-Saharan African countries like Ethiopia. Some reports show that, millions of people, animals and vegetations are being affected by climate change since the early 1980's (MME, 1994, Abebe et al, 1999).

Ethiopia is vulnerable to climate variability and change because large segments of its population are poor, dependent on income opportunities that are highly sensitive to the weather, and have low access to education, information, technology, and health services((FAO, 2010) .They have low adaptive capacity to deal with the consequences of climate variability and change. It is one of the poorest countries in the world, where 77.5 percent of the people live on less than two dollars a day and 46 percent of the total population is undernourished. Eighty-five percent of the population depends on agriculture to make a living. The average number of Ethiopians requiring food aid is growing by more than half a million people per year. These chronic and increasing aid requirements may soon extend beyond the capacity of early warning systems (FAO, 2010).

Ethiopia has experienced at least five major national droughts since 1980, along with a large number of localized droughts (World Bank, 2008). These cycles of drought create poverty traps for many households, constantly consuming their efforts to build up assets and increase

income. About half of all rural households in the country experienced at least one major drought from 1999 to 2004 (Agrawala, Fankhauser, 2008). With agriculture highly dependent on rainfall variability and amount, weather in general rules the lives and well-being of many rural Ethiopians.

According to (Pankhurst, 1985), there are historical accounts of many centuries ago indicating that climate variability and change are not recent phenomena in Ethiopia. For example, from 1540 to 1800 AD, 26 major famines and droughts, accompanied by the spread of human and livestock diseases, had been recorded. Similarly, the great Ethiopian famine (1889–92) is known for its epidemics and famine (McKee 2008, Pankhurst 1985).

Evidences that could be associated with climate change have already started appearing in Ethiopia (Wakgari *et al* 2005, NMSA, 2001) .It is reported that in the last 50 years only, the annual average minimum temperature over the country has been increasing by 0.2 °c every decade. Climate change related events like the occurrences of frequent and extensive droughts in recent decades, spreading of malaria in high land areas which have never experienced before, loss of biodiversity and decline in wildlife number have been observed (Wakgari *et al* 2005, NMSA, 2001). Even the country has recently experienced flood hazard which has killed more than 500 people in 2006. This was associated with extreme weather event related to climate variability and changes (UNEP, 2006).

Accordingly, in recent times, a significant number of people in Ethiopia are being affected chronically by drought and/or flooding, leading to deaths and loss of assets and to an appeal for international support. The problem is very serious in the arid and semi-arid areas, especially among the pastoralists (Yohannes and Mebratu, 2009).

Moreover, it has led to a decline in biodiversity, shortage of food and increases in human and livestock health problems, shortage in quantity and quality of pure water, conflict over resources, violence of human right, rural-urban migration and dependency on external support. More frequent floods, especially in East Africa increased water stress due to both climate change and increased demand increased water scarcity could trigger more conflicts (Asress 1994, NMSA, 2001).

In Ethiopia, as well as many other African countries, a range of factors may undermine communities' ability to adapt to climate change (Agrawala and Fankhauser, 2008). The

country has a complex climate system, in addition to socioeconomic challenges, such as endemic poverty, limited access to capital and global markets, ecosystem degradation, complex disasters, and conflicts.

Accordingly, the effect of climate change on Ethiopia's economy will likely be a function of both the macro-economy and sector-specific vulnerability. This means that the government's adaptation policies will be crucial. However, such policies are likely to be costly and, without a realistic baseline scenario, there is a risk that government programs will be evaluated against an inappropriate status quo (no cost, no climate change), rather than against the outcomes that will prevail if no government adaptation is carried out (Stage, 2010). It is important, then, to assess the impacts climate change is likely to have, if private agents are left to adapt on their own. Such a baseline impact assessment can be used to assess the effects of activist adaptation policies.

2.2. Causes of Vulnerability to Climate Conditions in Ethiopia

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

Vulnerability assessment based on existing information and rapid assessments carried– out for various researches indicated that the sectors most vulnerable to climate variability and change are agriculture, water and human health. In terms of the livelihoods approach, smallholder rain-fed farmers and pastoralists are found to be the most vulnerable. The arid, semi-arid and the dry sub-humid parts of the country are affected by severe drought and flood.

Vulnerability assessment based on existing information and rapid assessments carried out under NAPA has indicated that the most vulnerable sectors to climate variability and change are agriculture, water and human health. In terms of livelihood approach, smallholder rain-fed farmers and pastoralists are found to be the most vulnerable. The arid, semiarid and the dry sub-humid parts of the country are affected most by drought.

Ethiopia's geographical location and topography, plus a low adaptive capacity, make the country highly vulnerable to the adverse impacts of climate change (World Bank, 2008).

2.3. Climate Variability, Change and Observed Trends of Ethiopia

2.3.1. Rainfall Variability

Ethiopia has diverse climates, ranging from semi-arid desert in the lowlands to humid and warm (temperate) in the southwest. Mean annual rainfall distribution ranges from a maximum of more than 2,000 mm over the Southwestern highlands to a minimum of less than 300 mm over the Southeastern and Northwestern lowlands. The mean annual temperature also varies widely, from lower than 15°C over the highlands to above 25°C in the lowlands.

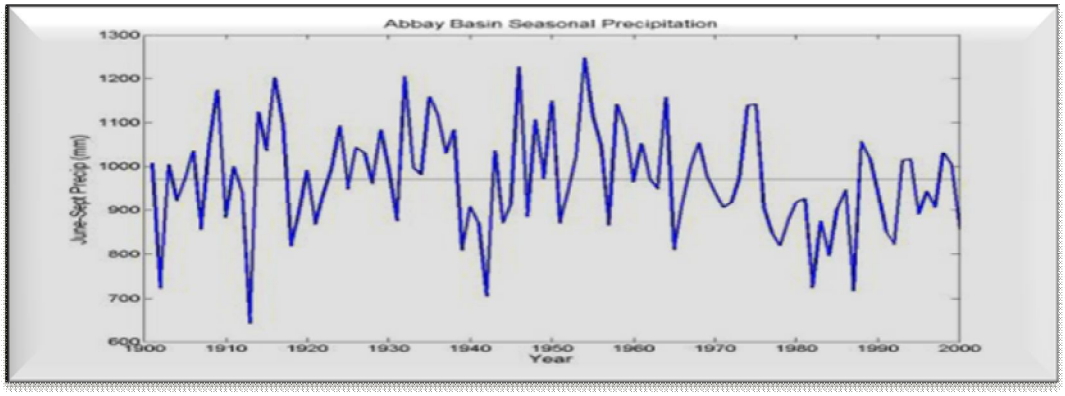
Several studies conducted by both development organizations and research institutions support the development of rainfall variability. Farmers and pastoralists are experiencing that the rain is becoming more unpredictable– or is failing to appear at all. In some places the rain falls more heavily and the degraded soil is unable to absorb this rain which falls over a shorter period. According to Kassahun, the farmers in the central part of the country have lost up to 150 tons of soil per hectare. The rains wash away the topsoil, which helps to make the soil fertile. In total, Ethiopia loses three billion tons of humus soil annually due to erosion (Stern, 2006)

Rainfall variability is the major source of risk for farmers who depend on crop production. There are two important rains in Ethiopia- the 'Kiremt' and 'belge'. The belge rains usually begin in March and May in South West and advancing northwards affecting most of the country from July through September. The kiremt rain constitutes about 90% of the crop production harvested during October -December (CSA, 2011). Historically the country has been prone to extreme weather variability. Major droughts that led to dreadful famines and floods struck different parts of the country were results of the absence of rainfall in the March to May (World Bank 2006).

Baseline climate was developed using historical data of temperature and precipitation from 1971- 2000 for selected stations. Figure 2.1 shows the year-to-year variation of rainfall over the country expressed in terms of normalized rainfall anomaly averaged for 42, stations. As it can be seen from the figures, the country has experienced both dry and wet years over the last fifty five 55 years. Years like 1952, 1959, 1965, 1972, 1973, 1978, 1984, 1991, 1994, 1999

and 2002 were dry while 1958, 1961, 1964, 1967, 1968, 1977, 1993, 1996, 1998 and 2006 were wet years

Fig.2.1 Abay basin seasonal rainfall



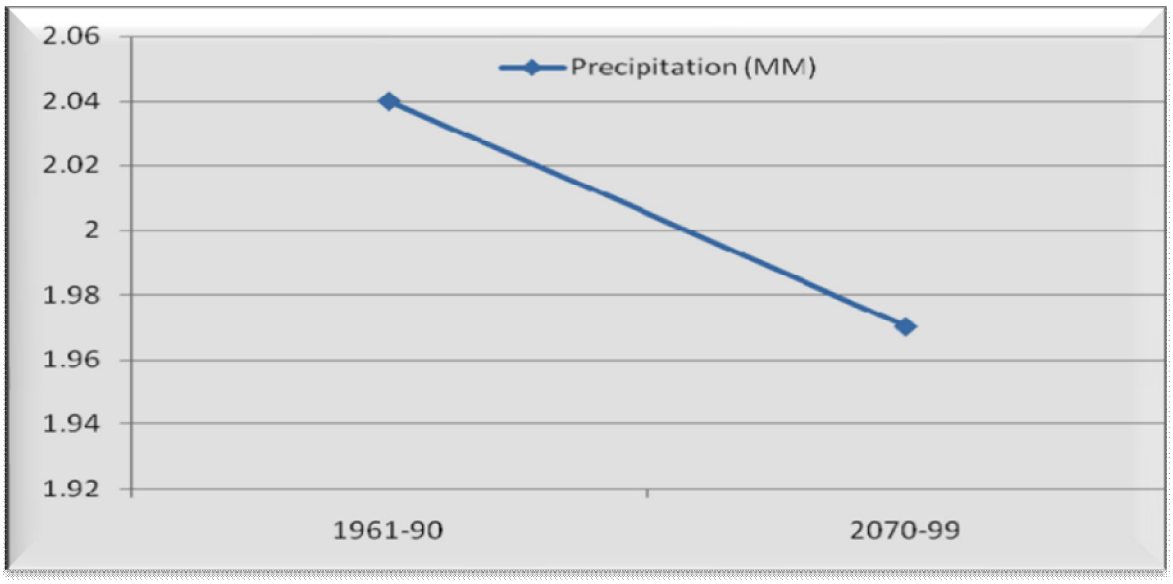
Source: **Source .** *NMSA, 2007*

Projections from different models indicate that there will be an increasing of annual rainfall in the short rainfall season in southern Ethiopia. However, the larger proportion of the country will see mixed result showing slight increase in south east and decrease in the northern and central Ethiopia.

Looking at the precipitation; there is inter-annual and inter-decadal rainfall variability in Ethiopia Geographical location topography leads the country to be vulnerable to rainfall variability. The strong inter-annual and inter-decadal variability in rainfall makers difficult to detect long term trends in the country. There is not statistically significant trend in observed mean rainfall in any season between1960-2006.

At country level, the average precipitation rate has been 2.04 mm per day in 1961-1990. This precipitation is projected to decrease to 1.97 mm between 2070 -2099 (Cline, 2007). The problem is exacerbated by higher evaporation rates associated with increasing temperature. Precipitation rate like the temperature is expected to vary between different parts of the country. While it will be decreasing in the northern, the southern part of the country would see an increase of temperature as much as 20%.

Fig.2.2 Precipitation rate in mm



Source: Author's calculation from WB

Average countrywide annual rainfall trends remained more or less constant between 1951 and 2006 (NMSA, 2007). However, both seasonal and annual rainfall has exhibited high variability. But some studies indicate that certain rainfalls have been declining. Considerable declines in March-September rainfall were observed in northeast, southeast, and southwestern areas of Ethiopia after 1997. In particular, rains have decreased during the Belge (February-May) season.

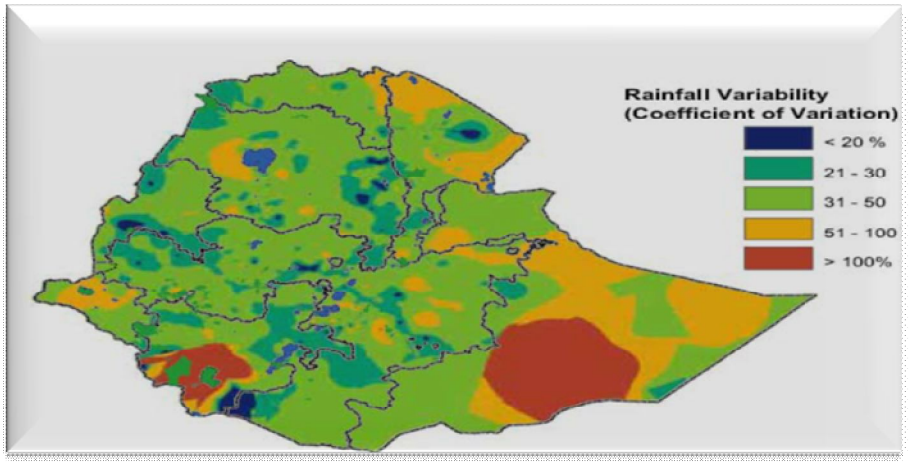
Belge rainfall in the east and southeast exhibit the largest percent reductions. Declines in Belge rains may impact long cycle crop production with crippling consequences for agricultural production. One study characterizes the magnitude of these recent changes, especially in the Belge as "dramatic"

Ethiopian mountain ecosystems are also affected by climate change. Plants and animals that can only live in these areas may vanish if temperatures continue to rise. Up to seventy-five per cent of Ethiopian species are in danger of migrating because of climate change, Kassahun writes. However, a warmer climate will also make it possible to grow crops in the highlands, crops previously unable to survive in the frost and cold.

According to agricultural economists, rainfall variability greater than 30 is risky for farmers who depend on crop production which is prevalent in most parts of Ethiopia. Annual rainfall considerably decreases towards the eastern low lands which is source of low crop production. Rainfall is distributed differently in Ethiopia. It has both spatial and seasonal nature as the following figures shows. Few highlands in the West get rainfall for most of the months of the year (May-October). However most of the country got the main rain during July-September and the 'Belge 'rain during February –May of each year. Rainfall variability measured by coefficient of variation shows most part of the country has rainfall variability with about 31-50 .The rainfall variability measured by the coefficient of variation is common in Ethiopia as figure 2.3 shows.

Climate change reduced yield of wheat staple by 33% in Ethiopia (World Bank, 2006). It also exacerbated the transient poverty. According to UNDP, Poverty rates would have been decreased by 14%if the recurrent drought did not happen (UNDP, 2007/08). Further, CCV is also projected to reduce up to one third of water resources flow to Nile Tributaries (Abay and Awash). Climate change also cause encroachment of malaria from lower altitude to higher altitude. An epidemic of cholera following the extreme floods led to widespread loss of life and illness (NAPA, 2007).

Fig.2.3 Rainfall variability measured by the coefficient of variation



Source . *NMSA, 2007*

Adequate studies of how climate change will affect Ethiopia's rich water resources have yet to be carried out. There are four major rivers in Ethiopia: the Blue Nile, the Omo, the Awash, the Wabe Shebelle,Ganale and Takeze. There are twelve reservoirs. Most rivers flowing from these reservoirs cross borders. According to(Daniel Kassahun,2008), climate change will lead to water shortages which, in the case of the river Awash, mean that it will lose between ten and thirty-three per cent of its volume. Several lakes in the main Rift Valley have also shrunk, in part due to climate change.

2.4.2. Temperature Variability

The year to year variation of annual minimum temperatures expressed in terms of temperature differences from the mean and averaged very high .It is not only the rainfall distribution that has changed in Ethiopia. According to the national program for how Ethiopia can adapt to climate change, it has also become warmer in the last fifty-five years. The minimum temperature has increased by 0.37 degrees Celsius per decade between 1951 and 2006 (NMSA, 2007).

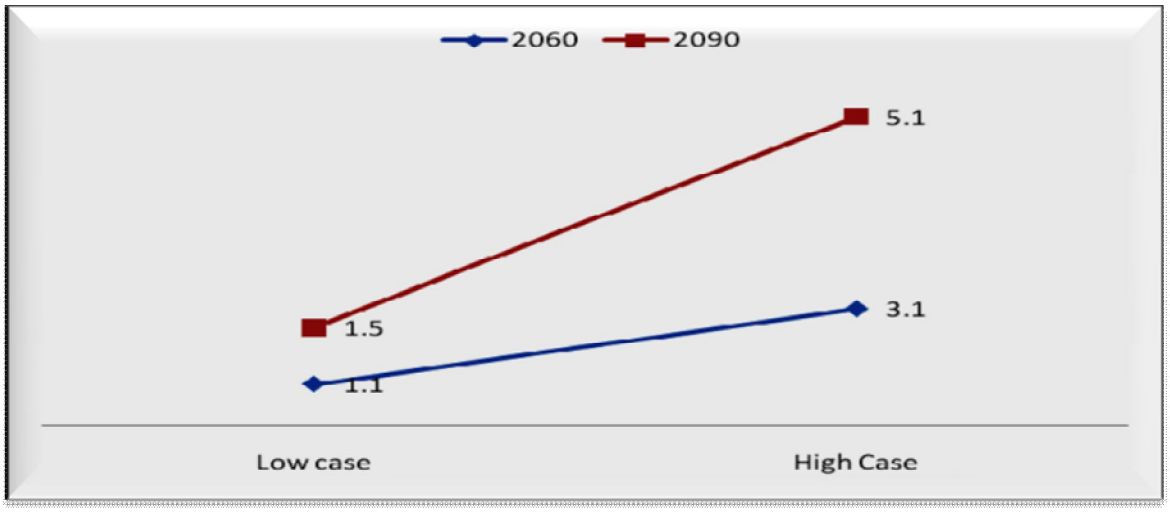
In case of Ethiopia, annual temperature has rapidly increased in the last five decades. The mean annual temperature rose by 1.3^0C or by 0.28^0C per decade during 1960-2006. The frequencies of hot days and nights have also showed an increasing trend during these years. While the average number of 'cold days' has decreased by 5.8 % between1960-2003, the average number of 'cold' nights per years has decreased by 11.2% (UNDP, 2008). In the coming 100 years, the average temperature in Ethiopia

has projected to increase from 23.08 ^{0}C during 1961-1990 to 26.92^{0}C in 2070-2099 (WB, 2008). However, there is also significant temperature difference temporally and spatially.

- Between 1951 and 2006, the annual minimum temperature in Ethiopia increased by about 0.37°C every decade.
- Between 1960 and 2006, the mean annual temperature increased by 1.3°C, at an average rate of 0.28°C per decade. Some sources assert that "the past 10 years have been substantially warmer than the 1986– 1999 average (about one standard deviation warmer)

On the IPCC's moderate scenario A1B, the annual mean temperature in Ethiopia will increase by 0.9–1.1 degrees Celsius by 2030 and by 2.7–3.4 degrees Celsius by 2080, relative to the 1961–1990 mean. The amount of rain will increase by 0.1–6.1% by 2030 and by 0.3–18.9% by 2080, relative to the 1961–1990 mean (IPCC, 2007b).

Fig.2.4**Trends of temperature in Ethiopia**



Source: WB report, 2010

The mean annual temperature is projected to increase by 1.1 - 3.1^{0}C in the 2060s and by 1.5-5.10 ^{0}C in the 2090s.All projections indicate substantial increase in the frequency of days and nights that are considered' hot' in current climate. All projections indicate decreases the frequency of days and nights that are considered 'cold' in the current climate.

2.4. Causes of Climate Variability and Change in Ethiopia

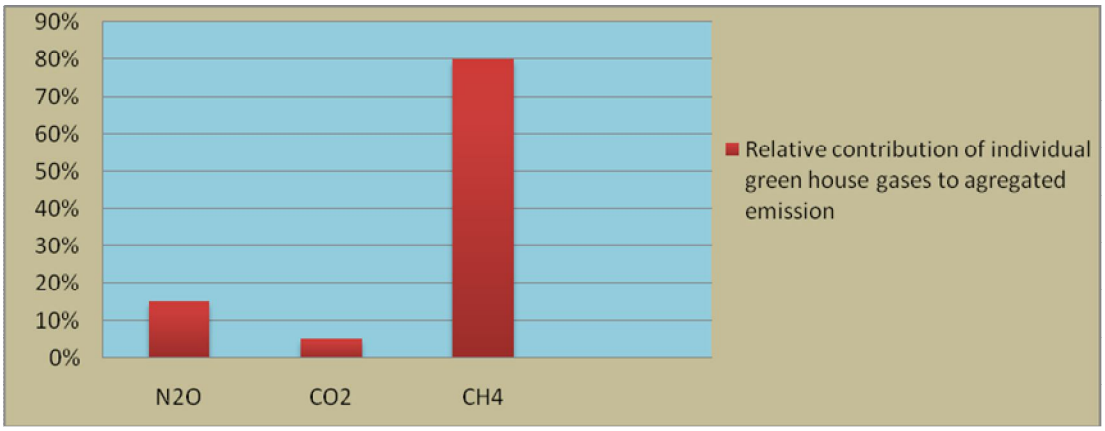
Earth's climate changes naturally. Change in the intensity of sunlight reaching the earth cause cycles of warming and cooling that have been a regular feature of the Earth's climatic history. Some of these solar cycles - like the four glacial-interglacial swings during the past 400,000 years - extend over very long time scales and can have large amplitudes of 5 to 6°C. For the past 10,000 years, the earth has been in the warm interglacial phase of such a cycle. Other solar cycles are much shorter, with the shortest being the 11 year sunspot cycle (Malen Haakansson, 2009).

At global scale, the main and direct cause of greenhouse gas (GHG) emissions is from carbon dioxide (70%), primarily from burning of fossil fuel (petroleum) imported other countries, while the other sources of GHG are methane and nitrous oxide caused by deforestation and agricultural activities, particularly the use of pesticides.

Sector wise, Ethiopia's GHG emissions are dominated by agriculture, which contributes 85 % of the total GHG emissions. Ethiopia's share to global GHG emission is very minimal. However, emissions from agriculture and energy sectors doubled since 1994. These two sectors are the major emitters in Ethiopia accounting for 85% and 15% of the total gas emission respectively (MoFED, 2010). This reflects the fact that livestock farming goes together with high methane emissions. The dominant position of livestock farming in Ethiopia's economy also influences the relative contribution of GHG to the total emissions (***see Figure 2.5***). These are dominated by methane emissions, which account for 80% of the warming potential.

Generally, leading climate scientists now agree the human pollution mainly from fossil fuels, has added substantially to global warming in the past 50 years (**Stern,** 2006).

Fig.2.5. Relative contribution of individual GHG to aggregated emission in 1994 (FIST, 2001)



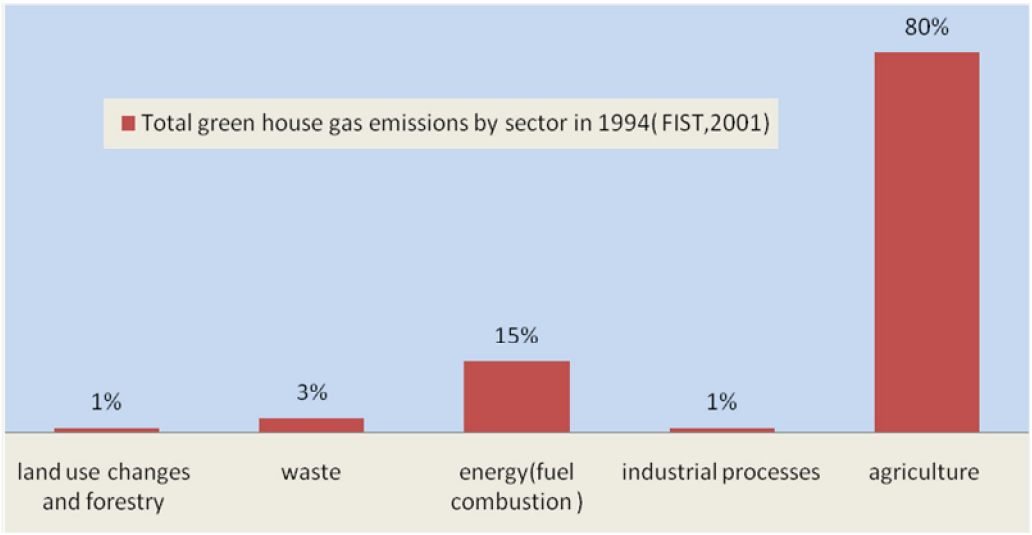
Source: Ministry of Mining and Energy, 2007

Ethiopia's emission profile is dominated by agriculture in sector wise, contributing about 80% of the total gas; it is dominated by methane which contributed 80% of the total CO_2-equivalent emission. Generally, there were increasing trends of greenhouse gas emissions in Ethiopia in a period of 1990-1995. The relative comparisons of increase indicated that, CO2 have increased by 24%while emission of CH4 and N2O increased by 1% and 19% respectively. Aggregate greenhouse gases emissions in terms of CO_2- equivalents have increased by 12 % (NMSA, 2001).

The GHG emissions per capita in 1994 totaled to 900 kg CO2 equivalent per capita and year. Compared to other countries, Ethiopia's emissions rate was very low (e.g. the U.S. emissions amount to 23.7 tones CO2 equivalent per capita and year in 1994).

In addition to agriculture, the energy sector (heating, cooking, and transport) contributes to the total GHG emissions with 15%. 95% of the energy consumption is satisfied by biomass sources (mainly wood); petroleum and electricity are of minor importance.

Fig.2.6** Total GHG emission by sector in 1994 (**FIST, 2001)



***Sources:** Ministry of Mining and Energy, 2007*

Ethiopia's GHG emissions are closely linked to basic needs of the population: Food production (through livestock farming) and heating. Therefore, the future GHG emissions will likely in-crease with the projected increase in population.

The contribution of Ethiopia to the global GHGs emission is negligible. Using the 1995 Global Warming Potential (GWP) values of the Intergovernmental Panel on Climate Change (IPCC) over 100 years time horizons it is reported to be about 48,003 e.g. CO_2-equivalent in1994. The per capita emission would be about 0.8976 tones of CO_2 equivalent (*MME 1994, NMSA* 2001).

The greenhouse gas emission from energy sector is also important contributor to the total national emission. According to the 2004 inventory, it was accounted for more than 50% of the total GHGs emission and was twice of the 1994 values. Among these sub sectors, the transport and the domestic take the largest contribution which accounts about 68% and 16.1% respectively in 2004.The combustion of fossil fuels mainly in the transportation sector was responsible for 88 % of the total CO2 in 1994 (B & M Development Consultants 2006).

On the other hand, in the past centuries and at present, there is a widespread cultural belief among the rural community that drought and famine are acts of God against

human sin (McKee 2008, Mesfin 1991, Pankhurst 1985). In this regard, on famine and epidemics, Pankhurst underlined that “several subsequent epidemics and famines are mentioned in the literature of the thirteenth and fourteenth centuries which suggests that such outbreaks were regarded as punishments sent down by God” (Pankhurst 1985, p17).

This historic account also underlines that despite such cultural perceptions of the causes of climate change and variability, the community practiced different adaptation mechanisms, including crop diversification, shifting from rain dependency to small scale irrigation, mobility and migration (Yohannes GebreMichael and Mebratu Kifle, 2009).

Many factors in Ethiopia are contributing to the deterioration of the local climate and making population ever more vulnerable to global and regional climate change. Widespread poverty is undoubtedly one of the principal causes."While the cause of most disasters is related to climate change, unrestricted human activity and poverty have contributed to destroying the environment and aggravating the situation," (NAPA, 2007).

2.5. Impacts of Climate Variability and Change in Ethiopia

Observed changes and their effects on the dry lands of Ethiopia and other parts of Africa: It is now profoundly clear that climate change is a global problem which is having profound impacts on poor countries of eastern Africa including Ethiopia, whose contribution to greenhouse gas (GHG) emission is insignificant. The IPPC (2007b) report highlighted that Africa will be one of the regions hardest hit by the impacts of climate change although it contributes the smallest amount of the total carbon dioxide (CO2) emissions (3.6 percent). The same report also predicted a significant decrease in crop yields, with smallholders most vulnerable.

In Ethiopia, climate variability and the frequencies of extreme events have increased over recent times. This is greatly menacing the various agricultural sectors and natural resource base upon which the poorest Ethiopian citizens depend for their livelihoods. Improvements in crop production are dwindling, lagging very much behind the rapid rate of population growth, thus there is increasing food insecurity at both household and national level and endemic grinding poverty.

The rise in temperature and fluctuations in rainfall create many problems in Ethiopia. It is hardest for the smallholder farmers, who are totally dependent on the rain falling at the right time and in the right quantities, and for the pastoralists who live in the already drought-stricken areas which are receiving less and less rain. In several places the pastoralists have already switched from cattle to goats and camels, as they are more able to endure the long periods of drought.

Climate-related hazards in Ethiopia include drought, floods, heavy rains, strong winds, frost, heat waves (high temperatures) and lightning. Although the historical social and economic impacts of all these hazards are not systematically well documented, the impacts of the most important ones, namely droughts and floods, are widely discussed.

Water availability has dramatically declined in Ethiopia's rivers, streams, lakes and reservoirs. Climate change, in conjunction with human activities and triggered by climate related disasters have already killed Lake Haromaya largely by water withdrawal for human consumption for the town of Harar and Adele. The predicted likely death of Lake Tana, Lake Ziway and River Awash, with the resultant loss of water resources and valuable biodiversity are too costly and painful to tolerate. There is great fear over the challenge of meeting the demands of escalating population water needs for food production including for irrigation, also domestic, municipal, and industrial and energy uses. Feed and water availability for livestock has greatly reduced and consequently livestock numbers have declined. This has already claimed lives and lost millions in financial and capital assets (Daniel Kassahun, 2008).

Ethiopia is highly vulnerable to drought and this is the single most important climate related natural hazard which periodically affects the country. Drought can occur anywhere in the world, but its damage elsewhere tends to be less severe than in Africa in general and Ethiopia in particular. Recurrent drought events in the past in Africa have resulted in huge loss of life and property, as well as migration of people (Pankhurst, 1985).

Rainfall variability and climate-related risks have been major causes of the country's food shortages and famines in the past and they continue to pose serious threat to Ethiopia's development.

It should also be noted that climate variability has also a direct bearing on the country's economy. According to (Temesgen, 2006) the contribution of agriculture to total GDP of the country is directly related to climatic variability, verifying its direct impact on the country's economic performance. The authors show that the percentage contribution of agriculture to the GDP is very low in years of severe drought, crop failure and famine (1984/1985, 1994/1995, 2000/2001), as compared to better seasons (1982/83, 1990/91).

The other climate-related hazard which periodically affects Ethiopia is flooding. Major floods occurred in different parts of the country in 1988, 1993, 1994, 1995, 1996 and 2006 which caused loss of life and property.

The trends observed in dry lands of Ethiopia are more or less similar to those in East Africa, notably Kenya. Fluctuations in African lakes and the retreat of glaciers on Mt. Kilimanjaro provide a guide to long term changes in dry lands. There has been increased risk of drought in dry lands areas of Africa coherent with observed climate change trends (IPCC WG I, 2001).

A recent study on local level assessments shows overall decline of rainfall in most major dry land areas such as Fogera catchments in northern Ethiopia, the Awash basin (Central), Omo-Gibe basin (South-West) upland catchments of Dire Dawa and Ogden in the East. Interviews with farmers across the nations also confirmed the same experience (Temesgen et al. 2009).

Available evidence suggests that Africa is warming faster than the global average and is likely to continue to do so, although with notably variations. Some African dry lands are seeing even greater warming than elsewhere, while in East Africa temperatures have fallen close to the coasts and major inland lakes (Wiggins, 2006).

Top 10 Disasters in Ethiopia, 1999-2009

Hazard	People affected	Date
Drought	12,600,000	2003
Drought	4,500,000	2008
Drought	2,600,000	2005
Flood	361,600	Oct 2006
Flood	239,586	July 2007
Flood	235,418	Apr 2005
Flood	110,000	Apr 2003
Flood	79,000	Oct 1999
Flood	45,000	Oct 1999
Flood	38,000	Aug 2006

Source: MoWR

In the arid and semi-arid areas of Ethiopia, climate variability and change particularity drought is part of a normal cycle (Devereux 2006) .Hence; the communities have developed some strategies to cope with it, such as mobility, cereal crop and livestock species diversity, reciprocity in use of resources, territorial fluidity and social safety nets.

However, according to many applied research findings, the vulnerability of pastoralists to drought is very complex and diverse. It is claimed that drought as such is not making pastoralists vulnerable but rather the increasing marginalization of their drought response mechanisms (Yohannes GebreMichael and Mebratu Kifle, 2009).

The famines were not only due to shortage of rain but also due to extended or excessive rain and unpredictable (unseasonal) rainfall (NMAS, 2009). This has many implications. Most important of all, however, is that because of the long history of climate variability and change the local people have developed some deep-rooted adaptation mechanisms and competencies (Malen Haakansson, 2009). In other words, adaptation to climatic variability is a way of life and nothing new to Ethiopians. (Yohannes GebreMichael and Mebratu Kifle, 2009).

The other climate related hazard that affects Ethiopia from time to time is flood. Major floods which caused loss of life and property occurred in different parts of the

country in 1988, 1993, 1994, 1995, 1996 and 2006(McKee 2008, Mesfin 1991, Pankhurst 1985).

A survey carried out by a leading national environmental organization, Forum for Environment, shows that the frequency and intensity of floods has increased in Ethiopia, particularly in the last thirty years. Daniel (2008) noted that climate change can affect how long the farmers have to grow their crops. There is already a great demand for improved seed which is more drought resistant, and for seeds which mature faster as the rains have become more unpredictable and shorter in some places. In addition, warmer weather provides better growing conditions for pests and other diseases that attack crops and destroy the farmers' harvests.

Flash floods and seasonal river floods are becoming increasingly common due to deforestation, land degradation, increasing climate variability and change, and settlement patterns. During the past two decades, major floods in 1988, 1993, 1994, 1995, 1996 and 2006 have caused significant loss of life and property. Large-scale flooding is limited to the lowland areas of the country; however, intense rainfall in the highlands caused flooding of settlements in a number of river basins, particularly the Awash River Basin in the Rift Valley. Annual flooding in urban areas, especially in Addis Ababa, causes property damage along streams descending from the nearby hills. Flash floods are common in most parts of the country, especially when rain occurs following prolonged dry spells.

Some authors underlined that the prolonged droughts due to climate change and variability, combined with environmental degradation and increasing sedentarisation, have led to deterioration of rural communities' livelihoods of Ethiopia (Yohannes GebreMichael and Mebratu Kifle, 2009).

The vulnerability to climate-related hazards and food insecurity is closely linked to land degradation. About 85% of the land surface in Ethiopia is considered susceptible to moderate or severe soil degradation and erosion. In the highlands ,shrinking farm sizes and soil degradation and erosion are reducing the sustainability of agricultural production and causing downstream pollution (including siltation of dams), thereby making it difficult for the rapidly growing rural populations to meet their basic needs. The annual costs of land degradation are estimated to be a loss of at least 2-3% of

agricultural GDP. To put this in perspective, this means land productivity would, need to increase by more than 20% immediately to reverse the damage of the past 10 years. In addition, land productivity is declining as average per household landholdings is declining due to population pressure, limited uncultivated land and climate variability and change (NPDPM, 2005).

Factors that currently compounding more the impact of climate change in Ethiopia are rapid population growth, land degradation, widespread poverty, dependency on rainfed agriculture, lack of awareness by policy and decision-makers about climate change and lack of appropriate policies and legislation (Malen Haakansson, 2009).

Detrimental and beneficial impacts of the ongoing and projected climate change and or climate variability are widespread in both socio economic and natural systems.

These impacts include:

- Agriculture, Food Security: The increasing year-to-year variability and in-creases in both droughts and heavy precipitation events lowers agricultural production with corresponding negative effects on food security.
- Water: The availability of clean drinking water is likely to decrease due to the increasing evaporation and the increasing variability of rainfall events.
- Health: Incidences of malaria in areas of the highlands where malaria was previously not endemic. The warming is further expected to cause an in-crease in cardio-respiratory and infectious diseases.
- Ecosystems, Biodiversity: Climate change but also human drivers such as forest fires threaten forest ecosystems. Furthermore, a large number of plant and animal species is threatened by extinction, as climate conditions are changing too quickly for them to adapt.
- Infrastructure: Heavy rainfall events and floods cause damages to roads and buildings.

2.6. Government Policy on Climate Change

Policy makers are playing an important role in the reduction of climate change and variability related impacts. Recently, many countries are mainstreaming climate change in to their development plans. The Ethiopian energy policy address issues pertaining to climate change. The policy has been approved in 1997 before climate

change has got high priority on the international agenda. It strongly emphasizes on the wise use of us resources for the survival of future generation.

This shows that there is high potential for mitigation through these sectors. Clean Development mechanisms (CDM) measures from agriculture and hydroelectric plants, geothermal and wind turbine, conservation of energy through efficient and switching energy sources, usage of compact and efficient vehicles, changing means of transport to fuel efficient modes of transport and usage of efficient stoves are some of the strategic directions that the government promoted in its policy documents. These directions are consistent with the United Nations Framework Convention on Climate Change (UNRCCC) recommendations.

In addition, the Ethiopian government gives emphasis to climate change adaptation and mitigation in the five years development plan (GTP). The Plan incorporated climate change issues to make national development paths more sustainable as compared to the previous plans. Although it's difficult to evaluate the effectiveness of the plan in terms of implementation at this stage, the plan gives due emphasis to the construction of hydroelectric dams and medium to large scale irrigation schemes, and the development of alternative and renewable energy sources like wind, solar and bio-fuel.

Although Ethiopia has ample amount of water resources and hydroelectric potential, capacity only less 5% of water has been developed for irrigation. In addition only less than 5% of the Nile basin was employed for irrigation development. That lead the per capita electricity to be the least in the world with more than 80% of the population living without access to electricity and relying on firewood, charcoal dung, kerosene, gas and bio-gas which are major sources of high CO2 emission (MoWE,20011).

The construction of large scale dams with about an installed capacity of 6000 MW has been introduced in the Blue Nile River. This project has also a potential to develop more than 35% or 250,000 hectare land around Nile River. Despite the fact that the irrigation part seems overlooked by the government to focus on the electricity generation, the implementation of this project will have economic, political, social, environmental and institutional benefits. Moreover, the project is creating great motivation among the citizens' current activities especially in the rural areas that will

create long term effects on scaling up the country's adaptation capacity to climate change and variability.

In return, the supply of energy in Ethiopia from renewable sources will reach 10,000MW at the end of 2014/15.The construction of such a huge dams increase the electric power supply coverage at country level from existing 41% to 75% coverage at the end of the plan period. This will make the country's green development strategy consistent with the global green development strategy (MoFED, 2010.

Furthermore, Ethiopia has suitable land for bio-fuel development. The major targets of the government regarding bio-fuel are increasing bio-ethanol from almost nonexistent to 194.9 million litters at the end of 2010/11, increasing bio-diesel up to 1.6 million litters and increasing the number of blending facility of benzene –ethanol to 8 and that of bio-diesel to 72 by the end of the plan period are the targets of the governments (MME, 2007).

To deceases the impact of the short term weather variation, the GTP promises to use the water resources properly through expansion of small scale irrigation. Thus if the plan is rightly implemented it would reduce the negative impact of climate variability as the alternative means of adaptation to climate variability and change.

In fact, the government promises to achieve the 7th goal of the MDG the latest by 2015. The main target of the goal is to ensuring environmental sustainability through different indicators including integrating the principles of sustainable development into the country's policies and programs; reverse loss of environmental resources; reducing biodiversity loss; reducing people without sustainable access to safe drinking water and basic sanitation, and improving the lives of slum dwellers (ibid)streams.

CHAPTER THREE

Research Methodology

3.1. Type and Source of Data

Mainly the data for this study come from both the primary and secondary sources. The researcher conducts the primary data collection. In this research, rural communities are the major sources of primary data. In order to ensure the reliability and validity of the data collected, triangulation of different methods will be employed during collection of primary data. These methods include observation, focus group discussion and interview with randomly selected farmers and other key informants. As part of the primary data, information will also be collected from zonal and woreda agricultural experts, Kebele leaders, soil and water conservation supervisors and DAs.

The primary data obtained from the fieldwork will also be supplemented with data obtained from secondary sources in order to fill information gap from primary sources. The secondary sources of information, both published and unpublished materials such as reports, plans, official records, journals, articles ,census records, project reports, and data files from internet/ web pages records, were obtained from Ware Jarso woreda agricultural and rural development office, Oromia region disaster prevention and preparedness commission /Desk (DPPC), north Showa zone and Ware Jarso woreda DPPD, National Meteorological Service Agency monthly average maximum and minimum temperature and monthly rain fall (1979-2009), federal DPPC and, Ministry of Agriculture .

3.2. Determination of Sample Size

Prior to determining sample size of the study, all Kebeles will be stratified in to villages based on their local agro-climate zone; dega, woina dega and kola agro-climatic zone.

The local agro-climate zone categories were divided based on the local peoples' and DAs categorization criteria. For the study, from each Kebele one village/got/ was selected from each agro-climate zone category. Eventually, the total sample size will be determined using the following formula (Cochran, in Belayneh, 2005).

$$n_o = \frac{z^2 pq}{d^2} \longrightarrow \qquad n = \frac{n_o}{1 + \frac{n_o - 1}{N}}$$

Where;

- n_0 is the desired sample size when the population is greater than 10000
- n is number of sample size when population is less than 10000
- Z is 95% confidence limit i.e. 1.96
- p is 0.1 (proportion of the population to be included in the sample i.e.10%)
- q is 1-0.1 i.e. (0.9)
- N is total number of population
- d is margin of error or degree of accuracy desired (0.05)

Using simple random sampling technique, proportional to the population of villages identified, study sample were selected from the list of households. Respondents in the study are household heads and in cases where household heads missing, randomly selected household heads are substituted for the missing household heads.

3.3. Methods of Data Collection

A combination of methods will be to collect relevant data. These include field observation, informal interview, focus group discussion and structured interview. These methods generated relevant information for the study.

3.3.1. Field Observation and Informal Interview

Field observation will be conducted throughout the whole courses of the research in order to ensure the validity of information obtained. It was done with the purpose of getting guidance for development of the formal question and to be familiar with the values of local people especially the norms of the society. In this regard, about 44 % of respondents' fields will be observed in order to assess what they did on mechanism of adaptation towards climate change and variability on their fields.

On the other hand, informal interview will be conducted for the purpose of obtaining information for developing completely structured questionnaire which is the main tool of collection of information needed. It will be conducted in an informal manner and in a relaxed setting while attempting to center the issue the researcher attempts to attain.

3.3.2. Structured Interview

This will be the most widely used tool of data collection in this research. On the bases of information obtained from techniques discussed above and literatures, questionnaire will develop. The questionnaires will administered by high university graduate enumerators. Enumerators and those who have experience on data enumerating and know the area well will recruited for the enumeration.

Prior to implementing the survey, the questionnaire will be briefed enumerators and tested for their clarity. Questioners that will found not to be clear to the local people and enumerators during training and testing were modified. Amendments will be also incorporated into the questionnaire so as to make the idea easily comprehendible to the interviewees and enumerators. The survey questionnaire will cover a wide range of information which included household characteristics, farming system and asset endowment and policy issues and farm orientation from the selected six Kebeles.

During data collection using structured interviews, attempt will be made to make the informants feel free, confident to express their feeling and give genuine information. Furthermore it will allow them to ask questions. Finally, the responses of the interviews fitted to possible lists of alternative answers, which will be worked out carefully during the prior test of the questionnaire on the fieldwork.

3.3.3 Administration of the Questionnaire

The questionnaires will be administered by trained data collectors and supervisors. A brief orientation and training for two supervisors and six data collectors will be given. The data will collect in the first three weeks of February 2012.

3.4. Method of Data Analysis

The data will be summarized and analyzed employing different methods. For descriptive part of the research percentages and mean value will be used. Pearson correlation will be used to measure the strength of linear association between dependent (local perception and attitude about climate variability and change and the independent variables (different age groups, educational background). A significance tests will be also used to see whether there is a significant association between responses provided by informants of different age group and educational background

with their perception towards climate variability and livelihood adaptation strategies. The significance is determined at P-value less than 0.05 or 0.01.

3.5 Variables

3.5.1 Dependent Variables

Perception of rural communities about the causes and consequence of climate change and variability and adaptation mechanisms will be measured by summing up their reaction for free response question. The questions will be provided with possible response options. Perception of rural communities towards climate change adaptation mechanisms will be measured by summing up the reaction of positive, negative and neutral response to a list of questions that seek knowledge, experience, exposure and attitude of rural communities to climate change and variability .To achieve this, a five point Likert scale containing items with response categories ranging from strongly agree (SA) with a score of three points to strongly disagree (SD) with a score of one point for favorable statements questions will be developed, while the scoring will reversed for unfavorable statements. The respondents will be asked to indicate which option best describe their opinion with respect to the questions asked. A total of 20 questions will be asked for the perception analysis, respectively.

3.5.2. Independent Variables

Other variables operated in this study include the socio-economic and demographic characteristics of the rural communities such as age, sex, educational status and access to information.

1. Age will measure as actual years of the household head experienced the study area.
2. Educational level will order hierarchically for the respondents to indicate their highest level attained.
3. Access to source of information includes contact with development agents, health extension officers; electronic media (radio, television, movies) schools, special trainings in soil and water conservation, peer groups, relatives and friends, access to road, town/market and household income.

CHAPTER FOUR

PROFILE OF THE STUDY AREA

Many, if not all, communities in the world align their behavior in concert with their natural and socio-economic baseline conditions (WCED 1987; World Bank 2008).Nowhere is this more visible than among the rural farming communities in the study area. Thus, to have better understanding as to the determinants of farmers knowledge and response toward climate variability and adaptation strategies in the context of the case study area, it was found much more imperative to look into the area's overall socio-economic and natural baseline conditions (such as the natural resource base, human resources, existing institution, and infrastructural base)and how these baseline conditions interact with one another to influence farmers knowledge and responses toward climate variability and, in so doing, affect mitigation strategies, livelihood and the sustainability of adaptation strategies.

With this in mind, therefore, this chapter considers the natural and socioeconomic situation of the area. To this effect, the chapter is divided into two broad sections, wherein the first section (section 4.1 and its subsections) analyze and present information on the overall natural or physical setting of the study area whereas the second section (section 4.2 and its sub-sections) treat the area's demographic and socio-economic characteristics' along with some institutional and policy related issues.

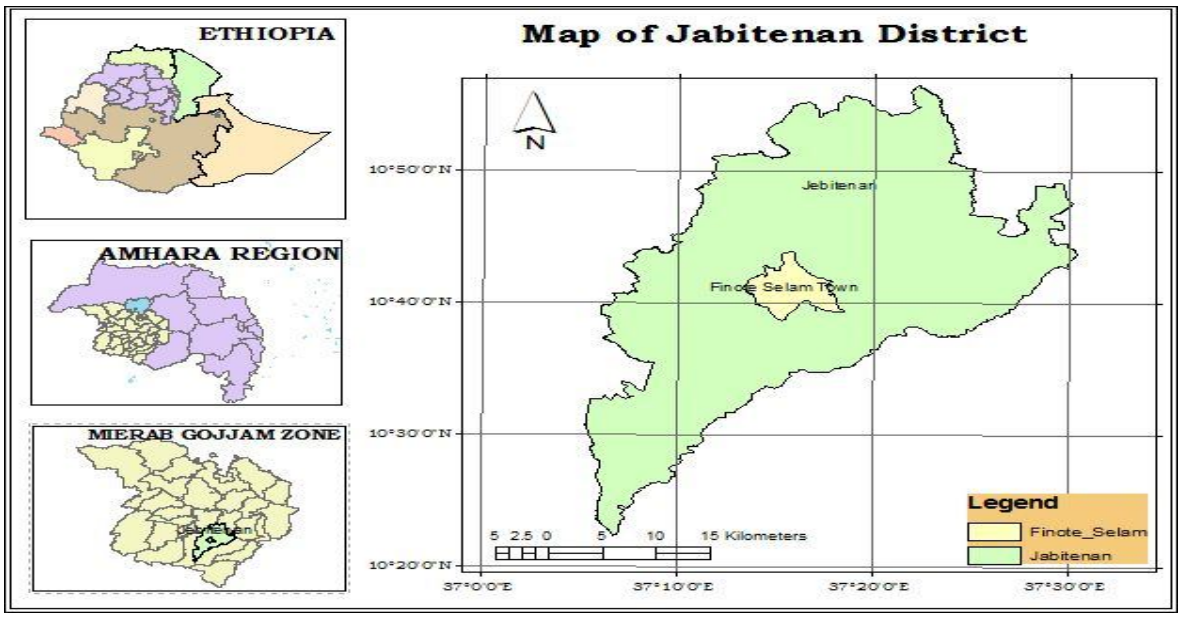
4.1. Physical Setting of the area

4.1.1. Location

The study woreda, namely Javie Tenan, is one of the 13 woredas of western Gojjam Zone, with a total land area of 1200.50 km2 and lies between $10^0$20'00'' -$10^0$50'00'' North latitude and 37^0 00''-37^0 30'' East longitudes. It is located at a distance of about 385 kilometers north of the country's capital city, Addis Ababa. A large part of the area is contained within the Gojjam Highland plateau at an elevation of generally above 2000masl.

Presently, the Woreda has comprised of 13 rural and 5 urban *Kebeles*. It shares boundary with other neighboring woredas such as Quarit in the Northern, Awi special zone in the South West, See the following figure :-

Figure 4.1: Map of the Study Area



4.1.2. Topography

The topography of the area falls within the South Western highlands of Ethiopia, specifically *Gojjam* highlands and the elevation of the area ranges from 1500 meters above sea level to about 2300 meters above sea level. For the purpose of analysis and simplicity, however, the land units of the study area have been classified into three major parts on the basis of their elevation and dominant physiographic features: upper, middle, and lower plateaus.

The area delineated as *upper* landscape in this study has entirely comprised of all the areas. This area virtually comprised 15% of the *woreda's* total area and elevation in this part ranges from 1800 to 2100 meters above sea level. Here, the gradient normally exceeds 45% and even rises over 60%. The area is predominantly characterized by undulating landscapes and receives intensive rainfall. Consequently, land degradation, mainly soil erosion by rain water, is dominant in this particular area.

The area designated as transitional zone between upper and lower landscape in this study has covered over 62% of the total area in the *woreda*. The dominant topographic features in this area are steep to gentle sloping pediments with wide and partly eroded valley bottoms. The elevation of the area ranges from 1500 to 2300 meters above sea level. The gradient in this particular area range from 15 % to 30 % and the gradient show a significant decline until it merges into flat plain with slope less than 15%. The lower landscape in the aforementioned

classification covers about12 % of the total area in the study area and the landscape exhibits a typical arid and semi-arid topography represented by predominantly flat plain extending over wide area.

4.1.3. Climate

As it can be observed from its geographical location, the study *woreda* lies in the inter-tropical zone. Consequently, the normal rainfall pattern in the area is bimodal in nature, which is largely determined by the movement of the Inter Tropical Convergence Zone (ITCZ) between the northern and southern hemispheres (JTWRDB, 2010).According to this source, the year may be divided into three broader seasons, one dry season (*Bega*) lasting from October to February and two rainy seasons, the main rainy season (*Kiremt*) from June to mid-September and a small rainy season (*Belg*) in March and April.

On the basis of its rainfall and temperature distribution, the area's agro-ecological zone can be described as *semi-humid and semi-arid* region, which agree well with the traditional classification of *Woinadega*[1] and/or dry *Woinadega* agro-climatic zone, with a mean annual rainfall ranging from 750mm to 1055.3 mm and average annual temperature of 23°C (JTWRDB, 2010). Because of its crucial nature to the life of the rural farming communities, however, rainfall is unequivocally the most important climatic element in determining the land use and land management behavior of farmers in the area. Among other things, as we shall see in our subsequent discussion, the livelihood of the rural farming communities in the study area mainly depends on rain fed crop-livestock production.

Thus, rainfall variability in precipitation in this area can have significant impacts on forage availability, crop production, access to water resources and ultimately the well-being of the human communities. Furthermore, the high intensity of the rainfall that characterize the area is also regarded as important factor for most observed soil erosion and sedimentation complexity in the area. In light of this information, thus, one can possibly conjecture how the variability and intensity of rainfall distribution directly or indirectly influence the livelihood adaptation behavior of farmers in the study area.

[1] A traditional agro-climatic classification

4.1.4. Soils

The types of soils are closely related to soil parent materials. The soils are characterized with diversified geomorphology and soil patterns. However, the identification of representative soil textures and their physical, as well as, chemical properties is based on the FAO/ UNDP 35 Classification. According to FAO/ UNDP soil classification, the most commonly found soil types of the study area are vertisols, Nitosols (Alfisols), Lithsols and Combisols. Because of good chemical and physical properties, Nitosols are very good for cultivation purpose.

4.1.5. Vegetation

Currently, there are widely open trees and shrubs dominated by poorly scattered ruminants of indigenous species in both study areas. Rural families in the study areas cut trees, reducing forest cover, and sell fuel wood and charcoal to generate income. In addition, lack of or insufficient environmental awareness and motivation to plant trees among local people is other important factor that contributed to the degradation of the natural conditions (JTWRDB, 2002).Vegetation covers of the area includes shrubs and bush in the lowland and open wood land and scattered forest in the *Woinadega* and *kola agro-ecological* zones of the study area. In the area natural forest covers a total area of 65.03 km^2.

Wild animal's lives in the area are limited in number, due to lack of shelter. The commonly observed willed lives are hyena, monkey, and willed fox are the majors.

4.2. Socio-economic features

The total population of *Javie Tenana woreda* in1999 was 193,699, with 90% of which were employed in agriculture and living in rural areas. About 51.46% of the population is male and the economically active population (people 15-64 years old) is 38%. The population growth rate is estimated at 2.9% per annum. The average farmland holding is 0.9 ha. The number of household organized in development task groups are 29,801 (JTWRDB, 2003E.C).

The type of crops grown in the area can be divided in into two major groups, namely annual and perennial crops. Annual crops are also divided into Cereals, pulses, oil crops and other perennial crops are cultivated annually in resending order of area coverage. Among cereals Maize is the leading crop by having percentage share of 46.83% followed by sorghum (29.31 %.) and teff (15.51%). The two most dominant types of perennial crops grown in the area are chat, which are harvested three times a year have the largest percentage share of

(70%) annual perennial production and coffee, which may be harvested one times a year have percentage share of 30% (JTWRDB, 2003E.C).

From the total area, 43.8% is cultivated, about 6.4% is used for forest, 35.5% is classified as bush and shrubs, grazing land accounts for 1%, and 6% of the land is used for social services. Unproductive land and other land uses account for about 8%. According to the estimation made from the 2007 population and housing census the total population of the woreda in 2011 was estimated to be 205, 096 of which more than 93 % lives in rural areas. The livelihoods of local farmers mainly depend on mixed farming of crops and livestock.

In 1999, the total population of *Javi Tenan Woreda* was 193,699, of which rural people were accounting for 90% percent of the total population (JTWRDB, 2012). Between 1999 and 2011, the population of the area grew from 193,699 to 205,096, and rural people were representing 86 percent of the total population in 2011 (JTWRDB, 2012).

This means that by 2011, the urban population of the area had showed a four percent increment from its position in 1999 (JTWRDB, 2012). While insufficient data exists to accurately ascertain the magnitude of urbanization, available statistics indicate significant level of urbanization in the area (JTWRDB, 2012). By 2020, the proportion of the area's urbanized population is expected to reach 53.5 percent, compared to 39 percent in 2005. This fast rate of urbanization places strain on infrastructure and other services. There is a growing and urgent need for integrated approaches to environmental planning and management. However, migration to urban areas is not inevitably destructive, nor does it necessarily lead to the formation or growth of dangerous and unhealthy slum areas. It is important to recognize the valuable role urbanization can play in stimulating the economy. The challenge lies in reversing the current pattern, and enhancing the efficiency of and the value derived from natural resource use.

Over the last 20 years, the area's population has got younger. In 2003, more than 40 per cent of the area's population was below the age of 15 years (JTWRDB, 2012). Given this, the youth are becoming increasingly important in natural resource management. The lack of employment and other livelihood opportunities, as well as setbacks in education, health and other capabilities, may mean that this generation will have increased natural resource dependence and pose new threats to the sustainability of marine and terrestrial ecosystems. Degraded environments may spur further social and economic hardships

The areas livestock population size shows that 40875 cattle (37% of total livestock), sheep's and goats account for 23073(21% of total livestock), donkey accounts for 12655 (11.6%), Horse and mules together accounts for 114 (0.1%) and finally 32000 (29.3%) poultry are found in the areas (JTWRDB, 2003E.C). Livestock provides drafts power, food, cash income, manure used for fertilizer and fuel. Livestock are also an important marketable wealth, and provide economic security in times of crop failures.

Although still largely rural, the study area has been experiencing major transformation in terms of population composition and distribution, with positive and negative implications for the environment and development. Changing demography and particularly the changing age structure of the population, a high rate of urbanization, and a faster rate of population growth in relation to economic growth are major drivers of environmental change in the area, with significant impacts on the natural resource base. Due to this, it is imperative that population growth and its structural changes are to be addressed to reduce environmental degradation.

Each year, the number of people increases, but the amount of natural resources with which to sustain this population, to improve the quality of lives and to eliminate poverty remain finite (WCED 1987), and accentuates the challenge of sustainable development. Demographic change is the major driver of land cover change: its primary and most direct impact is through opening new land for agricultural, settlement and infrastructural development (UN Millennium Project 2005).

In 1999, the total population of Javi *Tenan Woreda* was 193,699, of which rural people were accounting for 90% percent of the total population (JTWRDB, 2012). Between 1999 and 2011, the population of the area grew from 193,699 to 205,096, and rural people were representing 86 percent of the total population in 2011 (JTWRDB, 2012). This means that by 2011, the urban population of the area had showed a four percent increment from its position in 1999 (JTWRDB, 2012). While insufficient data exists to accurately ascertain the magnitude of urbanization, available statistics indicate significant level of urbanization in the area (JTWRDB, 2012). By 2020, the proportion of the area's urbanized population is expected to reach 53.5 percent, compared to 39 percent in 2005.

This fast rate of urbanization places strain on infrastructure and other services. There is a growing and urgent need for integrated approaches to environmental planning and

management. However, migration to urban areas is not inevitably destructive, nor does it necessarily lead to the formation or growth of dangerous and unhealthy slum areas.

It is important to recognize the valuable role urbanization can play in stimulating the economy. The challenge lies in reversing the current pattern, and enhancing the efficiency of and the value derived from natural resource use.

Over the last 20 years, the area's population has got younger. In 2003, more than 40 per cent of the area's population was below the age of 15 years (JTWRDO, 2012). Given this, the youth are becoming increasingly important in natural resource management. The lack of employment and other livelihood opportunities, as well as setbacks in education, health and other capabilities, may mean that this generation will have increased natural resource dependence and pose new threats to the sustainability of marine and terrestrial ecosystems. Degraded environments may spur further social and economic hardships.

CHAPTER FIVE

RESULT AND DISCUSSION

In this chapter a central analysis, presentation and discussion of data would be made based on the quantitative and qualitative data obtained from questionnaires, interview, discussions, observation as well as available secondary sources while, for the most part, giving due attention to sample households' engaged in this study.

The chapter has been organized into three broad sections and each section has been further classified into different sub-sections. The first section (section 5.1 along with its sub-sections and divisions) has dealt with the analysis, presentation and/or discussion of sample households' demographic and socio-economic characteristics. The second section (section 5.2) has been devoted to the treatment of institutional and policy related and the section that follow (section5.3) has given due attention to the central theme of this study and dealt with farmers knowledge, perceptions and practices of climate variability. In doing so, therefore, this chapter provides important information on sample households' demographic, socio-economic and farm land characteristics while explaining farmers knowledge and their response climate variability in terms of factors that are believed to have affecting the adaptation decision of farmers within Javie Tenan of the western Gojjam Zone.

5.1. Demographic, Socio-economic and institutional characteristics of Households

In fact, there are a number of demographic and socio-economic features that, in one way or another, are affecting the adaptation decisions of rural farming households in the study area. This section, however, has focused on the analysis, presentation and discussion of key demographic and socio-economic characteristics that are to do with the climate variability and adaptation decisions of sample rural farming households. More specifically, in the following sub-sections and divisions, the researcher give strong attention to the analysis and presentation of such socio-economic and demographic variables as gender, age, and educational levels of sample farmers along with their occupation and income level; marital relations, religion and ethnicity. And these will be followed by the analysis and presentation of farmers' family member in terms of age and sex composition.

5.1.1. Demographic Characteristics

5.1.1.1. Gender, Age and Education Status

Table 2 and Table 3 below present the distribution of sample farmers in terms of their gender, age and educational background. As shown in Table 3, about 86 percent of the households in this study were found to be male-headed; and female-headed households make up only the remaining 14 per cent of the sample household.

When we look into the age structure of sample household heads, the majority of them were belonging to the age category ranging from 19 to 50 years. This by itself comprised about 75% of the total sample population where 45 (41.7 %) of the household heads were within the age category ranging from 19 to 35 years and the other 21 (19.4 %) were found to be in the age group ranging from 36 to 50 years. The rest of the sample populations i.e. 30(27.8%) and 12(11.1%) were aged between 51 to 65 years and above, respectively. The median age of sample household head was 41.9, while their average age is about 49 years.

As expected, larger farm size was associated with older age. For example, the average age of household heads that have had 2 hectares or less were 40.6 years, compared to 50.7 and 55.5 years for household heads with medium and large-size of land holdings.

Table 1: Sample farmers' distribution in terms of their gender and age

		Number	*Percent*
Sex of farmers	Male	*101*	*85.8%*
	Female	*19*	14.*2%*
	Total	*120*	*100.00%*
Age of household heads	19-35	*50*	*41.7%*
	36-50	*23*	*19.1%*
	51-65	*33*	*27.5%*
	66-80	*14*	*11.7%*
	Total	***120***	***100.00%***

Source Field Survey, 2013

While only 24.2% of sample farmers were found to be females, considerable number of female house hold members older than 7 years were observed while working in the field, most commonly contributing to harvest and post harvest activities. Moreover, female in

many parts of the study sites were observed while executing their responsibility for child rearing and nutritional needs of their family, food production and weeding of crops, fetching of water and fuel woods where as men usually dig up farm land and look after cattle. During one of one of the FGD sessions of the study, some informants were asked to give their perception of females' role including their access to and control of productive agricultural assets or land resources. Accordingly, one informant interviewed in the area recounted that:

> *Of course, females in our locality have limited access to productive asset or land resources as compared to male. But females play a leading role in the provision of water for animals, crop growing, and food processing. It is often females who decide where to collect fire wood and what sources (usually crop residuals, animal dugs, woods, etc) should be used for what purposes.*

Thus, in the study area, female are the main protector of environmental resources by virtue of their position in their households, giving them responsibility for managing energy, water and farm land residuals, among other things.

In spite of the numerous improvements that have been made in the educational sector of the country over the past two decades, adult literacy is still very low with female having a higher illiteracy rate compared to men in many parts of the country. According to the survey result, about (49.1%) of the sample household head were illiterate. Added to that, about 25% of the sample farmers reported that they could read and write. These are farmers who claimed to have acquired basic education through some informal and traditional religious education as well as basic literacy campaigns during the Derge regime.

About 14(11.7%) of the sample household heads attended primary education (1-8). Similarly, about 8(6.7%) of the sample population attended a high school education (from 9 to12 grades). Of the total sample size, only a very few percentage of the respondents had acquired college diploma and above (about 5%).

Table 2: Sample households' educational level

Educational background	*Number*	*Percent*
Illiterate	*63*	*52.5 %*
Reading and writing	*27*	*22.5 %*
Elementary and primary education(1-8)	*14*	*11.7%*
Secondary education(9-12)	*8*	*6.7 %*
College diploma and above	*5*	*4.2 %*
Total	***117***	***100.0%***

Source: Field Survey

5.1.1.2. Marital Status, Religion and Ethnic Composition

Table 4 below summarizes the marital status, religion, and ethnicity of sample household heads. As far as their marital status is concerned, a great majority, i.e., 95%, of the sample household heads of the study area were ever married. And the remaining small percentages 6(5%) of the sample farmers in this survey were people never married before.

Religion wise, the vast majority of the farmers (90%) were Christians and a considerable proportion of the sample household heads (7.5%) were found to be Muslims. The remaining 2.5% of the sample population reported that they belong to other religion. In terms of ethnicity, the Amhara constitute of majority (79.2%) followed by very distant proportions of Oromo and *others*, which respectively constituted 10.0 % and 2.5 % of the sample household heads.

Table 3: Distribution of Sample household heads in terms of their marital status, religion and ethnicity

Marital status, religion and ethnicity		*Number*	*Percent*
Marital Status	Widow/widower	*6*	*5.0%*
	Married*	*103*	*85.8%*
	Divorced	*11*	*9.2%*
	Total	***120***	***100.0%***
Religion	Orthodox Christian	*108*	*90.0%*
	Moslems	*9*	*7.5%*
	Others	*3*	*2.5%*
	Total	***120***	***100.0%***
Ethnicity	Amhara	*95*	*79.2%*
	Oromo	*12*	*10.0%*
	Others	*3*	*2.5%*
	Total	***120***	***100.0%***

Source: Household survey

5.1.1.3. Household members[2] by Sex and Age Composition

Among surveyed household head, the averaged number is 5.8 members, with a median of 5.3 family members. The whole data, however, revealed that 80.0% of the households in this study had four members or more and about 31% were found to have seven or more family members (Table 5).

In the study area, rural farming households with large family size are commonly thought to have sufficient labor to carry out time-demanding farming activities such as weeding and harvesting.

Table 4: **Sample Households' Family size**

Family size	***Frequency***	***Percent***	***GCP****
1-3	*24*	*20.0 %*	*20.0%*
4-6	*59*	*49.2%*	*69.2%*
≥7	*37*	*30.8%*	*100.0%*
Total	***120***	***100.0%***	*--*

Source: Field Survey

*****GCP is used here as a short hand expression for 'Greater than Cumulative Percentage'*

[2]household members in this study refers to the total number of persons who are living in the same household and include both nuclear and extended family members of sample households.

All the same, as it can be observed from table 6 next, a significant proportion of households' members were found to be economically inactive people of age less than 15 years (55.9%) or above 65 years (13.6%). This means that about 70 percent of the sample households family members are currently dependent upon the 30% percent economically active sample household members. It is a well established fact that as number of economically inactive family members (i.e., number of people below 15 years of age and those above 65 years) in a given household increases, the level of dependency in the household—that is the proportion of economically inactive persons to economically active people within the household—would undeniably increases. Given the lack of employment and alternative livelihood opportunities in the study area, this condition would pose significant pressure on households' land use and land management decisions to livelihood adaptation strategies.

Among other things, farming households with large dependent family members and limited livelihood opportunities would stick on securing their short-term consumption than to engage in long-term sustainable land resource management activities. This fact was stressed and frequently mentioned by a number of farmers, development agents and experts who were involved in focus group discussion.

Table 5: Distribution of Households' family members by age and sex composition

Age category	***Sex***		***Total***	***percentage***
	Male	***Female***		
0-14	186	201	*387*	*55.9%*
15-64	110	101	*211*	*30.5%*
≥65	38	56	*94*	*13.6%*
Total	***334***	***358***	***692***	***100%***

Source: Field Survey

5.1.2. Socio-economic Characteristics

5.1.2.1. Livelihood and Income Level

Table 7 below summarizes the main sources of sample farmers' livelihood along with the amount of income that they claimed to have received on daily basis. Occupation wise, as it can be observed from the table, the great majority of sample household heads, i.e., 112

(about 93.3%), derived their livelihood from different forms of farming activities. More specifically, it was found that about 32% of the farming households in this study were participating in crop production whereas 17% of the farming households depend on animal rearing, and about 5% of them reported vegetation and fruit growing as their dominant source of livelihood. The whole data, however, revealed that the great majority of the farming households (46.3% of the total sample population) engaged in crop-livestock, mixed farming activities.

Cash crops such as *chat*[3], coffee, onion, potatoes, sugar cane and tobacco are the principal source of income for the majority of the rural farming communities in the study area, providing cash income to cover family expenses for food grains and other essential household requirements, mostly consumer goods. Non-farming activities such as petty trading, daily wage labor participation, local crafting activities (like carpeting, weaving, pottery, etc.), selling of forage and fuel woods were frequently reported as supplementary sources of income by a significant proportion of sample households in this study. The following table presents a summary of responses from the sample household:

Table 6: Households' livelihood and income level

Description		Number	Percent
Major farming activities	Crop cultivation	12	10 %
	Livestock rearing	0	0
	Mixed farming	102	85 %
	Vegetables and fruits	6	5%
	Total	***120***	***100.0%***
Major non-farming sources of income(those who mainly participate on non farming activities)	petty trading	10	9.3%
	daily wage labor participation	5	4.6%
	participation in local crafting activities (such as carpeting, weaving, pottery, etc.	2	1.9%
	selling of forage and fuel wood	7	6.5%
	Total	***24***	***22.3%***
Average household daily income	10 Birr and below	29	26.9%
	Birr 11-17 Birr	76	70.3%
	More than 17Birr	3	2.8%
	Total	***108***	***100.0%***

[3] A stimulant plant widely grown in the area

Source: Field Survey

Generally, on the basis of the aforementioned data, one could easily understand that over 75 percent of the sample household heads in study area were farmers, who were directly relying on land resources for their livelihoods and well-being. Furthermore, many of the non-farming activities that were reported by sample farmers as supplementary sources of income (which include petty trading, charcoal and forage production, carpentry and craft production) are largely dependent on the natural environment. Simply stated, therefore, income and services that are derived from land resources such as arable land, forests and woodlands, plant and animal life (flora and fauna) are central to the livelihood of many sample households in this study.

Sample household heads' were also asked to report on the amount of money that they earn per day. As it can be observed from the third item in the above table, the vast majority of them (90.8%) earned a maximum of Birr 17and below per day. On the other hand, others who were, earning Birr 17 and above accounted for only about 9.2% of the total sample population in this study. As reflected by sample households' daily income level, therefore, the vast majority of sample households in this study are said to be living under poverty line in which their income per day was reported to be below $1 Dollar[4].

In sum, from the aforementioned discussion, one can understand that the great majority of the sample households in this study are more reliant on agriculture than any other form of economic activities with virtually all the sample household heads are working in this sector. The foregoing discussion has also made it clear that cultivation and livestock rearing are the two dominant economic activities that employed the great majority of sample rural households in this study.

Over the greater part of the woreda, cultivation and livestock rearing are combined in the mode of production known as mixed farming, though the mixture differs following topographic (elevation) and climate differences(BoRD, 2010).Generally speaking, however, the livelihood of the rural farming communities in the study area mainly depend on rain fed crop production. Most of all, it should be noted that virtually all the farmers in the locality are subsistence farmers, who are tilling small plots of land to feed their families (see households' landholding status as presented in Table7). Unpublished document of jave Tenan woreda of agricultural office shows that the major stable crops cultivated in the area

[4] According to the 1992 World Bank report on development indicator, an income $1 Dollar per day is regarded as a base line for delineating poverty. Nevertheless, this measure has been severely criticized for its rigidity and lack of comprehensiveness

include sorghum, maize, and small amount of and other legumes (BoARD, 2010). Cash crops such as c*hat,* coffee, onion, potato, green paper, and tobacco are predominantly cultivated in the central and northern part of the study *woreda* where small scale traditional irrigation supplements the rain fed production. However, other agricultural activities such as horticulture and agro forestry practices are very limited in the study area despite the area's potential and suitability for such types of agricultural activities.

According to the information obtained from the Woreda's Agricultural Development office, the major constraints of agricultural production in the area include: degradation of soil fertility resulting from weak or absence of fallowing and soil erosion; crop disease, too little or none application of modern farm inputs such as chemical fertilizers and improved seeds; inadequate and/or inappropriate provision of extension service; poor linkage among agricultural research, extension and farmers; and poor infrastructural development that deter farmers from accessing alternative markets for their agricultural produces.

In an attempt to have a good picture of the area's agricultural production, informants were also asked to report on whether rural farming households in their locality had produced adequate food production over the last 10 years. Almost all informants unanimously and frequently reported that rural farming communities in the area had not produced sufficient food to sustain their household total food requirement over the last 10 years. Recounting on this issue, for instance, one focus group participant said:

> Of course, over the past ten year, due efforts were made by governmental and non-governmental organizations to increase the agricultural production of farming households [in the area]…and [these stakeholders] have made available modern agricultural inputs, extension packages and introduced a number of soil and water conservation schemes. Despite all these efforts, production increment in the area's agriculture has rather been limited showing no significant increase at one time and even a sharp decline was observed at another time.

The data obtained from household survey also attested similar result. Here, sample households were asked to report on the number of times that their family members consume food per day. As Table 8 below shows, about 35% of the sample households in this study confirmed that their family members have access to food only once per day. On the other hand, 46.7% and 18.3% of the sample households', respectively, reported that their family members consume twice and three times a day. This means that most of the sample

households (around 77%) did not cover their households' food requirement from their agricultural production. Such high vulnerability of people to hunger and starvation in turn could have been one of the root causes of climate variability and livelihood adaptation practices in the locality under consideration.

Table 7: **Distribution of sample households' food intake per day**

Responses	***Number***	***Percent***
Once a day	42	35%
Twice a day	56	46.7%
Three times a day	22	18.3%
Total	***120***	***100.0%***

Source: Field Survey

5.1.2.2. Households' Land Holding Status

As indicated shortly above, the target populations in this study were farmers whose livelihood directly or indirectly depend on land resources. Land holding status, therefore, is one of the most decisive determinants of their livelihood behaviors. Among other things, access to farm and pasture lands play the most decisive role behind farmers' action to take part in mitigation activities and/or stick on environmentally fragile areas.

In the view of obtaining better understanding as to the impacts of farmers' landholding status on their adaption decisions, some key informants were asked to give their view of the issue in brief during the field work. In connection with this, one interviewed agricultural expert, for instance, recounted that smallholding or landless farmers in the area showed little or no initiatives to participate in soil and water conservation schemes, and to take part in climate variability adaptation measures. According to this expert, this issue appears to be more of concern in and around areas where land redistribution and resettlement programs are still problematic.

Data obtained from the household survey also attested the aforementioned ideas. As indicated in the following table, the land ownership status of sample farmers' was ranging from possessing own *land* to *crop sharing* and others that are considered to be illegal landholding on the view of authorities. In terms of their ownership status, only 37.5 % of the surveyed farmers are said to have access to their own farm land. In other words, about 62% of the sample farmers were landless in the strict sense of possession and these groups are predominantly relying on renting, crop sharing or communal land for their grazing, firewood

collection and cultivation purposes. The inevitable consequences of which, therefore, would become both increased land degradation and expansion of agricultural activities into fragile uplands and other marginal lands, which in turn, further intensifying problem of production due to climate variability in the area.

In terms of landholding size, the share of farmers' landholding status ranges from less than 0.5 hectare of land to above 2 hectares. The average landholding of the surveyed farmers was between 0.5 and 1 hectare and only 30.8 % of the surveyed farmers have had access to farm land in excess of 1 hectare. Note that land ownership in terms of landholding size has showed significant decline over the past two decades. Virtually all farmers, who were participating in this study, confirmed that their holding declined over the past two decades and a very few farmers reported that they did not see any change in their farm size during this period.

According to the view of those farmers who observed decline , the most important reasons for the observed decline in land holding size are sharing of the limited land with family members 68(56.7%), soil erosion 12(10%), nutrient depletion of land 9(7.5%), followed by land redistribution programs 7(5.8%), infrastructure development and urbanization 4(3.3%). There are also farmers who faced with a combination of factors that led to decline in their landholding size. Whatever the case may be, the limited land resource is constantly competing for, especially between agriculture and fast growing urban areas. Furthermore, as indicated in the table, inheritance from parents was the main source of land for most of the surveyed farmers who owned land. And land holding diminution mainly due to dividing among family members would ultimately result in unsustainable intensification of both land and land based resources. Renting, share cropping with landholders by investing inputs of labor, and borrowing from family for limited period were also frequently mentioned as means of access to land by those farmers who were landless.

At this point it seems important to look into how farmers' utilize their available farm land given the different land use options that farmers perceive as their land use alternatives. In terms of size, crop cultivation comprised a larger share than any other land use alternatives. This overview of sample farmers land use provides insights for better understanding how landholding status affects the climate variability adaptation decision of rural farming households. It is clear that medium and large-size farmers have sufficient land to undertake both production and management activities simultaneously. However, given the priority of

cultivation for sustaining their family life, it is unlikely that smallholding farmers would dedicate their land for fallowing and/or soil and water conservation measures without significant changes in policies/ technologies which could enable these groups of farmers to better cope with the unpredictable nature of local climatic condition, especially low and erratic rainfall.

Moreover, information obtained during field observation clearly indicated that those households with larger landholding have a better capacity of producing their annual food requirements, while those households with no or limited landholdings have found it difficult to produce sufficient food for their family and hence they hardly engage in land management activities as adaptation measures at the expense of their current consumption. This means that land scarcity and uneven distribution of land in the area played unequivocal role in exacerbating the situations of landless farmers, especially poor farmers, who have little or no alternatives than to intensively utilize their existing agricultural land or to migrate into environmentally sensitive marginal lands at the expense of deforestation and other forms of degradation.

Table 8: **Distribution of Households' by their landholding status**

Description		*Number*	*Percent*
Ownership status	Owen	45	37.5%
	Rented	15	12.5%
	Crop sharing	19	15.8%
	Others*	41	34.2%
	Total	***120***	***100.0%***
Farm size in hectare	< 0.5	48	40%
	0.5-1	35	29.2%
	1-1.5	21	17.5%
	1.5-2	10	8.3%
	>2	6	5%
	Total	***120***	***100***
Purpose/s for which households use their land	***Land use***	***Area(ha)***	***proportion***
	Crop cultivation	96	***90%***
	Grazing	4	***3.3%***
	Hedgerows	4	***0.8%***
	Soil and water conservation activities	3	***2.5%***
	Settlement	2.5	***2.1%***

Source: Field Survey

5.1.3. Physical characteristics of farm land

5.1.3.1. Plot distance

Only about 22 (18.3%) of farmers interviewed have had cultivated plots located far away from their residence. As it is shown from the following Table 10, the vast majority of respondent farmers 98(81.7%) were reported to have farm plots on the near distance, while the remaining 22 (18.3%) farmers reported to have farm plots on the near distance. During the focus group discussion it was indicated that farmers having land far from their residence usually do not give visit to their cultivation field except during harvesting and planting season. During slack season, livestock roam on the field freely.

Table 9 percentage distribution of farmers by their distance

Distance of farmland	Distance intermesh of walking hour	Farmers' response	
		number	% of response
Near		98	81.7%
Far		22	18.3%
Total		120	100

Source: field survey, Javi Tenan woreda, 2013

5.2. Institutional and Policy Related Factors

Policy and institutions, although most often regarded as the response to mitigate the problem of climate variability , can also promote sustainable land use practices and/or affect farmers' decision to degrade land resources against conserving these resources as the measures of adaptation . Keeping this in mind, the present study has attempted to assess whether or not government policies affect farmers adaptation behavior in the study area. According to the responses of sample household heads included in this study, government policies relating to infrastructure development, market development, input and credit supplies, land tenure, agricultural research and extension, conservation programs, and land use regulations had never been friendly until recently. But over the past ten years the government has tried to readdress these gaps even though there are still some problems.

According to the information obtained from the Woreda Agriculture and Rural Development office, about 4,532 household heads were targeted to benefit from different rehabilitation and developmental program undertaken in the area over the past five years. The minimum target to be achieved was to attain a successful transition of 1,553 household heads to food self-sufficiency. Generally, from the year of intervention to date, it was expected to graduate

a total of 4,532 heads of households. However, only 74(1.6%) heads of households graduated from the targeted households.

From the above data, one can easily understand that even though the importance of land management program as the means of adaptation to climate variability is indispensable. The result has proved to be a unsuccessful; such failure of a designed program was because of many factors. Existence of clear objectives of the government against climate variability at the global and local level was mentioned as one factor. Rainfall scarcity and development of dependency syndrome for aid has been also identified as contributing factors. Moreover, lack of monitoring and inspection mechanisms and practices were other factors attributable to the failure of this program. Meanwhile, informants claim that there was abuse or misuse of budget to other improper activities. Generally speaking, even though households are not expected to achieve the intended result due to the aforementioned factors, some other activities related to the program were found successful as illustrated on the following figure.

Figure 2: Activities undertaken by PSNP

Photography (Mesay Mersha, 2012)

The land management technique in the area has not yet changed its conventional approach in that as usual farmers are advised to adopt biophysical soil and water conservation measures; they are encouraged also to apply chemical fertilizers on their farm

plots. No rational person object these emphasis as these are necessary to augment the agricultural productivity of farmers in and around the study area, but these efforts had to be supplemented by other programs focusing on human behavioral change since most of the land degradation and land management problems are to do with human irrationality. The results obtained from different sources, however, indicated that many government and donor-funded soil and water conservation projects undertaken in the area continue to treat land degradation as a biophysical rather than as a socio-economic problem, that requires different solutions. This partly explains rather low rates of adoption of soil conservation methods, particularly among poor rural households in the area.

While poverty was cited as a catalyst of conflict, it was also said that conflicts often worsen poverty and deprivation and lead to cyclical hostilities. Generally, poverty is one of the most evident characteristics of the case study area. The residents the area have access to education, health services and safe water supplies compared to the majority of the populations of the country. Physical and social infrastructure is well developed in the area. Commercial crops are the basis of the economy in the area, yet opportunities for commercial crops marketing are meager among the agrarian communities of the study area. It is important to recognize that there are very good economic opportunities for the population of the study area.

Currently, expansion of information and communication technology—including mobile cell phone services—are recognized as the most important catalyst of economic change in the area. But, access to better communication technology and infrastructure in the area remains low and limited the economic opportunities and participation of the local population in different markets and save various kinds of tradable agricultural commodities that are produced in the area.

Thus, by endorsing unsuitable policies and poor implementation of programs and interventions, states play an integral role in the process of solving the problems. According to a respondent; poor farmers do not receive proportional consideration in the majority development programs in their area. Coupled with uneven distribution of land resources, this has significantly added to continues vulnerability in the area. In comparison with the past two regimes the current government policy and its relevance has improved the situation, albeit there is a lot to be done by both local as well as regional government.

Poverty, worsen by lack of alternative livelihood, is increasingly becoming the main source of unsustainable land use and land management practices in the area. Strong sentiment of deprivation and neglect by government officials are a fertile ground for lack of belongingness and voluntary participation in environmental rehabilitation efforts. Lack of employment opportunities was also mentioned as a cause of sustained land degradation problem in the study area. While poverty was most often cited as a catalyst of land degradation, it was also said that degradation often worsens poverty and deprivation and lead to cyclical degradation

5.1.5.1. Extension Service

Table 10: percentage distribution of farmers by level of contact with development agents

Farmers' contact with extension agents	**Farmers' response**	
	number	**Percentage**
Good contact with extension agents	81	67.5%
No or limited contact with extension agents	39	32.5%
Total	120	100

Source: field survey, Javi Tenan woreda, 2013

Most of the respondents in the study area have contact; they had contact with development agents. As it can be observed from table 12 below the large majority (67%) of the respondents have contact with extension agents. The remaining 33% of respondents did not have contact with extension agent. The good contact that farmers have had extension agents can affect farmers' decision by enabling them to get adequate and timely information. This enables them to perceive the economic significance of the problem of climate variability of the study area.

5.1.5.2. Land tenure security

As far as land tenure is concerned, the findings of the present study deny the claims of past empirical studies that send away the link between land tenure and farmers land use or land management behaviors. In light of that, when asked whether they believe that land tenure or periodic land redistribution has affected farmers' investments on climate variability in their particular area, most of the FGD participants answered in affirmative. Similarly, 83.7% of sample farmers said land insecurity or periodic redistribution discourage them from adopting SWC measures which could adversity affect climate variability adaptation

decisions where as only 1.1% of farmers failed to find any negative impacts of land tenure or periodic land redistribution on climate variability investments. Note that 15.2 % of the households responded that they had no idea whether one affects the other or not. However, recent programs in all the major regions to promote mapping and certification of land use rights appear to have important positive impacts on the livelihood adaptation strategies.

Table 11: farmers' response to land tenure security

Land tenure security	**Farmers response**	
	Number	**percent**
Not secured	99	82.5%
Secured	3	2.5%
I don't know	18	15.0%
Total	120	100

Source: field survey, Javi Tenan woreda, 2013

5.2. Farmers Perception about the problem of climate variability and their response to adaptation practice with their coping mechanisms

5.2.1. Farmers Perception on the pattern and cause of climate variability

Climate variability is a complex phenomenon, which is caused by a combination of natural and human induced factors. Specifically, as indicated in the preceding sections, a number of socio-economic, demographic, political, and environmental factors are leading to unsustainable natural resource use and management practices in the case of study area. Thus, different people give differing emphasis and significance to varied factors associated with the dimensions of climate variability and adaptation activities. There are also a number of ways of addressing matters related to such problem. Nevertheless, farming households— farm land resource users— have their own reasons for what they do with their resources and these, in turn, affect their perception of climate variability problem, and the gain received from its management activities.

In other words, farmers' perception of the causes and pattern of climate variability play decisive role in determining their willingness to adopt different adaptation measures. Thus, farmers' perception of resource, natural and social environments are to be given the required attention to better explaining farmers' land use and land management decisions.

In light of that, this section provides a more detailed analysis and discussion of farmers' perception on the cause and pattern of climate variability in the study area.

As indicated by sample households, the most well-known indicators of climate variability in the area include changes rainfall pattern and timing, natural resource depletion and deforestation. Table 14 summarizes farmers' perception of the causes of climate variability in their area. The most frequently mentioned climate variability in the area, as indicated by sample farmers, were deforestation (100%) followed by unfavorable industrialization condition such as emission carbon dioxide from industries (81.7%) and population pressure (79.5%) and followed by continuous cultivation of farm land with inadequate investments in soil conservation or vegetative cover (74.5%), expansion of agricultural activities into fragile environments(73.3%), over grazing (72.5%), and soil erode ability (55%) were also mentioned as direct contributors of the problem of climate variability in the study area.

Table 12: Distribution of sample farmers by their perception of the causes of soil erosion

Respondents Perception	***Number***	***Percent***
Population pressure(fast population growth rate)	95	79.2%
The climatic condition of the area such as erratic rainfall patterns, wind and temperature that are causing severe erosion	98	81.7%
Continuous cultivation of the land without applying appropriate conservation measures or vegetative cover	89	74.2%
Soils being too erodible	66	55%
Overgrazing	87	72.5%
Deforestation	120	100%
Expansion of agriculture on to marginal areas	88	73.3%

Source: field survey, Javi Tenan woreda, 2013(based on multiple responses)

4.2.3. Farmers adaptation practice

This section tried to find out the kinds of response made and strategies adopted by sample population to mitigate the climate variability problems which were caused by their current status of demographic and socio-economic characteristics. During the surveyed, the farmers were asked to identify among the listed strategies those they adopted to mitigate these climate variability problems and their response presented in number and percentage distribution (See Table 15, Table 16 and Table 17. In the field, the target populations were asked questions

regarding to their response to these problems. Among the interviewed 120 respondents who perceived climate variability as problem, 108 (90%) were explaining their different ways of responding mechanism (See table 15). Among interviewed 120 respondents, 78(65%) use different ways of farm land nutrient improvement mechanisms (see Table 16). Among the interviewed 120 of the respondents who perceived deforestation as a problem, 97(80.8%) were responding to this climate variability problem in various ways (See table 17).

The data presented in table 15 below shows the number and percentage distribution of target population response for the problem of climate variability. About 42 percent, 33 percent, 9 percent and 8 percent of respondents were used to as the means of livelihood adaptation strategies conservation techniques to terracing, tree planting traditional ditches and contour ploughing respectively. Conservation techniques of respondents about check dams and other were about 8.4 percent.

Table 13: percentage distribution of respondents by their response for the cause for climate

Farmers response to the causes of climate variability	Number	Percent of farmers response
Terracing	46	42.6%
Contour plough	13	12.0%
Traditional ditches	9	8.3%
Check dams	7	6.4%
Tree Planting	31	28.7%
Others	2	1.9%
Total	108	100

Source: field survey, javie Tenan woreda, 2013

The data presented in Table 16 below shows the number and percentage distribution of target population response for the problem of soil erosion. As it can be observed from Table 20 below the most frequently used soil fertility management method employed by respondents were crop rotation(28.1%), use of manure (23.1%), use of crop residues (16.7%), use of modern fertilizer (15.4%), and fallowing (2.6%).

Table 14: percentage distribution of respondents by their response for the cause for nutrient depletion, java tenan woreda, 2013

Farmers response to the causes of soil erosion	number	Percent of farmers response
Fallowing	2	2.6%
Crop rotation	22	28.1%
Inter-cropping	11	14.1%
Use of manure	18	23.1%
Use of crop residual	13	16.7%
Use of modern fertilizer	12	15.%4
Total	78	100

Source: field survey, Javie Tenan woreda, 2013

From 120 cases, 97(80.8%) respondents perceived that an environmental problems of deforestation. Table 21 bellow shows the percentage distribution of farmers' response to the problem of deforestation. About 33%, 20%, 16%, 14% and 19% of the respondents' attributed the problem of deforestation to planting trees, using controlled grazing, applying modern farming, limiting family size, and using modern source of energy and others respectively

Table 15: Percentage distribution of respondents by their response for the problem of nutrient depletion, Javi tenan woreda, 2013

Farmers response to the causes of deforestation	Number	Percent of farmers response
Planting trees	31	32.9%
Using modern source of energy	7	7.2%
Limiting family size	14	14.4%
Using control grazing	19	19.6%
Applying modern farming	15	15.5%
Others	11	11.3%
Total	97	100

Source: field survey, javie Tenan woreda, 2013

Sample farmers were also asked to give their perception of the pattern of land degradation in their locality. As it can be observed from the Table 17, the great majority of sample household heads (85%) acknowledged that the level and severity of land degradation in their

locality has shown increasing trend over the last 10 years. The remaining 15% of the sample household heads were responded either negatively or they did not have full ideas as to the patterns of land degradation in their locality over the years.

Those sample household heads who perceived increasing trends of land degradation problems in their locality were further asked to pinpoint their perception of indicators of land degradation problems in their locality. The most frequently mentioned indicators of land degradation were including nutrient depletion, because of soil erosion, deforestation, over grazing, over(continuous) cultivation, and water logging, loss of vegetation cover (or biodiversity), sedimentation or burial of soils, and exposure of stoniness/rockiness.

Table 16: Sample Households' Response on Pattern of Land degradation in the area

Statement	***Percentage(%) of farmers Response***		
	Yes	*No*	*Don't Know*
Over the past two decades, the level and severity of land degradation in the area showed increasing trend	*102(85%)*	*7(5.8%)*	*11(9.2%)*

Source: field survey, javie Tenan woreda, 2013

The increase in the level and severity of land degradation over the past decade was also widely reported by key informants in the study area. The frequently reported reasons by informants include the widespread lack of economic opportunity (in particular lack of alternative livelihoods for the rural poor farmers); the enormous increase in human and livestock population, which ultimately resulted in a large increase in croplands and grazing land demand at the expense of forest and grassland. This in turn has lead to degradation of soil structure and changes in the chemical and biological properties of the soil.

Sample household heads who perceived a declining trend, on the other hand, contends that there are improvements in the state of land resource in their locality. Reasons provided by these respondents for the alleged improvement of local land resources include: improvement in agricultural production, decreasing level of hunger/poverty, expansion of water utilization and irrigation, equal land distribution and efficient use of land, and the relative peaceful and democratic rule that have been witnessed in the area for the past one and half decades.

Information obtained from unpublished document of agricultural bureau of the woreda and situational observation also suggested mixed result with regard to the problem of land

degradation in the area. In some places the problem has showed declining trend while in others it has showed increasing trend from time to time in terms of magnitude and type. Factors that have contributed to the declining nature of land degradation over the past two decades include increase in community awareness on the causes and consequences of land degradation and their willingness to participate in land resource management activities. Furthermore, according to this source, land resource management stakeholders at all levels (community, zonal and Woreda administrators, and non-governmental organization) have given due attention to the management of communal lands that are located over a slope of 30%.

Those sample household heads who perceived increasing trends of land degradation problems in their locality were further asked to give reasons for the perceived increase in the level and severity of land degradation problems in their locality over the past 10 years, these respondents indicated the followings as the major reason: vulnerability to drought (98.1%), land scarcity (96.1%), uneven distribution of land or inequality in land holding (94.4%), population growth (90.7%), soil infertility (82.4%), crop disease (57.4%), pests (%), moisture stress (41.7%), and deforestation(11.1%).(see Table 18 below)

Table 17: Farmers' response on factors affecting the level and severity of land degradation

Responses	Number	Percent
Vulnerability to drought	106	98.1%
Pests	59	54.6%
Crop disease	62	57.4%
Deforestation	15	13.9%
Soil infertility	89	82.4%
Climatic problems	12	11.1%
Uneven distribution of land (Inequality in land holding)	102	94.4%
Land scarcity	104	96.1%
Moisture stress	45	41.7%
Population growth	98	90.7%

Source: field survey, Javie Tenan woreda, 2013

According to unpublished sources of Javi Tenan woreda rural development bureau, despite such impressive improvements in some localities, the problem of land degradation in some other places did not show considerable improvement over the years. As per rural development bureau, the level and severity of land degradation problems in some localities of the study *woreda* have showed increasing trend when viewed in terms of continuous decline in the productivity of land resources and climate changes unfavorable to crop production, loss of assets and food crops.

One agricultural expert from woreda rural development office interviewed recounted the following:

> *Though the government has been trying to improve the problem of land degradation in the area for the last decade, there are challenges which have been yet resolved. However, the situation is not consistent. Sometimes we achieved better outcomes when there is adequate rainfall and food, but the reverse happens when there is drought and food shortage.*

Thus, one can roughly conclude from the above evidences that the trend of land degradation in the area is quite uncertain. However, unless intervention is made to reverse the situation of land degradation, achieving sustainable land management in the area seems quite difficult. The most noted factors by informants and farmers were shortage of farm land, land fertility problem, in adequate rainfall (moisture stress), food shortage, shortage of water and grazing land.

As indicated by sample households, the most prominent forms of land degradation in the area under consideration are soil erosion; nutrient depletion (fertility loss) and deforestation are the most well-known forms of land degradation in the study area. The unquestionable causes of these forms of land degradation problems in the area are biophysical causes and unsustainable land management practices. Unsustainable land management practices, such as deforestation and overgrazing, declining use of fallow, limited recycling of animal and crop residues to the soil, limited application of external sources of soil nutrient and cultivation on steep slopes and fragile environments with inadequate investments in soil conservation or vegetative cover are also considered as direct contributors of the problem of land degradation in the study area. Thus, unless intervention is made to reverse the impacts of these problems, achieving sustainable land management in the area seems quite difficult.

In sum, according to some participants' perceptions, recent years have witnessed problems climate variability, particularly reduction in land productivity which increased food shortages. Many residents of the study area are adversely affected by these changes and hence, most of them considered land degradation as the most serious threat to the area's long-term socio-economic development. This condition was regarded as an important factor stimulating efforts toward land management practices in the area over the past two decades. In other words, the great majority of farmers interviewed believed that reversing the negative trends of land degradation would make a significant contribution to sustainable development while benefiting local residents.

However, the increase in the level and severity of climate variability has also led to increased short term benefit and a strong desire for satisfying their immediate benefits investing in improved land management activities as the means of adaptation whose gains could be accrued sometime in the future.

Above all, according to the information obtained from the *woreda* safety net program, large percentages of food-insecure population are currently residing in the study area. This is made worse by periodic reductions in production because of erratic and low rainfall conditions in the area (BoRD, 2011). According to this source, the overall agricultural productivity of the area has failed to keep pace with the local population food requirement and the area's agriculture suffered particularly from falling productivity in the crop production sector.

The normal rainfall distribution in the area is bimodal in nature. The two rainy seasons are locally called *Kiremt* (the main rainy season) and *Belg* (the small rain season). There is also one dry season called *Bega*. The rainfall patterns during these three seasons have showed marked variation and thus strongly affecting farmers' production patterns and land management behaviors. In *Kiremt*, the rain is more abundant and is distributed almost evenly over a five month period (June through Mid-September) where as during *Belg* rainfall is much lower and commonly absent during the second half of the season. Thus, farmers' production systems differ across these seasons and have important impact on farmers' decisions as to the use and management of land resources in the study area.

Several farmers interviewed in the area reported that rainfall variability in precipitation has affected forage availability, crop production, access to water resources and ultimately their

capacity to produce sufficient food for their family let alone to manage their farm land. Therefore, as indicated by farmers, variability in precipitation has a directly affect the land use and land management behavior of farmers in the study area (Discussion with Farmers in Javie Tenan woreda, 2012-04-25). One expert interviewed in the area also attested this assertion, saying

> *"…the land use and land management behavior of farmers [in the area] change drastically following change in climatic conditions, especially with reference to drought, which is caused mainly by decreasing rainfall and rainfall variability."*

Accentuating this point, another Development Agent mentioned the following:

> By encouraging farmers to adopt soil and water conservation measures, local and regional governments have tried to improve the problem of land degradation in the area for the last decade…But, there are still challenges which have not yet been resolved. Here, natural environmental factors, particularly rain fall pattern play the most decisive role in that many farmers show willing to participate or adopt land management actions when there is adequate rainfall and food, but when there is scarcity of rain and food shortage the reverse is true.

While stressing the observed local environmental change, a 65 years old farmer, who has residing in the area since birth recounted:

> *We do not know what is happening to our area, things are not as they were in the past ….the rain has been reduced and changed its pattern, the size of rivers and small swampy lakes have also reduced and in some cases dried…. We produce little, even sometime, as a result of rain fall scarcity, the crops we planted were perishing on farm fields before their maturity period and hence we do not have enough food to feed ourselves unless we obtain aid from the government.*
>
> *In time of severe drought, as it was happening same seven years before, the land was bare with nothing over it and small surface streams in the area were drying up so we hardly found water for us and our cattle… frequent drought killed significant number of human beings and livestock….*

When asked to recount on any local environmental change he had observed over his life time, this farmer noted the general reduction in the area's precipitation and another proof is offered by sever reduction in the size and eventual elimination of swampy areas. The area also experienced changes in its biodiversity which is manifested through the disappearance of some plant species and the spreading of plant disease that perish the fruit of some species.

Although this is difficult to document, the increase human and animal population in recent decades is believed to have contributed proportionately to pressure on resources scarcity and the resulting land degradation problem. The other cause of land degradation and improper land management practice in the area, which is closely related with this, is the noticeable conversion of communal forest and marginal lands into agricultural and/or grazing lands. According to the interviews and discussions held in the study area, the socio-cultural and economic basis of the area, which is largely dependent on the cultivation and selling of cash crops (particularly chat), provides fertile ground for the presence of persistent competition over these resources. Similarly, expansion of agricultural fields ranging from small plots to large holdings, new settlement by people from towns, demographic changes within and around the surrounding woreda are all forced famers, especially poor landless farmers, to intensively utilize their existing agricultural lands or to abandon it and migrate into other areas where they believe get access to better livelihood opportunities.

To make matters worse, failures in production are exacerbating adverse market conditions characterizing the study area. According to informants, most of the time, crop price has been increase rapidly. Similarly, the price of commodity that farmers could demand such as sugar, oil, clothes and other industrial products are shooting up in market centers. The severity of the protracted drought in the study area was also aggravated by large scale livestock mortality. Due to shortage of animal food and lack of adequate water in the dry seasons, the contribution of livestock to … has been greatly affected and adversely undermined. This has in turn led to loss of potential sources of income of the farmers.

4.2.2 Coping strategies

Given that the diverse communities of the study area are definitely food insecure, the reasonable question is what should they do in the occasions of food shortage? Households could possibly resort to a number of mechanisms to ensure their need as regards to food consumption. While coping strategies and mechanisms appear to vary in terms of time and sequence, certain common patterns can easily be observed. According to Webb, Bravn and

Yohannes (1992), the first response to such crises is to possibly preserve assets; the second stage is the disposal of depletion of assets; the final stage necessarily involves actions that may go against prevailing social norms.

The rather widespread coping practices or mechanisms usually consist of sale of fire wood, food for work, purchasing cheaper grain, sale of household items, daily wage labor, relying on relief assistance, sale of charcoal and livestock sales in their descending order. Moreover, the repeatedly mentioned mechanisms by sample households are migrant labor, reduction of consumption and changing food habit. The following table presents a summary of responses from the sample household:

Table18: Coping up mechanisms of the study area

No.	Items	Count	percent
1	Daily wage labor	56	46.7%
2	Migrant labor	35	29.2%
3	Food- for – work	80	66.7%
4	Sale of fire wood	87	72.5%
5	Reducing consumption	21	17.5%
6	Changing food habits	15	12.5%
7	Sale of household items	57	47.5%
8	Livestock sales	26	21.7%
9	Relying on food assistance	25	20.8%
10	Resettlement	16	13.3%
11	Sale of agricultural equipments	14	11.7%
12	Purchasing cheaper grain	65	54.2%
13	Sale of charcoal	53	44.2%

Source: Source: field survey, Javie Tenan woreda, 2013 (based on multiple responses)

4.2.3. Farmers land management practice as means of adaptation

This section tried to find out the kinds of response made and strategies adopted by sample population to mitigate the environmental problems which were caused by their current status of demographic and socio-economic characteristics. During the surveyed, the farmers were asked to identify among the listed strategies those they adopted to mitigate these environmental problems as the results of climate variability and their response presented in

number and percentage distribution (See Table 18, Table 19 and Table 20. In the field, the target populations were asked questions regarding to their response to these problems. Among the interviewed 120 respondents who perceived soil erosion as problem of climate variability, 108 (90%) were explaining their different ways of responding mechanism (See table 19). Among interviewed 120 respondents, 78(65%) use different ways of farm land nutrient improvement mechanisms (see Table 22). Among the interviewed 120 of the respondents who perceived deforestation as a problem, 97(80.8%) were responding to this environmental problem in various ways (See table 20).

The data presented in table 20 below shows the number and percentage distribution of target population response for the problem of soil erosion. About 42 percent, 33 percent, 9 percent and 8 percent of respondents were used to conservation techniques to terracing, tree planting traditional ditches and contour ploughing respectively. Conservation techniques of respondents about check dams and other were about 8.4 percent.

Table 19: percentage distribution of respondents by their response for the cause for soil erosion, Javi Tenan woreda, 2013

Farmers response to the causes of soil erosion	Number	Percent of farmers response
Terracing	46	2.6%
Contour plough	9	28.1%
Traditional ditches	9	14.1%
Check dams	7	23.1%
Tree Planting	35	16.7%
Others	2	15.4%
Total	108	100

Source: field survey, javie Tenan woreda, 2013

The data presented in Table 21 below shows the number and percentage distribution of target population response for the problem of soil erosion. As it can be observed from Table 20 below the most frequently used soil fertility management method employed by respondents were crop rotation(28.1%), use of manure (23.1%), use of crop residues (16.7%), use of modern fertilizer (15.4%), and fallowing (2.6%).

Table 20: percentage distribution of respondents by their response for the cause for nutrient depletion, Javi Tenan woreda, 2013

Farmers response to the causes of soil erosion	Number	Percent of farmers response
Fallowing	2	2.6%
Crop rotation	22	28.1%
Inter-cropping	11	14.1%
Use of manure	18	23.1%
Use of crop residual	13	16.7%
Use of modern fertilizer	12	15.%4
Total	78	100

Source: field survey, Javie Tenan woreda, 2013

From 120 cases, 97(80.8%) respondents perceived that an environmental problems of deforestation. Table 22 bellow shows the percentage distribution of farmers' response to the problem of deforestation. About 33%, 20%, 16%, 14% and 19% of the respondents' attributed the problem of deforestation to planting trees, using controlled grazing, applying modern farming, limiting family size, and using modern source of energy and others respectively.

Table 21: Percentage distribution of respondents by their response for the problem of nutrient depletion, Javi Tenan woreda, 2013

Farmers response to the causes of deforestation	number	Percent of farmers response
Planting trees	31	32.9%
Using modern source of energy	7	7.2%
Limiting family size	14	14.4%
Using control grazing	19	19.6%
Applying modern farming	15	15.5%
Others	11	11.3%
Total	97	100

Source: field survey, Javie Tenan woreda, 2013

In the above discussion sections soil nutrient and forest conservation methods practiced by respondents were discussed. The following subsection to understand the general conservation practice for analysis purpose. Based on this, the respondents who were practicing land

management practice (activities) at the time of the survey was categorized under 'yes' and not practicing categorized under 'no' category.

The survey result on the question do farmers' practice land resource conservation management in their area? For this question a majority 73.3% of farmers respond by saying 'yes', while the remaining 26.7% of them replay by saying 'no'.(see the Table 23 below)

Table 22: Do farmers practice land recourse conservation management?

Farmers' land practice	Farmers response	
	Number	Percentage
Yes	88	73.3%
No	32	26.7%
Total	120	100

Source: field survey, Javie Tenan woreda, 2013

5.3. Determinants of farmers land management practices as means of adaptation: logistic regression model

In the previous chapters some of the specific research questions were discussed using descriptive statistics such as cross-tabulation and percentage distribution. Moreover, the researcher tried to look at the relationship among the respondent's socio-economic, demographic, and policy and institution related characteristics of farmer in the study area. In addition to this farmer perception about the problem of climate variability and their response to with their coping mechanisms are discussed. However, this was not enough to make deduction and explore the predictive power of the independent variables.

The background variables of the respondents were also analyzed by applying the binary logistic regression model. In the field, the targeted populations were asked questions regarding to their response to the problems. Among interviewed 120 respondents 88(73.3%) of total population respond to land degradation as the problem of climate variability in different ways and the remaining 32(26.7%) farmer households did not respond to the problem of land degradation as the problem of climate variability one way or another.

Age, sex, literacy, marital status, household size, major occupation, income level, land ownership status, farm size, distance, slope, land tenure security, contact with extension agents, availability of credit services, farmers perception as a problem were taken as

predictors to fit model. These predictors (independent variables) are believed to have the power to predict the probability of occurrence of outcome variable (land management). This is to mean that, the probability or likelihood to which a respondent has towards land management practices are explained by these independent variables. For this purpose, binary logistic regression model is the multivariate statistical tool that was used for the analysis of the subject matter. For the purpose of simplicity only those variables statistically significant are discussed.

5.3.1. Demographic variables

Age category of farmers

Binary logistic regression model showed that there is no significant relationship between age of farmers and terracing, but the relationship is positive since the value of Exp (B) is greater than 1 (Table 2). However, it is observed that binary logistic regression model indicates age of farmers to have predictive power in manure application. A one unit increase in the age of farmers is found to have increased odds of manure application by a factor of 1.419 and the result is statistically significant ($p<0.05$) (Table 3). The positive and significant relationship could be explained by the fact that older farmers have better experiences in indigenous knowledge of adaptations.

Sex of farmers

Most of the land management practices require more labor force. Hence, male headed households are expected to better undertake different land management practices, as better endowed with labor. Women are often faced with more labor constraints than male farmers and male-headed households. Women are also sometimes inhibited from making decisions about land management practices while their husbands are away (Benin, 2006).

In addition, women are commonly busy in household activities and their prime responsibility is usually child rearing. In this research too, negative and significant 91 relationships between sex of household heads and terracing is observed and the result is statistically significant ($p<0.05$). For the analysis, male sex is given a code of 1 and for female sex code 2 is given. Taking male headed households as a reference group; the odds of applying terracing among female headed households was only .235 times that of the male headed households (Table 2). The finding is in conformity with the assumption that men are more likely to practice terracing than women.

With regard to the relationship between sex of household head and manure application, no significant relationship is observed.

The majority of demographic variables found to be strongly associated with the farmers livelihood adaptation strategies. The demographic variables incorporated in the model, namely age (0.440), sex (1.125) and marital status of household (1.815) have positive relationship with farmers livelihood adaptation strategies. And the correlations of these variables were found significant at 0.05 significant levels. The significance level of age of HH heads shows that farmers with larger age found to have a greater livelihood adaptation strategy. The result of this model shows that other demographic variables, namely literacy and household size are not statistically significant.

5.3.2. Socio economic variables

Among the socio economic variables; the only statically significant variable is ownership status (0.000) at a significance level of 0.01. The other variables are not statically significant.

5.3.3. Physical variables

The two physical variables encoded in this model are distance of the plot from homestead and slop of farm land. The results of these variables shows that distance has positive relation (2.288) with adaptation practices, while, slope is negatively related (-0.568). Both distance and slope are statically significant at level of 0.01.

5.3.4. Institutional variables

Access to extension services

Access to extension services is assumed to improve farmers' attitude towards land management practices as means of adaptation to climate variability. This is because farmers with access to extension services are expected to have better access to information which could play a significant role in improving land management practices can improve soil productivity. As per expectation, the analysis indicated farmers' access to extension services to have predictive power in terracing. Using the odds of terracing among farmers' with no access to extension services as a reference, farmers with access to extension services have much higher chance of applying terracing. Farmers with access to extension services are found to have increased odds of applying terracing by a factor of 2.475 higher when compared to farmers with no access to extension services and the result is statistically significant ($p<0.05$) (Table 2).

The analysis further shows farmers' access to extension services to have predictive power in manure application. Using the odds of manure application among farmers' with no access to extension services as a reference group, farmers' with access to extension services have much higher chance of applying manure. Farmers with access to extension services are found to have increased odds of manure application by a factor of 2.396 higher when compared to farmers with no access to extension services. The result is statistically significant (P<.05) (Table 3).

Even though, access to extension services is assumed to improve farmers' attitude towards land management practices, the results of this model shows a negative relationship (-2.48) with land management practices and statically significant at a significance level of 0.01. The other variable which is statically significant (0.002) at a significance level of 0.01 is land tenure security. It has negatively related with the adaptation strategies.

5.3.5. Perception as a factor

There is a general understanding that the better the farmers perceive problems of climate variability, the better they can act to achieve sustainable adaptation practices. Nonetheless, no significant relationship is observed between farmers' perception of climate variability problem on their own farmland and their practices of both terracing and manure application.

This insignificant relationship might be due to the fact that though they are aware of the climate variability problem on their land, yet they might not feel the real impact of the problem, that is, a decline in yield. For more comprehensive understanding, there might be a need to conduct further research. The insignificant relationship is consistent with a previous study that indicated perceptions of climate variability problem to have no significant influence on the decision of farmers to continue using different adaptation strategies.

There is a general understanding that farmers who perceived the problems of climate variability, they can more actively act to achieve sustainable land management practices as the means of adaptation to climate variability. The results of the statics also shows positive relation is observed between farmers' perception of climate variability problem on their own farmland and their practices.

REFERENCES

Agrawala, S and Fankhauser, S. (2008). *Economic Aspects of Adaptation to Climate Change: Costs, benefits and policy instruments*. OECD, Paris.

Asress Wolde Giorgis, (1995). Ethiopia Greenhouse Gas Emissions and Source.

B & M Development Consultant PLC 2006. National Metherological Agency Climate Change Enabling Activity Phase II. Technology Needs Assessment in Climate Change Mitigation in Energy Sector.

Belayneh Ayalew (2005). Land Degradation Assessment and Evaluation of Current Land Use and Soil Conservation Structures at Upper Chena Catchments.MA thesis, Addis Ababa University, Ethiopia. Unpublished.

Calow (2002). Climate Change Impacts on Food Security in Sub-Saharan Africa: Insights from Comprehensive Climate Change Modeling.

Central Statistical Agency (CSA). 1994. Population and housing census of Ethiopia: Results for Amhara Region. Volume 1, part 1. Available at:http://www.csa.gov.et/surveys/Population%20and%20Housing%20Census%201994/survey0/data/docs%5Creport%5CStatistical_Report%5Ck04%5Ck04_partI.pdf

Climate change national adaptation programme of action (NAPA) of Ethiopia ministry of water resource ,national meteorological agency ,Addis Ababa –Ethiopia June 2007.

Daniel Kassahun. (2008). Impacts of climate change on Ethiopia: a review of the literature. In:_____ (ed.), *Climate change – a burning issue for Ethiopia: proceedings of the 2ndGreen Forum Conference held in Addis Ababa, 31 October–2 November 2007*. AddisAbaba: Green Forum.

Deressa, T, (2006). Measuring the economic impact of climate change on Ethiopian agriculture: Ricardian approach. CEEPA Discussion Paper No. 25. Centre for Environmental Economics and Policy in Africa, University of Pretoria.

Deressa, T, Hassen, R, Alemu, T, Yesuf, M, and Ringler, C, (2008). Analyzing the determinants of farmers' choice of adaptation measures and perceptions of climate change in the Nile Basin of Ethiopia. IFPRI Discussion Paper No. 00798. International Food Policy Research Institute, Washington, DC.

Devereux S. (2006).Vulnerable livelihoods in Somali Region, Ethiopia. IDS Research Report 57. Brighton: Institute of Development Studies.

Dinar, A, Hassan, R, Mendelssohn, R & Benhin, J, (2008). *Climate change and agriculture inAfrica: impact assessment and adaptation strategies,* Earth Scan, London.

Dinar, A, Mendelsohn, R, Everson, R, Parikh, J, Sanghi, A, Kumar, K, McKinsey, J &Lonergan,

S, (1998). *Measuring the Impact of Climate Change on Indian Agriculture.* Earth Scan, London.

Ethiopian Strategic Investment Framework for Sustainable Land Management (Draft). SL M Secretariat. August 2008.

FAO (2008b). Water for Agriculture and Energy in Africa: The Challenges of Climate Change.

Ministerial Conference on Water for Agriculture and Energy in Africa: The Challenges of Climate Change. Libyan Arab Jamahiriya.

FAO, (2007). Africa: Climate change challenges agriculture. Retrieved from:

http://www.africanews. Com/site/list messages/12337. (Accessed date: October 02,2011).

FAO/WFP crop and food security assessment mission to Ethiopian FAO/WFP, 21 January 2007.

Federal Democratic Republic of Ethiopia FDRE, (2007) Climate Change National Adaptation Programme of Action (NAPA) of Ethiopia- Addis Ababa: Ministry of Water Resource and National Meteorological Agency.

Fischer, G., Shah, M., Tubiello, F.N. and van Velhuizen, H. (2005) 'Socio-economic and climate change impacts on agriculture: an integrated assessment 1990 – 2080', *PhilosophicalTransactions of the Royal Society.* 360: (Pp. 2067-2083)

Fistum Hagos, Pender, J. and Nega Gebreselassie (2002). Land Degradation and Strategies for Sustainable Land Management in the Ethiopian Highlands: Tigray Region. Socioeconomic and Policy Research Working Paper 25. 2nd edition. International LivestockResearch Institute, Nairobi, Kenya.

Gbetibouo, G. A., Understanding Farmers' Perceptions and Adaptations to Climate Change and Variability: the Case of the Limpopo Basin, South Africa, IFPRI Discussion Paper (Washington, DC: International Food Policy Research Institute, forthcoming 2009).

Harwood, R.R.: 1979, Small Farm Development – Understanding and Improving Farming Systems in the Humid Tropics, Boulder, West view Press.

Intergovernmental Panel on Climate Change, IPCC (2000): Emission scenarios, Summary for policy makers, Intergovernmental Panel on Climate Change, online at http://www.grida.no/climate/ipcc/spmpdf/sres-e.pdf

IPCC, (2001). Climate Change Impact, Adaptation and Vulnerability, WG-II Fourth Assessment Report .Retrieved from http: www.ipcc.ch/SPM6avr07.pdf. (Accessed Date: Oct,13,2011).

IPCC, (2001): Climate Change 2001: *Mitigation - Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)* [Metz, B., O. Davidson, R. Swart, and J. Pan (eds.). Cambridge University Press, Cambridge, 700 pp.

IPCC, (2005): Safeguarding the Ozone Layer and the Global Climate System: issues related to Hydrofluorocarbons and Perfluorocarbons [Metz, B., L. Kuijpers, S. Solomon, S.O. Andersen, O. Davidson, J. Pons, D.de Jager, T. Kestin, M. Manning, and L. Meyer (eds.). *Special Report of the Intergovernmental Panel on Climate Change (IPCC*), Cambridge University Press, Cambridge.

IPCC, (2007). Climate Change Synthesis Report. Cambridge University Press. Cambridge.

Intergovernmental Panel on Climate Change, IPCC, (2007a): Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B.M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp.

IPCC, (2007b) Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Parry, M.L., O.F.Canziani, J.P. Palutikof, P.J. van der Linden, C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and NewYork, NY, USA

IPCC, (2011). Climate Change Impact, Adaptation and Vulnerability, WG-II Fourth Assessment Report Summary for Policy Makers. International Food Policy Research Institutes (IFPRI), how can African agriculture adapt to climate change, June 2011.

Kurukulasuriya, P & Mendelsohn, R, (2006). A Ricardian analysis of the impact of climate change on African cropland. CEEPA Discussion Paper No. 8. Centre for Environmental Economics and Policy in Africa, University of Pretoria.

Kurukulasuriya, P & Rosenthal, S, (2003). Climate change and agriculture: A review of impacts and adaptations. Paper No. 91 in Climate Change Series, Agriculture and RuralDevelopment Department and Environment Department, World Bank, Washington, DC.

Malene Haakansson ,When the rains fall Ethiopia' s Struggle Against Climate Change ,2009

Mastrandrea, M.D., and S.H. Schneider, (2004) Probabilistic Integrated Assessment of 'Dangerous' Climate Change. *Science*, 304 (5670): (pp. 571-575).

McKee J. (2008). Deconstructing some myths about climate change adaptation and mitigation, In: Green Forum (ed.), Climate change – a burning issue for Ethiopia: proceedings of the 2nd Green Forum Conference held in Addis Ababa, 31 October –2 November 2007 (Addis Ababa: Green Forum), pp111–135.

Meze-Hausken, E. (2000). Migration caused by climate change: How vulnerable are people in dry land areas? A Case-study in Northern Ethiopia' *Mitigation and Adaptation Strategies for Global Change*. 5(4): 1573-1596.

Ministry of Finance and Economic Development (MoFED), (2006), Ethiopia: Building on

Progress, a Plan for Accelerated and Sustained Development to End Poverty (PASDEP), (2005/06-2009/10) Volume I: Main Text, Addis Ababa, Ethiopia.

Ministry of Finance and Economic Development, (MoFED) (2010) Survey of the Ethiopian economy. Addis Ababa, Ethiopia.

Ministry of Water Resources (2007). Climate change Technology needs Report of Ethiopia, Addis Ababa.

Morgan, R.P.C. (1995). *Soil Erosion and Conservation*, Second Edition. Longman Group UK Limited: UK.

National Meteorological Services Agency of Ethiopia (2007).Climate Change National Adaptation Programme of Action (NAPA) Addis Ababa, Ethiopia: the Federal Democratic Republic of Ethiopia, Ministry of Water Resources, and National Meteorological Agency.

National Meteorological Services Agency (NMSA), (2001): Initial National Communication of Ethiopia to the United Nations Framework Convention on Climate Change (UNFCCC), Addis Ababa, Ethiopia, online at http://unfccc.int/resource/docs/natc/ethnc1.pdf

National Meteorological Services Agency (NMSA), (2001). Initial National Communication of Ethiopia to the United Nations Framework Convention on Climate Change (UNFCCC):pp. 1-10, 60-65

National Meteorology Services Agency (NMSA), (2007). Final Report on Synergy between Adaptation and Multilateral Environmental Agreements prepared by B and M Development Consultants for NMA. Addis Ababa, Ethiopia.

Nhemachena, C & Hassan, R, (2007). *Micro-level analysis of farmers' adaptation to climate*

change in Southern Africa. IFPRI Discussion Paper No.00714. International Food Policy Research Institute, Washington D.C.

Nicol and Slaymaker, 2003). Climate Change Impacts on Food Security in Sub-Saharan Africa:

Insights from Comprehensive Climate Change Modeling.

OECD (2003). Poverty and Climate Change. Reducing vulnerability of the poor through adaptation. Paris: OECD.

Olsen, K.H.(2006). National ownership in the implementation of global climate policy in Uganda.Clim. Policy, 5: 599-612.

Pankhurst R. (1985). *The history of famine and epidemics in Ethiopia prior to the twentieth century*. Addis Ababa: Relief and Rehabilitation Commission.

Pankhurst, A. (1992): *Resettlement and Famine in Ethiopia: The Villagers' Experience*. Manchester: Manchester University Press.

Paul, J. Block, K. and Balaji, R. (_____). Integrated Management of the Blue Nile Basin in Ethiopia under Climate Variability and Climate Change: Hydropower and Irrigation

Modeling.

Polsky, C & Esterling,W.(2001). Adaptation to climate variability and change in the US Great

Plains: A multi-scale analysis of Ricardian climate sensitivities. *Agriculture, Ecosystem and Environment* 85(3): 133–144.

Shah, M., Fischer, G. and Van V. H. (2008). *Food Security and Sustainable Agriculture the Challenges of Climate Change in Sub-Saharan Africa.* Ladenburg: International Institute for Applied Systems Analysis. Shah, Mahendra, Gunther Fisher and Harrij Van V. (2008) *Rain fed agriculture, climate change and food security*. A

report submitted for discussion at the FAO Expert Meeting on Climate Change, Water and International Food Policy Research Institute, Washington,DC.

Shibru Tedla (2003), Ethiopia's Environmental Condition: Today and Twenty-Five Years From Now, in Economic Focus, Vol., 5, No., 5, pp., August 2003, Bulletin of the Ethiopian Economic Association, Addis Ababa.

Stern, N. (2006). The Stern Review: The Economics of Climate Change. http://www.hmtreasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cf>, accessed 28. November 2006.

Temesgen T. Deressa, Rashid M, Hassan, and Claudia Ringler (2008) Measuring Ethiopian FarmersVulnerability to Climate Change across Regional States, International Food Policy Research Institute (IFPRI), Environment and Production Technology Division Discussion Paper 00806.

The United Nations Millennium Development Goals by 2015 (UN, 2007).

UNDP (2007).Human Development Report 2007/2008. Fighting Climate Change: Human Solidarity in a Divided World, New York: Palgrave Macmillan.

UNDP (2008). Fighting Climate Change - Human Solidarity in a Divided World. New York:

Wakgari Deressa, Dereje Olana and Shelleme Chibsa (2005). Community participation in the Malaria Epidemic Control in Highland Areas of Southern Oromia, Ethiopia. Ethiopian Journal of Health development.

WHO (2007).How much disease would climate change cause.Availableat:www.who.int/globalchange/climate/summary/en/index6.html

WMO 2005. Climate Change in 2006.

Wiggins, S. (2006) .*Agricultural growth and poverty reduction: A scoping study*. Working Paper

World Bank (____) Ethiopia Climate Risk Fact Sheet (Draft work in progress).Availableat:http://siteresources.worldbank.org/INTAFRICA/Resources/Ethiopia_Country_Note.pdf

Yesuf, M, Di Falco,S Ringler, C, Kohlin,G, (2008) . *Impact of climate change and adaptation to climate change on food production in low income countries: Household survey data evidence from the Nile basin of Ethiopia.* IFPRI Discussion Paper No. 828.

Yohannes G/ Michael (2003). *Economic diversification in the pastoral areas of Ethiopia: Opportunities and challenges.* Consultancy works for Oxfam International, Addis Ababa,Ethiopia.

Yohannes GebreMichael, and Mebratu Kifle (2009). *Local innovation in climate-change adaptation by Ethiopian pastoralists.* Addis Ababa, Ethiopia

You, G. J.Y., and C. Ringler. (2010). *Hydro-Economic Modeling of Climate Change Impacts in Ethiopia.* IFPRI Discussion Paper No. 960. Washington, DC