COMMUNITIES' PERCEPTION ON CLIMATE CHANGE VARIABILITY AND ATTITUDES TOWARDS LIVELIHOOD ADAPTATION STRATEGIES IN WARE JARSO DISTRICT, ETHIOPIA

A Thesis

Presented to the school of graduate studies

of Addis Ababa University, Addis Ababa

In partial fulfillment of the requirements for the degree of

Master of Arts in Geography and Environmental Studies

(Specialization: climate change adaptation)

By:

Mesfin Tesfaye Demissie

June 2012

AAU

Declaration

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

Declared by:

Name: Mesfin Tesfaye

Signature: ———————————

Date: ———————————————

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF GEOGRAPHY ANDENVIRONMENTAL STUDIES

This is to certify that the thesis prepared by Mesfin Tesfaye Demissie entitled: **Communities' perception on climate change variability and attitudes towards livelihood adaptation strategies** and submitted in partial fulfillment of the requirements for the degree of Master of Arts in Geography and Environmental studies (specialization: Climate change adaptation) compiles with the regulations of the university and meet the standards with respect to originality and quality.

Approval by the Board of Examiners

Name:	Signature
Advisor: Muluneh W/Tsadik (PhD)	_____
Examiner: Mohammed Assen (PhD)	_____

_____

Chair of department of graduate program coordinator

ACKNOWLEDGEMENTS

Almighty God deserves the first word of thanks for all the achievements which I have been able to attain in my entire life and for the successful completion of my two years postgraduate degree course in Climate change adaptation.

I would like to express my sincere thanks and deep gratitude to my advisor Dr. Muluneh W/Tsadik for his commitment and dedication to help me bring my thesis to this end tirelessly. My work would have not come to this end had it not been for tireless assistance and availability the time I needed him.

My special thanks also extend to Dr. Dessalegn Wana and Dr. Eshetu Gurmu for their brotherly advice on my thesis work and personal life throughout the two academic years of the program.

I would like to express heartfelt thanks to Tsega Gashu,Colonel Tadege Yehuala and Dereje Hailemariam for their indispensable moral and material support from the beginning until the end of the thesis. Heartfelt thanks also go to my sister Genet Tesfaye for her priceless psychological appreciations and support throughout my study.

I am indebted to my respondents / sources of information /rural communities of the study areas for their time to respond to my questioner and cooperation for all my questions and their hospitality while I was collecting information who made this paper come to an end and north Showa zone agriculture and rural development, education bureau, special thanks to, Ato Siyoum Nigussie for his positive thinking and willingness to accommodate and help individuals who are working research in the zone.

It might be unusual to extend thanks for individuals who delay someone feat; God changed their barrier and made me to be stronger in my careers as well as in pursing my further study. Therefore, my heartfelt thanks go to my former bosses, Ato Tadesse Hailu.

Table of contents

Chapter six

List of Table

List of Figures

Abstract

The study assessed the rural communities' perception about climate change and their attitudes towards livelihood adaptation strategies in Ware Jarso district, north Showa zone of Oromia regional government. A total of 139 farmers were surveyed for the study with the structured questionnaire, scheduled interview and focus group discussion.

The assessment of the rural communities' perception about the impacts /consequence/ of climate variability and change in the study area shows that all of the rural communities have been perceived the loss of agriculture production. The majority perceive water shortage for; household consumption, small scale irrigation and animal to drink, incidences of communicable human, animal and plant diseases, increasing the number of people in need of food aid, increases the requirement of fertilizers, frequent occurrences of drought and famine, seasonal migration of people, and desertification were responded by 98.6 %, 92.8%, 88.4%, 82.6%, 79.7%, 72.5% and 68.1% respectively.

The findings of rural communities' perception and attitude towards livelihood adaptation strategies indicate that all of the respondents were perceived the building water harvesting scheme, to store water during rainy season for dry season in ponds, and implementing the multi use of water from one source (water recycling) for different purpose, example, for their cattle, irrigation and Cultivating crops that can resist drought, diseases and have short harvesting season, Different planting dates, Shifting from subsistent rain fed agriculture to small scale market oriented irrigation, Growing commercial crops and vegetables under irrigation, Pooling of resources through societies, safety net and social grants from government, Use of inter-household transfers and loans and increasing petty commodity production , Mixed cropping and crop diversification, Reduction of consumption amount and frequency of agricultural products, 95.7%,95.7 %,88.4 %,84.1 %,81.2 %,79.7 %, and 76.8 % respectively .

The survey showed that the respondents have positive attitude towards livelihood adaptation strategies and there is a significant association between age, education and perception in the causes and consequences of climate change and the preferences and uses of the livelihood adaptation strategies.

Based on the findings of this study, it is recommended that there is a need of modifying educational/training programs which was provided for the rural communities by considering the existing knowledge and practices in the particular areas and providing of energy which it's by products can substitute's chemical fertilizer and will minimize the rural communities' expenditure.

LIST OF ABBREVIATIONS AND ACRONYMS

A.D	Anno Domini
B.C	Before birth of Jesus Christ
CDM	Clean Development Mechanisms
CLICO-	Climate Change,Hydro-confilit and Human Security
CVC-	Climate Variability and Change
DAs	Development Agents
DPPC	Disaster Prevention and Preparedness Commission
GDP	Gross Domestic Product
GHG	Greenhouses Gases
GWP	Global Warming Potential
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
LHASs	Livelihood Adaptation Strategies
MME	Ministry of Mining and Energy
M-	Meters
mm	mill meters
MoFED	Ministry of Finance and Economic Development
MoWE	Ministry of Water and Energy
NAPA	National Adaptation Programme of Action
NMSA	National Meteorological Service Agency
NSPEDD	North Showa Zone Planning and Economic Development Department
NPDPM	National Policy for Disaster Prevention and Preparedness Management
SSA -	sub-Saharan Africa
UNFCCC	United Nations Framework Convention on Climate Change
TV-	Tele Vision
UNEP-	United Nations Environmental Policy
UNMDGs	United Nations Millennium Development Goals
WB-	World Bank

CHAPTER ONE

INTRODUCTION

1.1. Back ground of the study

There are now strong evidences, which show that the earth's climate is changing mainly as a result of the increasing concentration of greenhouse gases in the atmosphere that are emitted from various human activities. 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 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.

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). Many research findings indicated that climate change have significant impacts on many parts of the world (Kurukulasuriya and Rosenthal, 2003). African countries like Ethiopia are prone to greater impacts of climate change and variability. This is due to their low adaptive capacity and high sensitivity of their socio-economic systems to climate variability and change (Olsen, 2006; Kurukulasuriya and Rosenthal, 2003). Sensitivity and adaptive capacity also vary between sectors and geographic locations, time and social, economic and environmental considerations within a country (IPCC, 2007a). However, Africa's, total contribution to emissions of greenhouse gases is less than 7% of the world's greenhouse emissions.

Developing countries are particularly at risk as their economies are highly dependent on agriculture and have fewer resources and options to combat damage from climate change and variability. Hundreds of millions of people in developing nations will face natural disasters, water shortage and hunger due to the effects of climate variability. Extreme weather events are likely to become more intense and more frequent, while higher global temperatures could affect crops and water supplies and spread disease. Adopting land

use practices in agriculture such as conservation agriculture would help to maintain significant amounts of carbon in the soil (FAO, 2007).

Ethiopia is one of the developing countries, which are more vulnerable to climate variability and change (FAO, 2007). Low level of socio-economic development, inadequate infrastructure ,lack of institutional capacity ,a higher dependency on natural resources base make the country more vulnerable climatic factors including climate variability and extreme climate events(Agrawala and Fankhauser, 2008)

Agriculture is the sector most affected by changes in climate patterns and will be increasingly vulnerable in the future (WB, nd). Abnormal changes in temperature and rainfall, and the increasing frequency and intensity of droughts and floods have long-term implications for the viability and productivity of world agro-ecosystems (FAO, 2007). Water resources, agriculture, natural resources and biodiversity, human and animal health (vector-borne diseases) are the most sensitive and highly at risk to climate variability in Ethiopia (Haakansson, 2009).

Current climate variability is imposing a significant challenge to Ethiopia by affecting food security, water and energy supply, poverty reduction and sustainable development efforts, as well as by causing natural resource degradation and natural disasters. The impacts of past droughts such as that of the 1972/73, 1984 and 2002/03 are still fresh in the memories of many Ethiopians (Pankhurst, 1985). Floods in 2006 caused substantial human life and property loss in many parts of the country. These challenges are likely to be exacerbated by anthropogenic climate change (Haakansson, 2009). In this context, planning and implementing climate change adaptation polices, measures and strategies in Ethiopia will be necessary.

1.2. Statement of the problem

Climate change is defining human development challenges of the 21st century. Responding to those challenges start and then reverse international efforts to reduce poverty. The poorest countries and the most vulnerable citizens will suffer the earliest and most damaging setbacks, even though they have contributed the least to the

problem. Looking in future, no country however wealthy or powerful will be immune to the impact of global warming. The economic activities of these countries are mostly primary as it is the most vulnerable to the problem of climate change and variability (CLICO, 2011).

Higher temperature and changing precipitation levels caused by climate change will depress crop yields. This is particularly true in low-income countries, where adaptive capacities are perceived to be low (Haakansson, 2009). Many African countries including Ethiopia which have largely based on weather-sensitive economic activities are highly vulnerable to climate change. This vulnerability has been demonstrated by the devastating effects of recent flooding and the various prolonged droughts and too late or early rainy season of the twentieth century. Thus, for many poor countries that are highly vulnerable, understanding farmers' responses to climatic variations and climate changes are crucial in designing appropriate coping strategies (Yesuf *et al*., 2008).

A number of countries in sub-Saharan Africa (SSA) already experience considerable water stress as a result of insufficient and unreliable rainfall, changing rainfall patterns or flooding. The impacts of climate change – including predicted increases in extremes are likely to add to this stress, leading to additional pressure on water availability, accessibility, supply and demand. For east African countries like; Djibouti, Eritrea, Kenya, Somalia and Ethiopia is estimated that 25% of the population currently experience water stress, with more countries expected to face high risks in the future (CLICO, 2011).

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. 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 (Pankhurst, 1985). 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

(Pankhurst, 1992). 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).

The expansion of agriculture usually takes place as the expense of the natural vegetation, particularly forests, wood lands and other wild life resources leading to the loss of both fauna and flora and ultimately destruction of habitats as a whole. Some wild relatives of cultivated crops are also threatened by such habitat destruction. The rate of deforestation due to mainly agricultural expansion and fuel wood gathering is remarkably high .this process as immense impacts on biodiversity and finally leads to desertification which is a manifestation of climate change and variability (Fischer *et al*., 2005; Shah *et al*., 2008). More than any other sectors, an improvement in agricultural performance have the potential to increase rural incomes and purchasing power for large number of people to lift them out of poverty and increases rural communities' capacity to adapt climate change and variability (Nhemachena and Hassan, 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)

The flood related consequences of climate change may be as serious and widely distributed as the adverse impacts of droughts and there is more evidence now that flooding is likely to become a larger problem in many regions, requiring adaptations not only to droughts and chronic water shortages, but also to floods and associated damages, raising concerns about dam and levee failure The Intergovernmental Panel on Climate Change concluded (IPCC, 2007a)

Ethiopian agriculture is not highly productive in general. Its improvement is constrained mainly because of climatic factors and soil and land degradation

(Haakansson, 2009). 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 (Fistum *et al*., 2002). 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).

Apart from these constraints, the history of drought is as old as the country itself. From the first century A.D. up to 1500 A.D, there were 177 droughts (famines) which killed millions of people and between 1500 A.D. and 1950, 69 drought events occurred (Pankhurst, 1985). Ethiopia has also suffered from extremes of climate, manifested in the form of frequent drought (1965, 1974, 1983, 1984, 1987, 1990, 1991, 1999, 2000, and 2002) along with recent flooding of 1997 and 2006 (Yesuf *et al*., 2008). These are because of the country's prominent location in the Sahel Region, a region with erratic rainfall and unpredictable climate variability.

Ethiopia enjoys extremely varied climatic conditions with an extensive altitude range that is suitable for different agricultural production systems. Taking the two extreme altitudes, temperature range from the mean annual of 34.5 ^{0}C in the Danakil Depression, while minimum temperatures fall below zero, with a mean of less than 0 ^{0}C, in the upper reaches of mount Ras Degen (4620m), where light snowfalls are recorded in most years. Between these extremes are vast areas of plateau and marginal slopes where mean annual temperatures are between 10 ^{0}C and 20 ^{0}C. Climatic elements are affected by altitude and geographical location. The rainfall is correlated with altitude.

The middle and higher altitudes (above 1500m) receive considerably greater rainfalls than do the lowlands, except the lowlands in the west, where rainfall is high. In the lowlands (below 1500m) rainfall is erratic and averages below 600mm. There is strong inter-annual variability of rainfall all over the country. Despite variable rainfall, which

makes agricultural planning difficult, a substantial proportion of the country gets enough rain for rain fed crop production under the normal circumstances but the drought and rainy seasons are fluctuating for and back due to climate change and variability (Dinar *et al.,* 2008).

One main feature of climate change adaptation at local level is its attempt to increase the resilience of populations to climate-related hazards. This means assessing the populations at risk of water, food, health and pasture insecurity. Risk is determined by, first, the external hazard and, second, the characteristics of the population that increase or decrease their susceptibility to the harm caused by the hazard. Adaptation to climate change impacts should not be approached as a separate activity, isolated from other environmental and socio-economic concerns that also impact on the development opportunities of poor people (CLICO, 2011). In countries where the majority of poor people depend on agricultural income proposed climate change adaptation strategies centre around increasing agricultural productivity and making agriculture, including livestock, fishery and forestry, less vulnerable to climate stress and shocks.

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 change with respect to the perception of rural communities towards climate variability and livelihood adaptation strategies. 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 assesses communities' perception toward climate variability change and livelihood adaptation strategies in Wore Jarso district. 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 communities' toward climate change variability and livelihood adaptation strategies were forwarded.

1.3. Objectives of the study

The general objective of the study is to assess climate change, variability and adaptation perception of rural communities of Wore Jarso district. The specific objectives are to:

1. Identify communities' perception on the climate Variability and change.
2. Assess local coping and adaptation strategies on climate variability and change in 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 change and variability and adaptation mechanisms.

1.4. Research questions

1. How are the rural communities' perceptions on climate change and variability in the study area?
2. What are the local coping and adaptation strategies on climate change and 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?

1.5. The Variables

1.5.1. 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.

1.5.2. 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 was measured as actual years of the household head attained.
2. Educational level was ordered 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) print media (newspaper, magazines) schools, special trainings in soil and water conservation, peer groups relatives and friends, access to road ,town/market and household income.

1.6. Conceptual framework

Rural communities' perception about climate change, variability and adaptation mechanisms practices are 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.

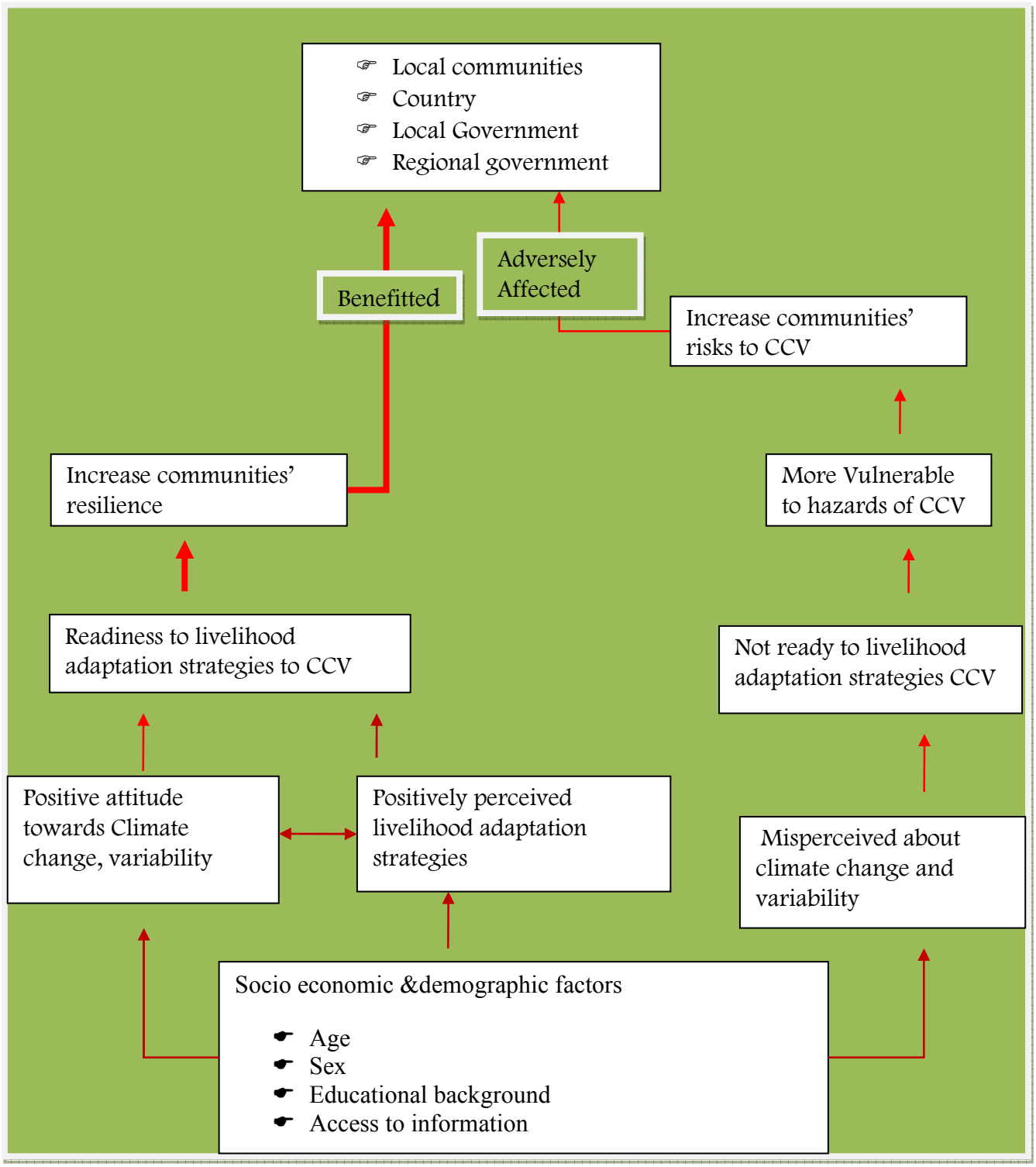


Figure 1: The conceptual frame work for the study of rural communities' perception towards climate change and variability and adaptation mechanisms in relation to socio economic and demographic characteristics. (Developed by the Author from the review of literature)

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).

- Socio-economic and demographic characteristics
- Educational background
- Available institutions with degree of capacity
- Access to different means of communication
- Indigenous traditions, culture and belief
- Sectors and people at risk
- Frequency of extreme events
- Causes and impacts of CV
- Available resources
- Knowledge level
- Level of political stability

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 rural 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 rural communities' perception towards climate change and/or variability, and livelihood adaptation strategies practiced at local level i.e. district and to assess some of the factors that determine rural communities' perception towards climate change and variability and adaptation mechanisms. There are a number of factors that affect rural communities' 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 was confined to relatively very large geographical area within which no the same research had been surveyed in Were Jarso district of north Showa 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).

Obviously, 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 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. The weather determines whether they will have enough to eat, be able to provide basic necessities, and be able to earn a living. Indeed, farmers' dependence on rainfall and its erratic patterns have largely contributed to the food shortages and crises with which they constantly battle.

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 .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 according to some sources (UNEP, 2006).

In countries like Ethiopia, whereby more than 85% of the people depend mainly on agriculture for their livelihoods, rendering them very vulnerable to climate variability and change. 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).

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. 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).

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 Daniel (2008), 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 'belg'. The belg 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. As indicated in Figure 2.1, 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.

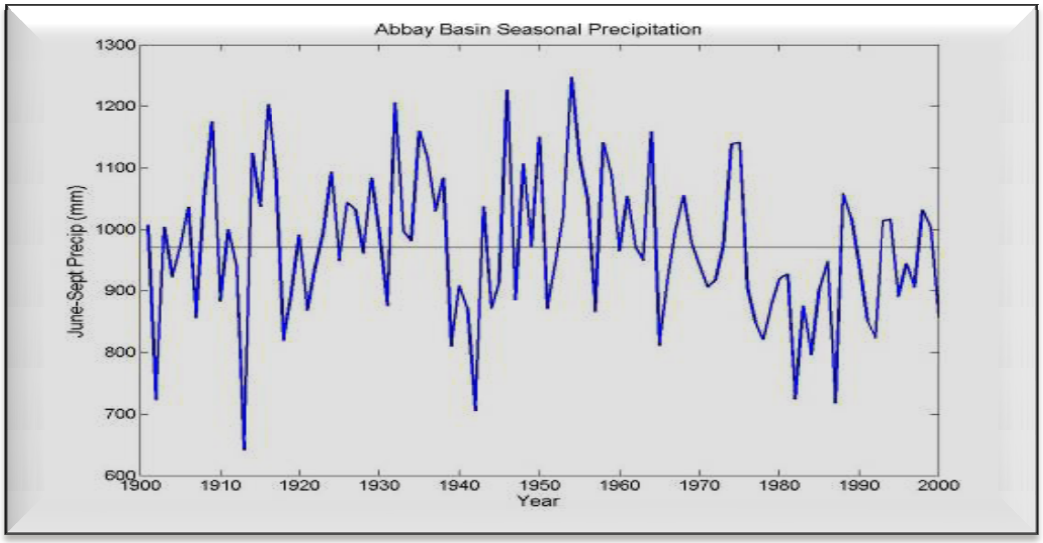


Fig.2.1 Abay basin seasonal rainfall distribution
Source: *NMSA, 2007*

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%.

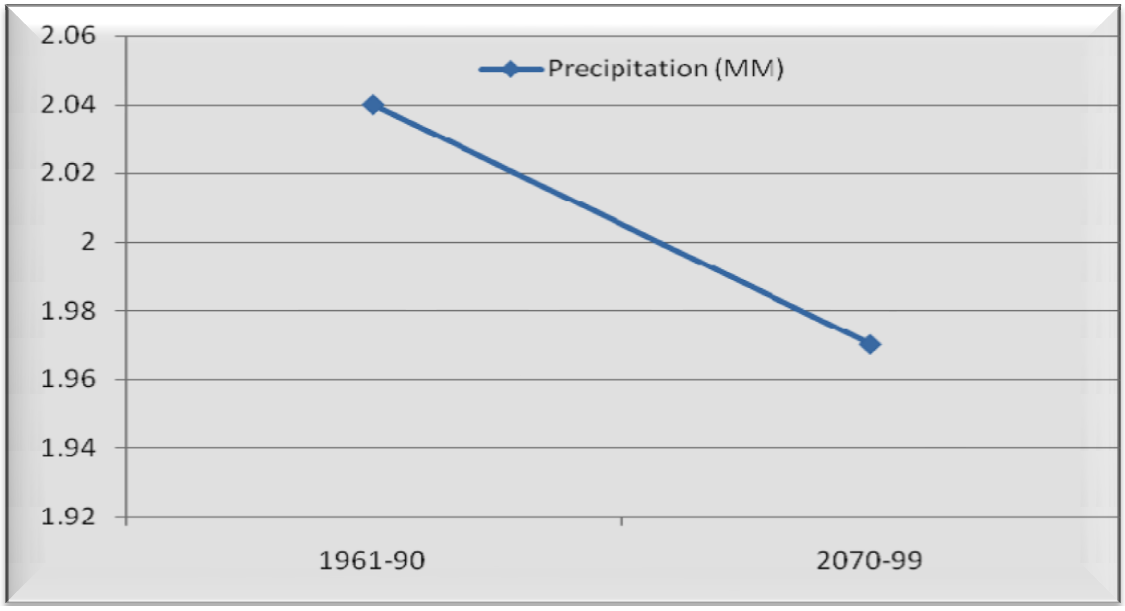


Fig.2.2 Precipitation rate in mm
Source: Developed from WB, 2010

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 Belg (February-May) season.

Belg rainfall in the east and southeast exhibit the largest percent reductions. Declines in Belg 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 Belg 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 'Belg '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).

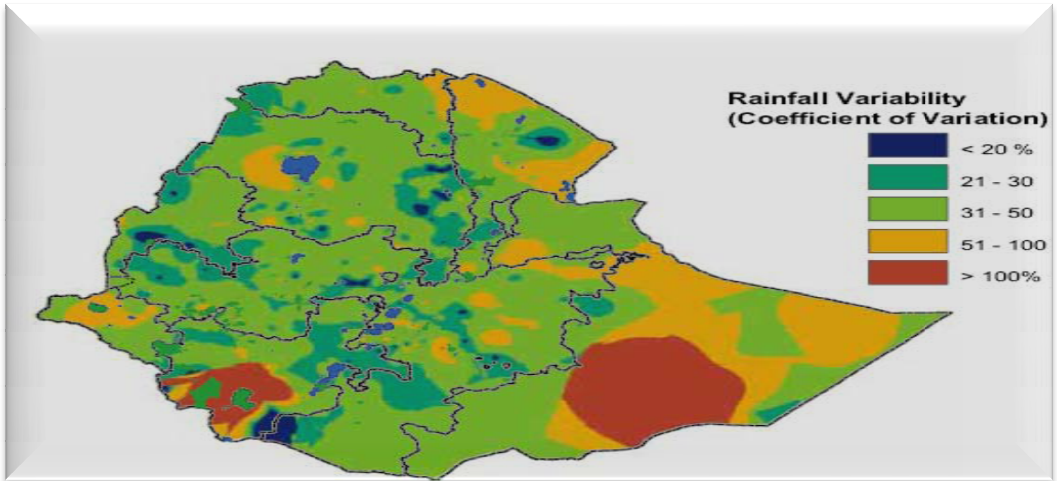


Fig.2.3 Rainfall variability measured by the coefficient of variation
Source . *NMSA, 2007*

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 and the Wabe Shebelle. There are twelve reservoirs. Most rivers flowing from these reservoirs cross borders. According to Daniel (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.

2.3.2. 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).

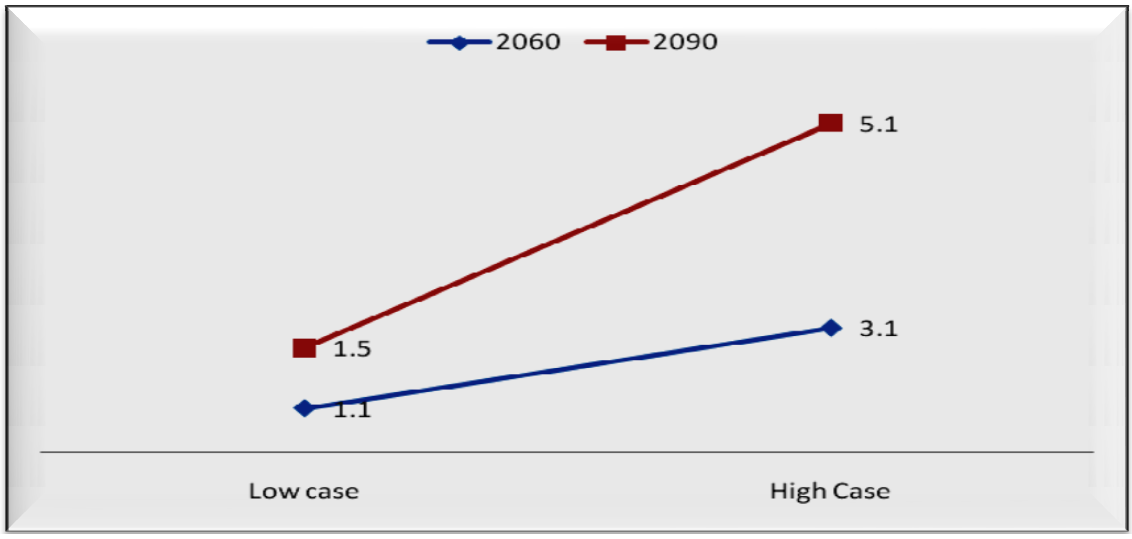


Fig.2.4. Trends of temperature in Ethiopia
Source: WB, 2010

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 (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)

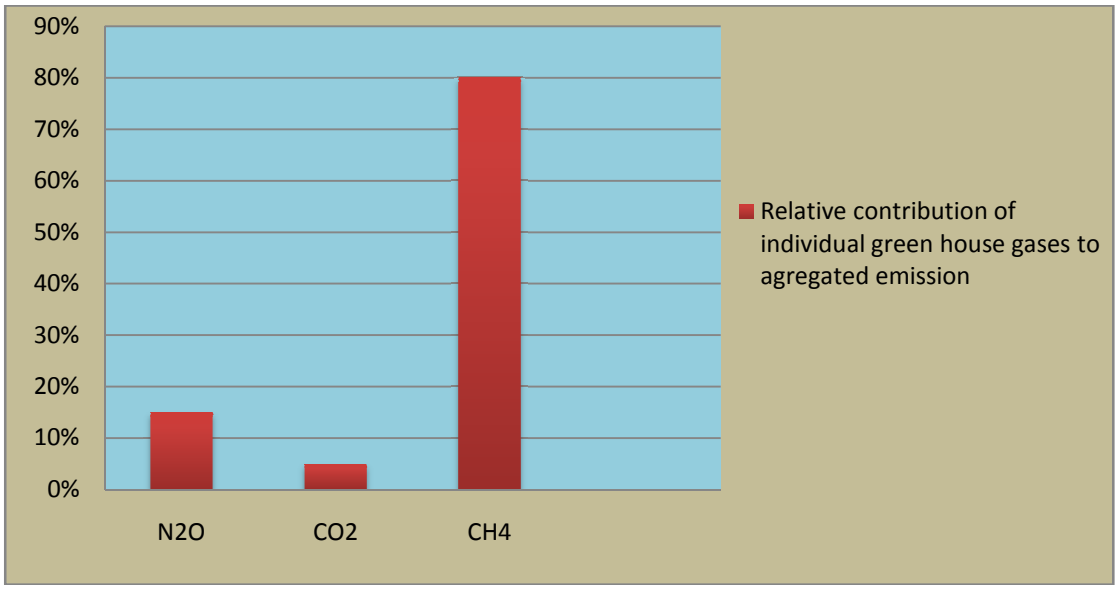


Fig.2.5. Relative contribution of individual GHG to aggregated emission in 1994 (FIST, 2001)
Source: Ministry of mining and energy, 2007

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, CO_2 have increased by 24%while emission of CH_4 and N_2O 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.

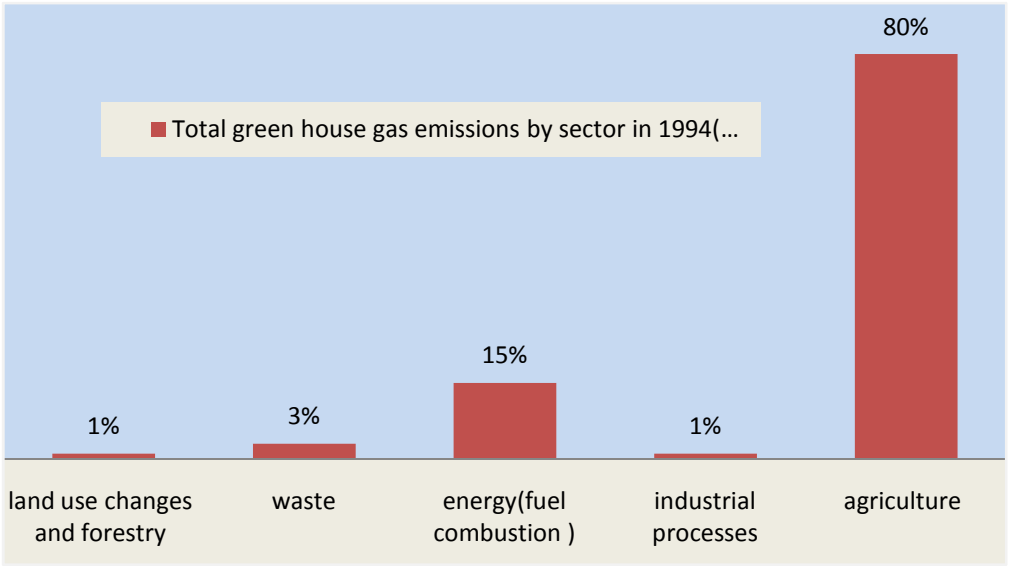


Fig.2.6 Total GHG emission by sector in 1994 (FIST, 2001)
Sources: Ministry of Mining and Energy, 2007

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).

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, and Mebratu, 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. 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 (Yohannes and Mebratu, 2009).

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).

Hazard	People affected	Years
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

Top 10 Disasters in Ethiopia, 1999-2009
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, and Mebratu, 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 (Haakansson, 2009). In other words,

adaptation to climatic variability is a way of life and nothing new to Ethiopians (Yohannes and Mebratu, 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 and Mebratu, 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 (Haakansson, 2009).

Detrimental and beneficial impacts of the ongoing and projected climate change and 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. Ethiopia 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 led 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)stream.

CHAPTER THREE

Description of the study area and research methodology

3.1. Description of the study area

3.1.1. Location

Ware Jarso district is found in the North Showa zone of Oromia Region. It is absolutely located between $9^{0}47^{'}$ to $10^{0}11^{'}$ North Latitude and $38^{0}27^{'}$ to $38^{0}43^{'}$ East Longitude (fig 3.1). It is bounded by East Gojjam Zone in the North West, Kuyu and Hidebu Abote district as in the south and Southeast, Dera district in the east and West Showa zone in the south west.

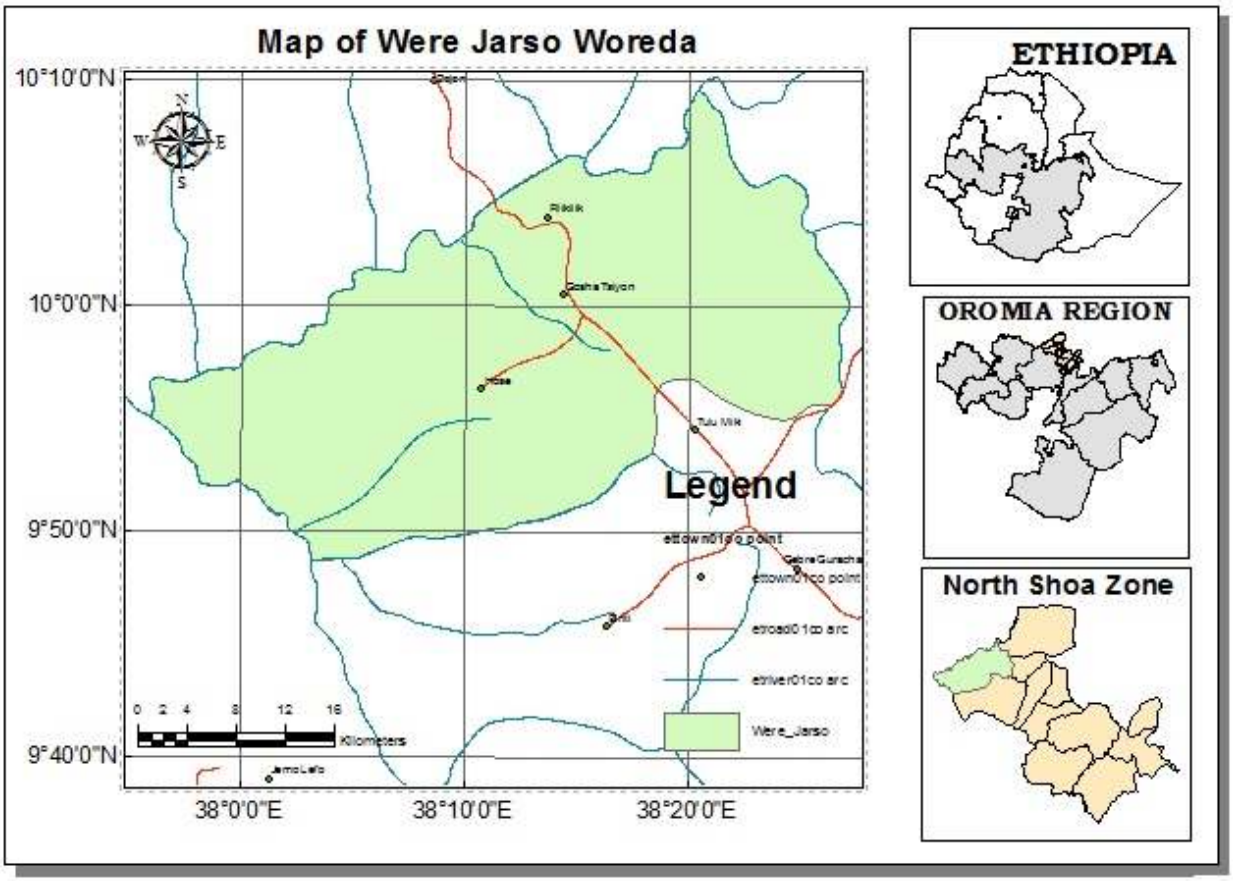


Fig.3.1 map of the study area

The study area spans over a total area of about 1198.35 sq. km and inhabited by 158,813 people with crude density of 132.5 persons per sq. km. with varied topographic features, rugged and undulating areas representing about 70%and flat plains 30%. Agro-Ecologically, the district is subdivided in to kola (49.5%), woina dega (43.4%) and dega (7.3%).

Gohatsion town is the capital of Ware Jarso district found at 185 kms away from Addis Ababa (in the North West direction) on the main road from Addis Ababa to Bahr Dar and at 73 kms away from the zonal capital, Fiche.

3.1.2. Topography

The nature of topography of a particular geographic entity has multi dimensional implications up on the development of physical infrastructure, human way of life and the type of flora and fauna exists.

Ware Jarso district is by large falls within the central highlands and in fact yet large portion of it lies within the Abay gorge physiographic regions. The map obtained from North Showa Zone Planning and Economic Development Department (NSPEDD, 2001) reveals that the elevation of the study area ranges between 800 and 2,500 meters above sea level. Consequently the elevation difference in the study area is about 1,700 meters that demonstrate the existence of varied agro climatic zones. This also creates the opportunity to have a varied flora and fauna. On the other side, however, the ruggedness of the terrain has adverse impacts on the cost incurred for the development undertaking infrastructure such as irrigation and using underground water for agricultural activities and mechanized farming particularly in the kola agro-climatic zones.

3.1.3. Climate

Climate is one of the elements of the physical environment which has a pronounced impact on settlement pattern, human way of life, the type of the soil, flora and fauna existed and/or developed so forth. Among different climatic elements temperature and rainfall have a considerable impact in such an agrarian country like Ethiopia and more actually in the area under study.

The temperature distribution of the study area is mainly a reflection of elevation. Accordingly, the study area comprises varied thermal zones ranging from ‘kolla’ (Tropical) to ‘dega’. According to Daniel (1977), the study area falls within the rain fall regime IA characterized by one of the rainy season, i.e. the rainy months stretching

from March to October. The district receives a mean annual rainfall varying from 801-1000mm in the western parts to 1001-1200mm in the central and northern parts.

3.2. Type and source of data

Mainly the data for this study came from both the primary and secondary sources. The researcher conducted the primary data collection. In this research, rural communities were the major sources of primary data. In order to ensure the reliability and validity of the data collected, triangulation of different methods were 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 was also collected from zonal and district agricultural experts, Kebele leaders, soil and water conservation supervisors and DAs.

The primary data obtained from the fieldwork was also 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, 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 .

3.3. Determination of sample size

Prior to determining sample size of the study, all Kebeles were 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/gots/ was selected from each slope category.

Accordingly, one village /got/ from dega, three villages/got/ from woina dega and two villages/gots/ from kola were selected for the study. Record of total households living

in the study villages was obtained from the three Kebele administrations. There were about 881 household heads residing in the study area. Out of 881 household heads, 143, 510 and 228 household heads were residing in dega, woina dega and Kola agro-climate zones respectively. Eventually, the total sample size was determined using the following formula (Cochran,in Belayneh,2005).

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

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. Accordingly, 23, 80 and 36 household heads were selected from dega,woina dega and kola agro climatic zones respectively. Respondents in the study were household heads and in cases where household heads were missing, randomly selected household heads were substituted for the missing household heads.

Table 3.1 The Sampling distribution of the household heads in the three RKAs

Agro climatic-zones	Name of Kebeles	**Total house holds**		**Sample house holds**	
		Frequency	Percentage	Frequency	Percentage
Dega	Jamo berdada	143	16.23	23	16.55
Woina Dega	Haro Michael	216	24.52	34	24.46
	Abu keku	172	19.52	27	19.44
	Faji Ejersa	122	13.85	19	13.66
Kola	Kola jamo Gedera	105	11.92	17	12.23
	Kola Mojo	123	13.96	19	13.66
Total		881	100	139	100

Source: - Field survey, Ware Jarso district, March (2012)

3.4. Methods of data collection

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

3.4.1. Field observation and informal interview

Field observation was 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 were 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 was conducted for the purpose of obtaining information for developing completely structured questionnaire which is the main tool of collection of information needed. It was conducted in an informal manner and in a relaxed setting while attempting to center the issue the researcher attempts to attain.

3.4.2. Structured interview

This was the most important tool of data collection in this research. On the bases of information obtained from techniques discussed above and literatures, questionnaire was developed. The questionnaires were administered by high university graduate enumerators. As the rural communities in the area were bilingual, speaking both Amharic and Afaan Oromo, enumerators and those who have experience on data enumerating and know the area well were recruited for the enumeration. Prior to implementing the survey, the questionnaire was used to brief enumerators and tested for their clarity. Questioners that were found not to be clear to the local people and enumerators during training and testing were modified. Amendments were also incorporated into the questionnaire so as to make the idea easily comprehendible to the interviewees and enumerators. The survey questionnaire covered a wide range of information which included household characteristics, farming system and asset endowment and policy issues and farm orientation from six Kebeles of Jamo Berdada, Haro Michael, Abu keku, Faji Ejersa, kola Jamo Gedera and kola Mojo.

During data collection using structured interviews, attempt was made to make the course of interview more effective through two ways conversation. This was made in order to make the informants feel free, confident to express their feeling and give genuine information. Furthermore it allowed them to ask questions. Finally, the responses of the interviews fitted to possible lists of alternative answers, which were worked out carefully during the prior test of the questionnaire on the fieldwork.

3.4.3 Administration of the questionnaire

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

3.5. Method of data analysis

The data collected from structured interview was analyzed using excel and statistical package for social science version 20 (IBM SPSS, 2010).

The data were summarized and analyzed employing different methods. For descriptive part of the research percentages and mean value were used. Pearson correlation was used to measure the strength of linear association between dependent (the rural communities' perception and attitude about climate variability and change and the independent variables (different age groups, educational background). A significance tests were 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 change and variability and livelihood adaptation strategies. The significance is determined at P-value less than 0.05 or 0.01.

CHAPTER FOUR

Data presentation and analysis

4.1. Demographic and socio-economic characteristics of the respondents

Fig 4.1 shows the demographic and socio-economic characteristics of the respondents. The results indicate that about 87.05 percent of the respondents were males and females accounts for about 13 percent.

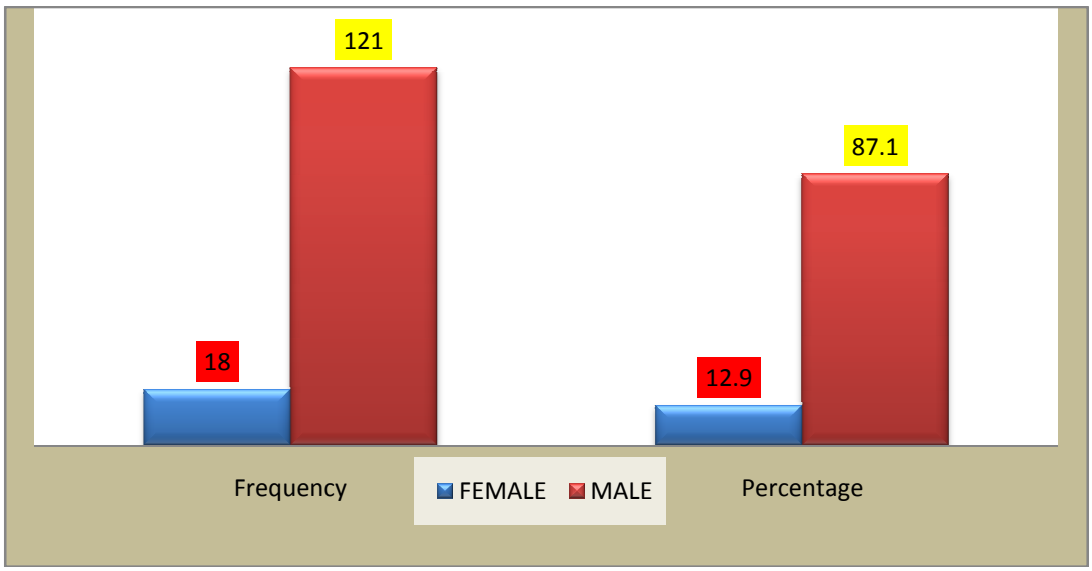
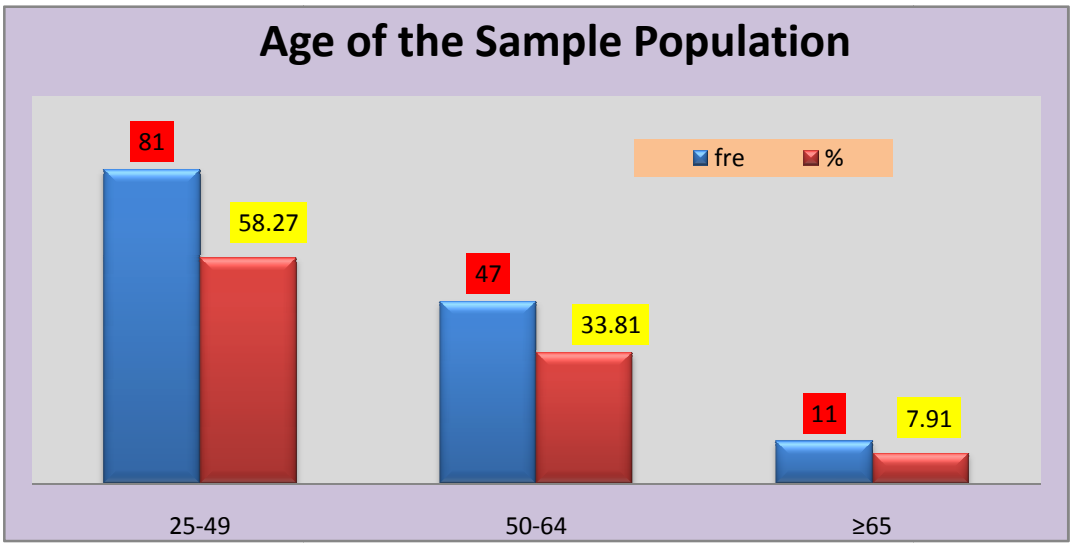


Fig: 4.1 Sex proportion of the house holds

Source: - Field Survey (2012)

Fig 4.2 shows distribution of the respondent, households' heads age . Percent distributions about 58.3% were in the age range of 25-49 while about 34% were between 50 and 64 years. The rest (about 8%) were aging beyond 65 years. The median age of the households' heads was about 45 years. This is middle and young adulthood age .Therefore; many of them seem amenable to changes and education of the rural communities in the study area. The implication could be that climate variability and change adaptation mechanisms would be high as agricultural activities are left in the hands of the younger groups who are more active and change agent. The age is also an incentive for a long lasting development of sustainable local practices has been experienced to mitigate and adapt climate variability and change in the area of study.

Fig.4.2 Percentage distribution of Age of the House holds



Source:- Field Survey (2012)

It is also evident from fig 4.3 that majority (87.1%) of the respondents were married while 9.4% and 1.4% were divorced and widowed respectively. This agrees with the findings of Soyebo *et al.,* (2005) that agriculture is very much practiced by married people to make ends meet and cater for their children

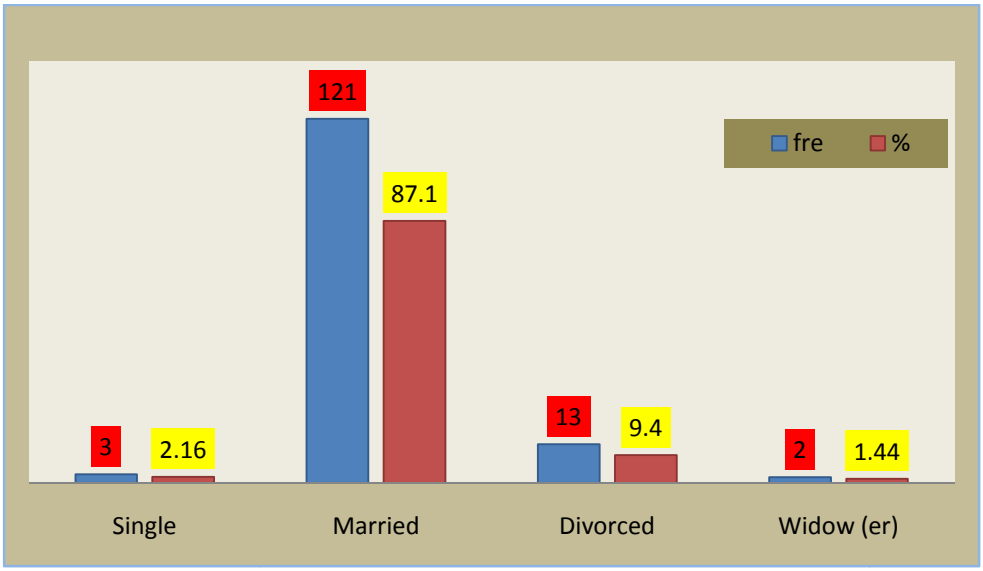


Fig.4.3 Marital status of house holds

Source: - Field Survey (2012)

Regarding with educational qualification, a high proportion of the respondents, 76.2 % had completed one form of formal schooling and the rest 23.8 percent had no formal

schooling (fig 4.4). Since adequate education enhances farmers' level of adaptation mechanisms. It is, therefore, expected that the farmers would be inclined to the sustainable climate variability and/or change adaptation mechanisms experienced in the study area.

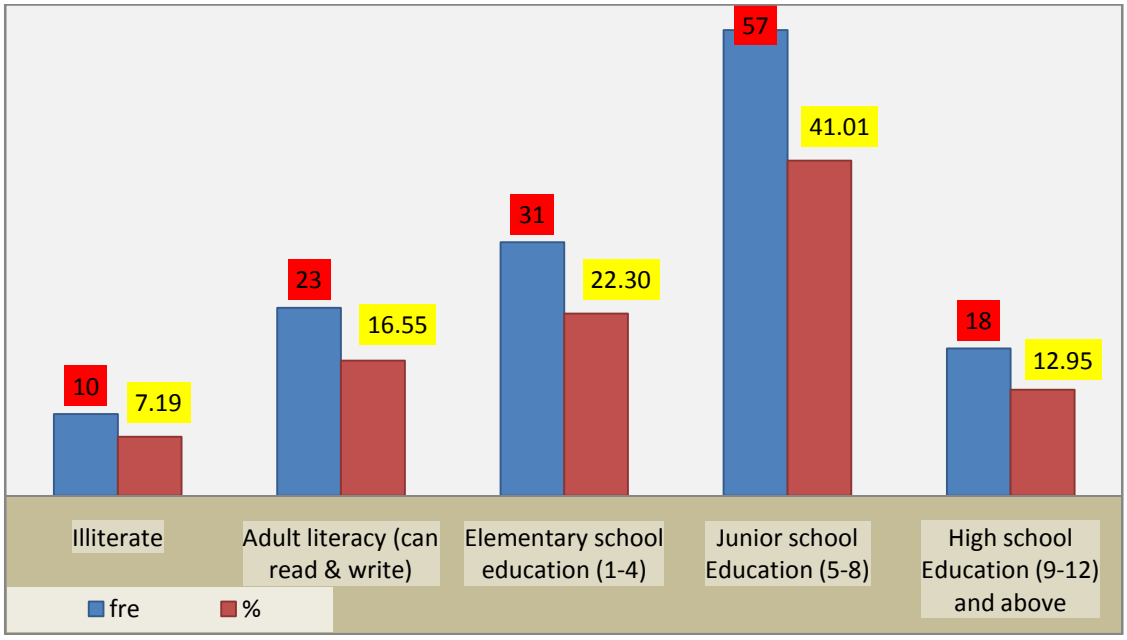


Fig.4.4 Percentage distribution 0f the households by educational background
Source: - *Field Survey (2012)*

The result also shows that average land holding size per household was 0.94 hectare. But about 31 % of the households have had land holdings less than 0.5 hectare and about 45 % had land holding less than a hectare (fig 4.5). Thus, most of them are small-scale farmers. Moreover, the land is fragmented into a number of small separate plots, often located at distant from each other. Hence land holdings are both small scale in size which make them less economically viable ,and fragmented here and there which can adversely affect agricultural performance and land management because travel to and from home requires longer time and effort to exercise different climate variability and change adaptation mechanisms.

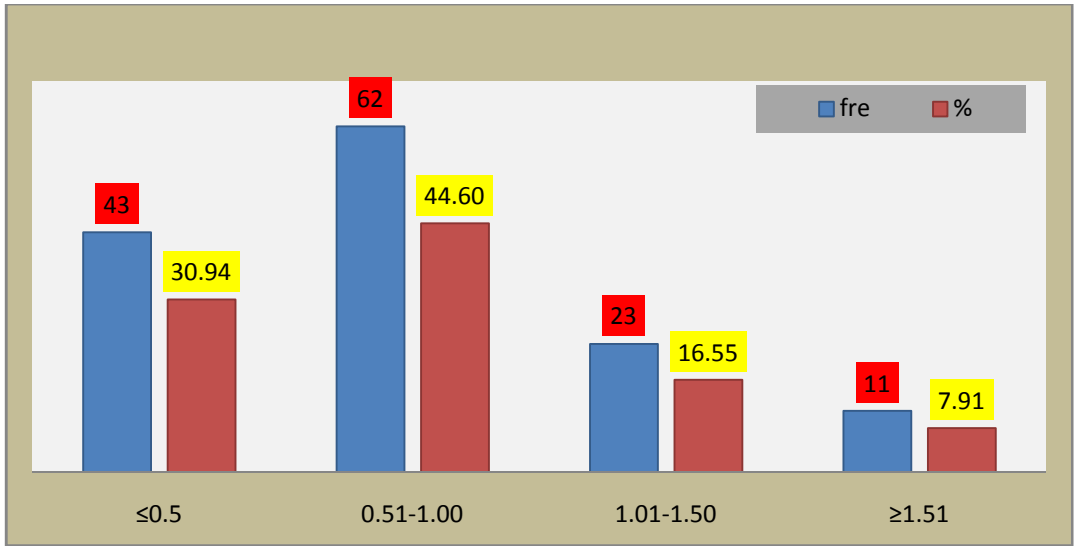


Fig 4.5 Percentage distribution of farm land holding size in hectare of the house holds
Source field survey (2012)

4.2. Perception on the causes of climate change

Fig 4.6 shows respondents' perception of the causes for CV and CC. The result indicates that all of the respondents perceived that human interaction with his/her natural surroundings and God's Allah's /punishments against human action /violence of the laws of the bible/Quran / have been the causes of climate variability and change. The majority of the farmers, (64.0%) responded the causes are due to human beings miss use of environment as a result of overpopulation CVC is natural phenomena /natural arrangement/ that might occur once in human life span (15.1%), it is the combined effects of human action and natural arrangement (11.1%) and CV and CC is God's punishment against human action (9.4%).

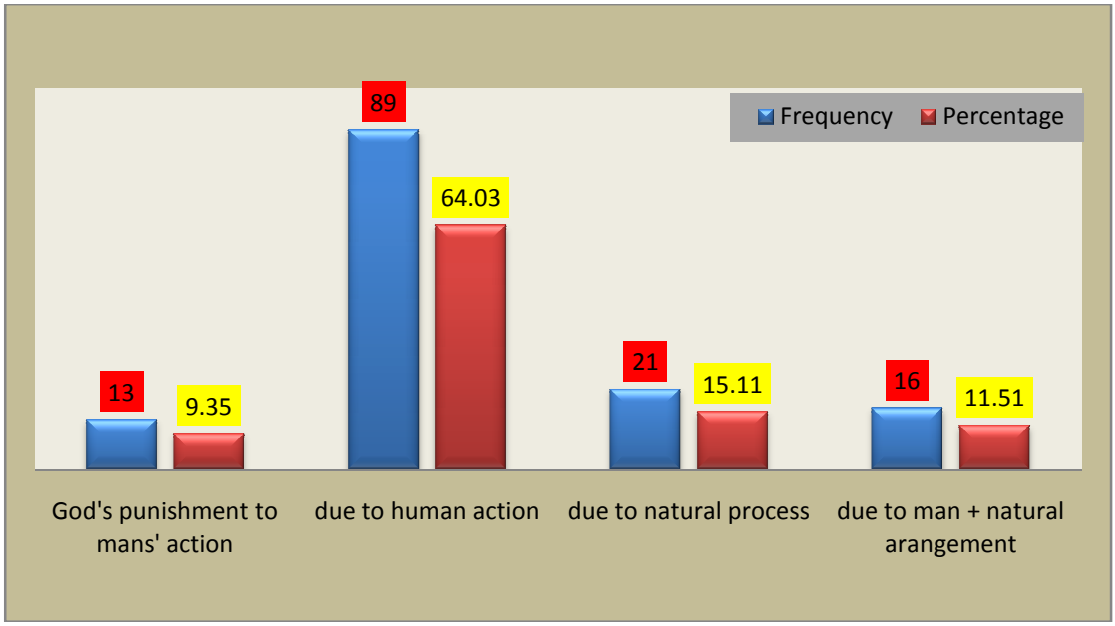


Fig 4.6 Percentage Distribution of Respondents perception on Causes of CV and or CC
Source field survey (2012)

4.3. Perception on the consequences of climate change

Table 4.1 Shows the respondents' perception about the consequences of climate variability and changes in their surroundings. The results indicate that all of the respondents were aware of loss of agricultural productivity results from land degradation. The majority of the respondents perceived an increase in the loss of agricultural production/crop cultivation/ (99.28 percent), frequent occurrences of drought and famine (89.93 percent) and loss of forest lands (66.91 percent), loss in livestock productivity/death of live stocks (100.00 percent), increase the requirement for fertilizers (97.84 percent), seasonal migration people (70.50 percent) and increasing the number of people in need of food aid (93. 53 percent).

Shortage of water for, household consumption, small scale irrigation and their animal to drink, desertification, drought and strong winds are also perceived by 93.53 percent, 69.06 percent, 67.63 percent and 66.19 percent of the respondents as a consequence of climate variability and change, respectively.

Nevertheless, conflict over common resources such as grazing land and water, loss of forest land and incidences of wild forest fire were not almost perceived by most of the

respondents as it results from climate variability and or climate change, this could be due to the fact that the area is less covered by forests.

Consequences of CVC	Perceived		Not Perceived	
	FERQ	%	FERQ	%
Increasing in animal death /loss in livestock productivity	139	100	0	0
Loss of agricultural production/crop cultivation/	138	99.28	1	0.72
Increase the requirement for fertilizers	136	97.84	6	4.32
Water shortage for ; household consumption, small scale irrigation and animal to drink	130	93.53	9	6.47
Increasing the number of people in need of food aid	130	93.53	9	6.47
Desertification and Frequent occurrences of drought and famine	125	89.93	14	10.07
Seasonal migration of people	98	70.5	41	29.5
Strong winds	92	66.19	47	33.81
Incidences of wild forest fire	12	8.63	127	91.37
Conflict over resources/grazing land and water/	9	6.47	130	93.53
Loss of forest lands	3	2.16	136	97.84

Table 4.1 Percentage Distribution of Respondents Perception about the Consequence of CVC
Source: field survey (2012)

4.4. Perception towards indicators of climate variability and climate change

4.4.1. Rainfall and temperature amount

Fig 4.7 shows distribution of the respondents' perception towards indicators of climate variability and change. The result indicates that about 66.19 % of the respondents agreed that there is change in rainfall distribution and the amount has decreased and there is an increase in daily temperature is an indicator of CV and or CC. About 20.86 % and 12.95 % increase in daily temperature and rainfall amount are perceived as indicators of CV and or CC respectively. This may implies that the rural communities of the study area are aware of the main indicators of climate variability and change in terms of fluctuation of rainy period and increases in temperature amount.

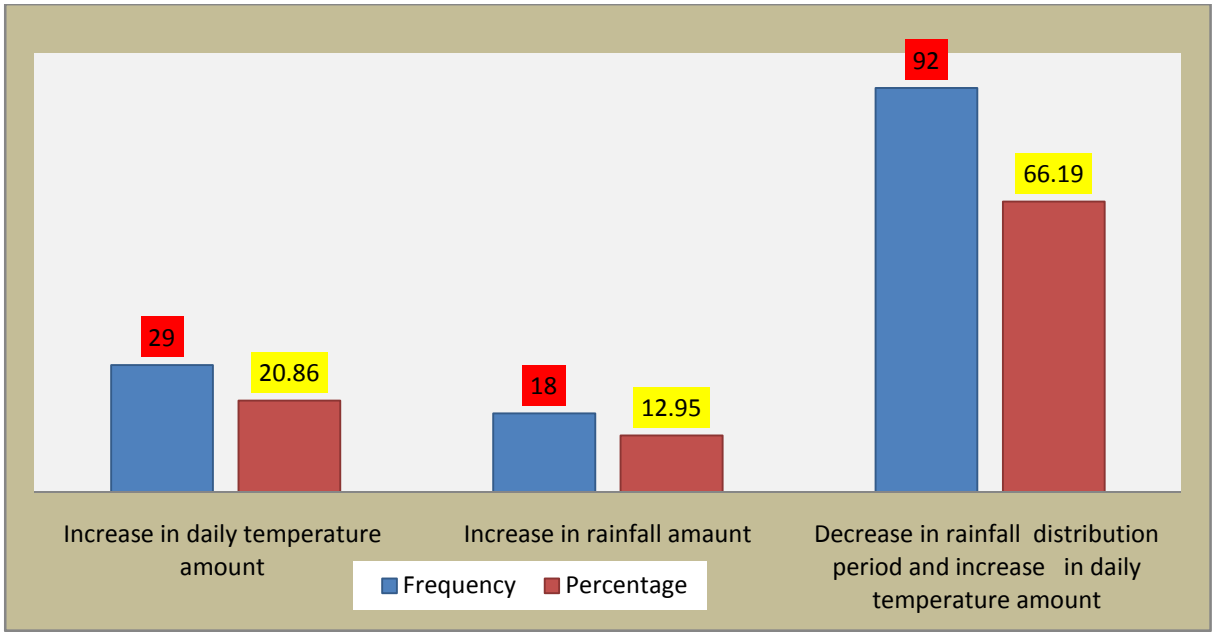


Fig 4.7 Percentage distribution of the households' perception of indicators of CVC
Source: field survey 2012

4.4.2. Temporal distribution pattern of rainfall

Fig 4.8 shows distribution of the respondents' perception towards indicators of climate variability and change. The result indicates that about 38.9 % of the respondents told that rain period starts late and stops early .Hence ,they can dived this as manifestation of climate variability and change. Meanwhile, 32.4 % and 20.1 % of the respondents reported that the rainfall distribution pattern is unpredictable, long dry period of time in a year (absence of rain fall for long period of time) respectively and only 8.6 % household responded that the rainfall has normal distribution pattern.

Hence climate variability and change is a clear, sustained changes (over decades or longer) in the components of climate such as temperature, precipitation, atmospheric pressure or winds either due to natural variability or as a result of human activity . The responses of the rural communities (see fig. 4.8) of the study area have some sort of understanding and awareness as to pattern the seasonal distribution of rainfall is the result or indicator of climate variability and change. This is different from the local drought that may occur within four to seven years interval.

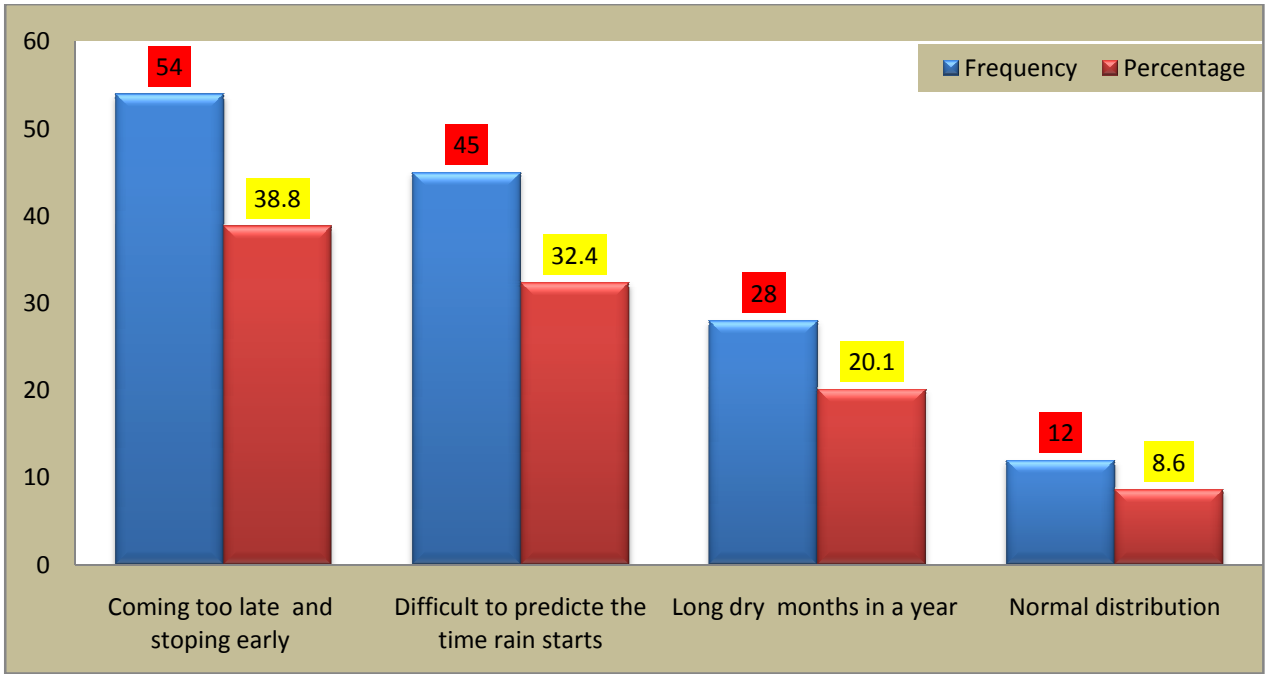


Fig 4.8 Percentage distribution of the households' perception temporal distribution of rainfall as an indicator of climate variability and change
Source field survey (2012)

4.4.3. Water volume and surface water cycle

Climate change will lead to an intensification of the global hydrological cycle and can have major impacts on regional resources. A change in the water volume and distribution of water will have effect both on ground and surface water supply for domestic uses, irrigation, hydropower generation and stream system. Figure 4.9 shows distribution of the respondents' perception on surface water cycle and water volume. The change of marshy/swampy areas to dry land, the extinctions or complete dried up of water springs existing in their areas for long time, the rapid evaporation of surface water and high fluctuation of water volume in water bodies (rivers, streams) are perceived as an indicators of climate variability and change in the study area by 49.64 %, 32.37 %, 12.95 % and 5.05 % of respondents respectively.

This implies that the rural communities have awareness and perception of streams and wetlands are influenced by climate change through altered temperature, flow regime and water level and volume in the rivers, streams wetlands, springs and surface water.

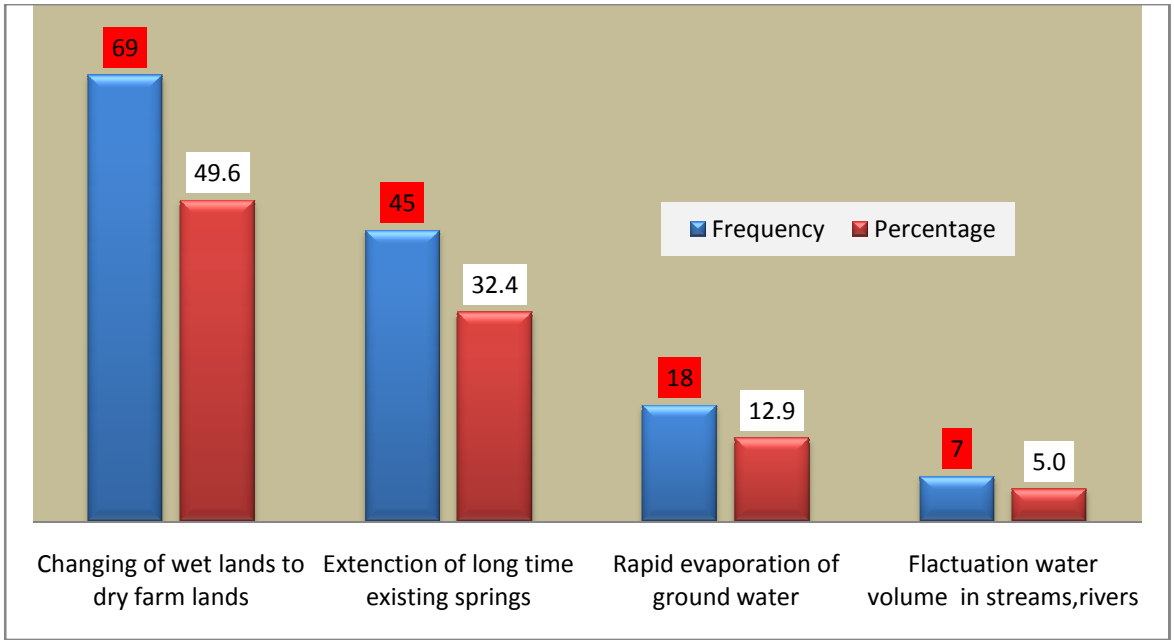


Fig 4.9 Percentage distribution of the households' perception of water volume and water cycle

Source: field survey (2012)

4.4.4. Communities' perception on the impacts of temporal distribution pattern of rainfall and water volume fluctuation.

A reduction of water availability especially in extensive drought –prone areas, would sharpen competition among uses, including agriculture and wetland ecosystem needs. More frequent occurrence high rainfall amount may enhance ground water recharge, but it may also increase the impacts of flooding, landslides and erosion with flood prone areas are exposed to high loss of animal and human life and financial loss hence the rain is coming after long dry period of time in a year. Heat stress can affect human comfort levels, and possible spread of water and vector –borne diseases after the rainfall.

According to the rural communities' responses shown in figure 4.10 illustrates that the temporal and spatial distribution pattern of rainfall could lead to the fluctuation of both ground and surface water volume which had adverse impacts on the community. Accordingly, drought and famines, shortage of pasture, incidence of both plants and animal communicable diseases, increase in the death of animal specially cattle, seasonal migration of people and flooding are supported by 100.00 %, 95.68% ,93.53%,76.26%,73.38% and 69.78% of the rural communities.

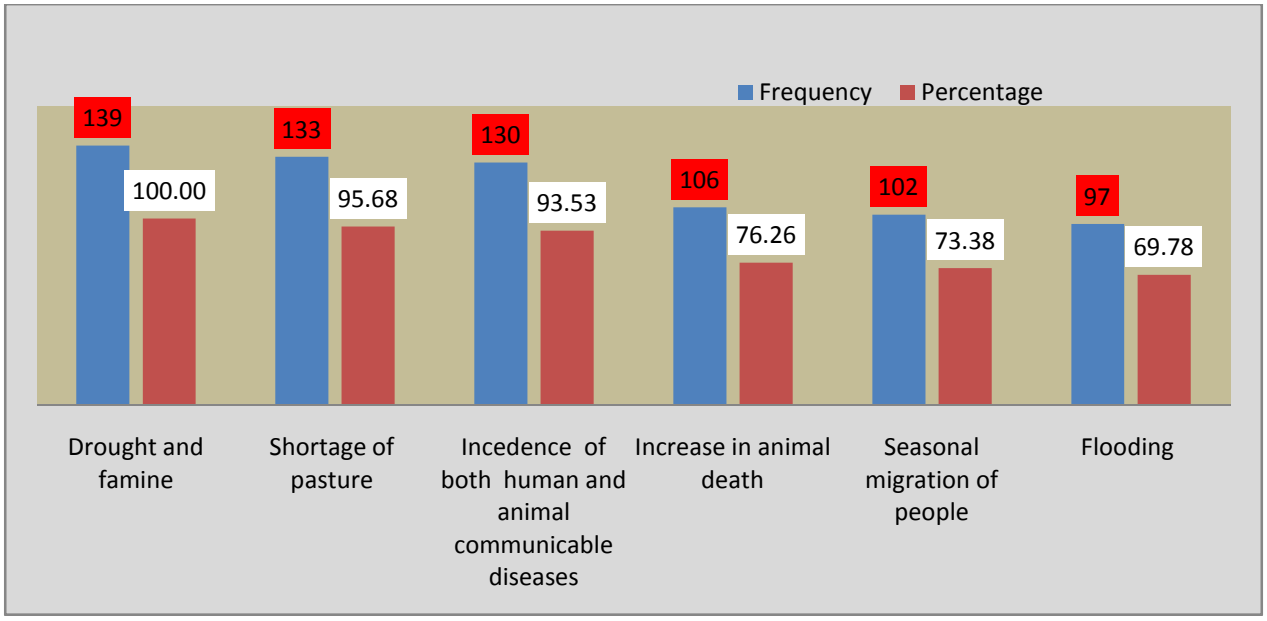


Figure 4.10 Percentage distribution of the households' perception on different indicators of CVC
Source: *field survey 2012*

Increase in flow variability, particularly the frequency and duration of large floods and long droughts would tend to reduce water quality and accessibility, biological productivity and habitat in the areas and led to drought and famine that would resulted in the seasonal migration of productive people in need of income generating jobs to support their family at home.

The old aged group ≥ 46 years old strongly agreed and reported that "when we compare the situation today with the past, the climate has changed. This area was very productive in the past. Climate change has affected our areas, community and family for the last six/nine years". In order to survive, the households have had to sell everything they owned. Today people have left the area to find work elsewhere because "We have not been able to save any of our food for the bad times because we never have any food to spare," said the old aged respondents.

4.5 Perception on the livelihood adaptation strategies

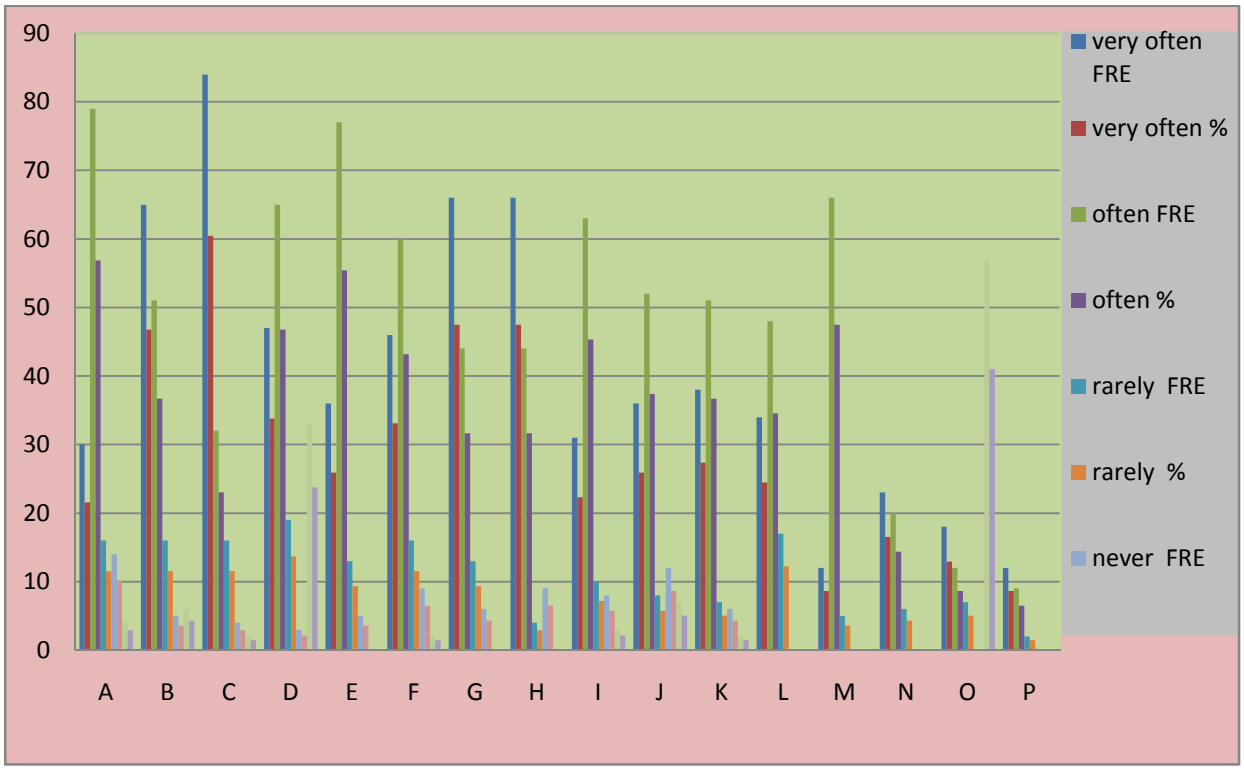


Figure 4.11 shows the respondents perception of CVC livelihood adaptation strategies.
Source: field survey 2012 Likert-type scale: - 4-Very often 3-Often 2-Rarely 1-Never

The result indicates that all the respondents' were perceive of selling assets such as livestock and agricultural tools in order to buy food whereas build water harvesting scheme that is collecting water during rainy season for the coming dry season in ponds, and implementing multiple use of water from single source (water recycling) for different purpose ,e.g., for cattle, irrigation and other purposes, cultivating crops that can resist drought, diseases and have short harvesting season, shifting from subsistent rain fed agriculture to small scale market oriented irrigation, Growing commercial crops and vegetables under irrigation where perceived grain storage and mortgaging of land by 98.6 %, 97.8%, 96.4 %and 94.2 % of respondents respectively. Furthermore, other livelihood adaptation strategies such as mixed cropping and crop diversification, reduction of consumption amount and frequency of agricultural products ,pooling of resources through societies, safety net and social grants from government ,change amount of land under cultivation or grazing, buy feed supplements, different planting dates, temporary and permanent migration in search of employment, use of inter-household transfers and loans and in ceasing petty commodity production , collection of wild foods and

involving in non agricultural activities were also the livelihood adaptation strategies perceived by 92.8 % , 88.5 %, 80.6 %, 77.7 %, 73.4%, 71.2%, 59.7 %, 35.3 %, 26.6 % and 16.5 % of respondents of the rural communities .

4.6. Farmers' sources of information on livelihood adaptation strategies.

Figure 4.12 shows information sources of the respondents on livelihood adaptation strategies. The result shows that development agents (DAs) were indicated by almost all (97.12%) of the respondents as a most important source of information.

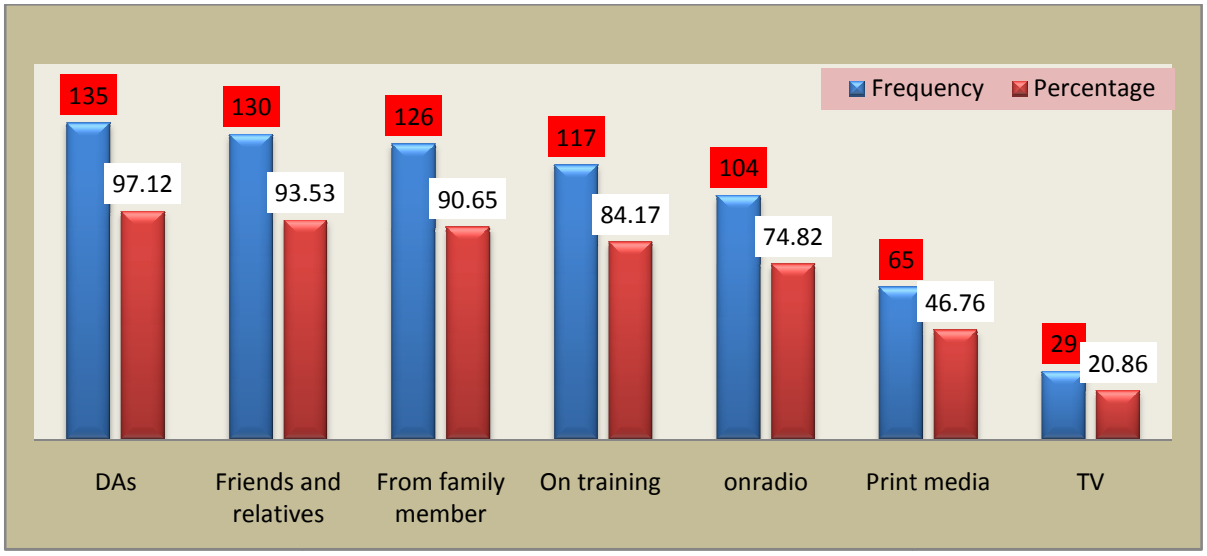


Fig 4.12 Percentage distribution of the households' sources of information
Source: field survey 2012

About 93.53 % of the respondents used their friends and relatives as a source. While a significant number of the respondents (90.65%) use family members as a source of information and 84.17 % respondents' source of information was the training given on the environmental protection and drainage development, for 74.82% of respondents radio was also their main source of information. However, small numbers of the respondents indicated print media and television as a source of information which accounted for 46.76%, 20.86 % respectively.

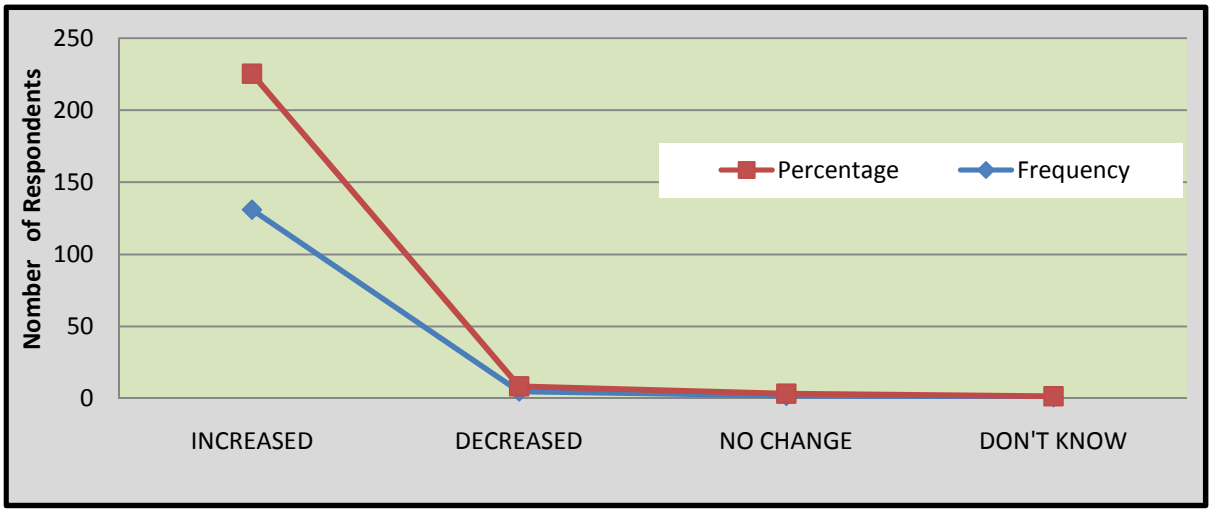
4.7. Assessing communities' perceptions on climate variability and change

4.7.1. Comparison between communities' perceptions on climate change and meteorological data

To assess the rural communities' perceptions of climate change and variability, analyses was priory made on how the climate data recorded at meteorological station evolved (trends and variability) and how farmers perceived these changes. Tests were undertaken for linear trend in annual means and seasonal means of temperature, and total annual and seasonal rainfall both at the district level. Descriptive statistics based on summary counts of the questionnaire structure were used to provide insights into producers' perceptions of climate change and variability. In the literature several studies have undergone the same type of analysis.

4.7.2. Temperature changes

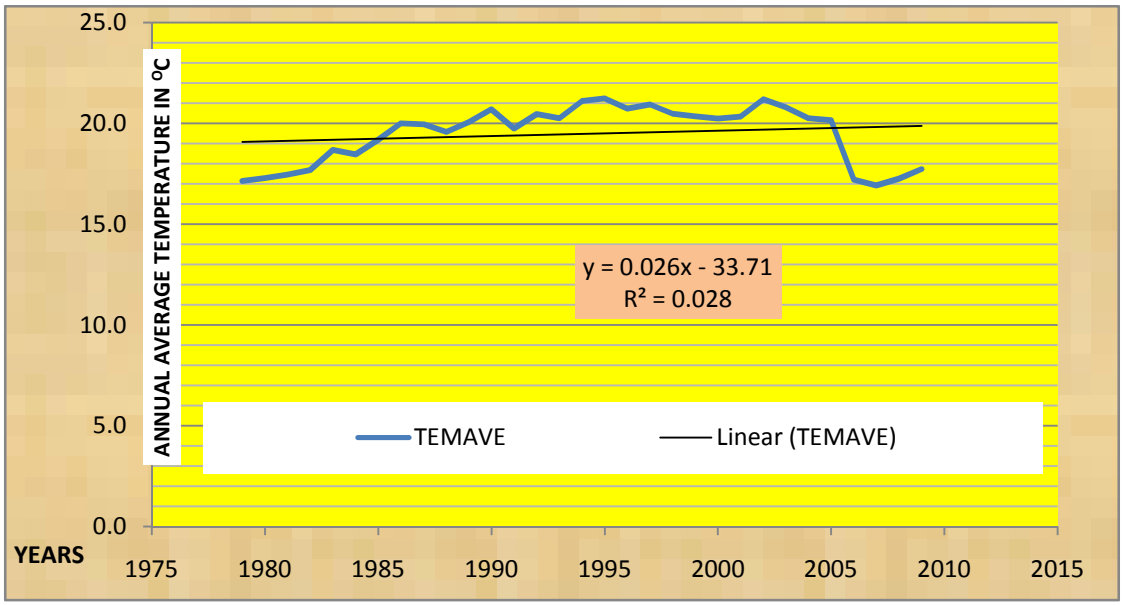
About 94.24 % of the rural communities interviewed perceived long-term changes in temperature. Most of them 87.05 % perceive the temperature has been increasing. Only 3.6% noticed the contrary, a decrease in temperature and 1.44 **%**, of them has not noticed any changes in the temperature.



(Figure 4.13) Percentage distribution of households' perception of temperature change
Source: field survey 2012

The national meteorology service agency statistical record of temperature of the woreda between 1979 and 2009 shows slight increasing trend with an increase mostly in the autumn and winter. In the last 30 years, the temperature has risen by about 1 degree

Celsius. An analysis at the provincial level shows the same general trend of increasing temperature.

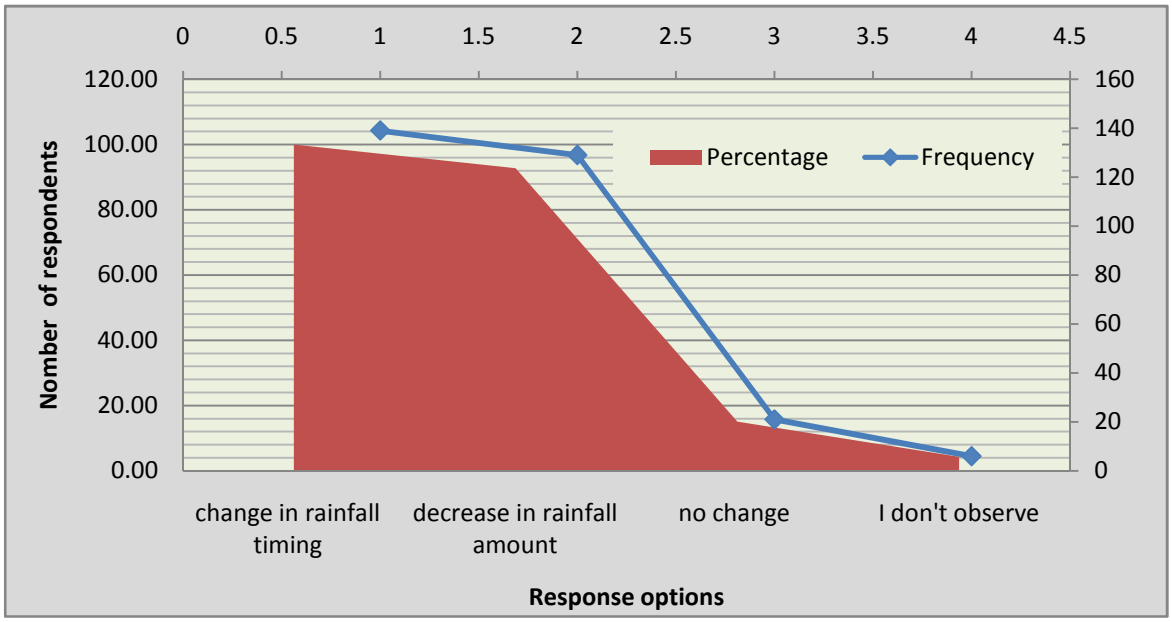


(Figure 4.14) Trends of annual average temperature distribution

Source: computed from NMAS data (1979-2009) Ware Jarso district annual average temperature.

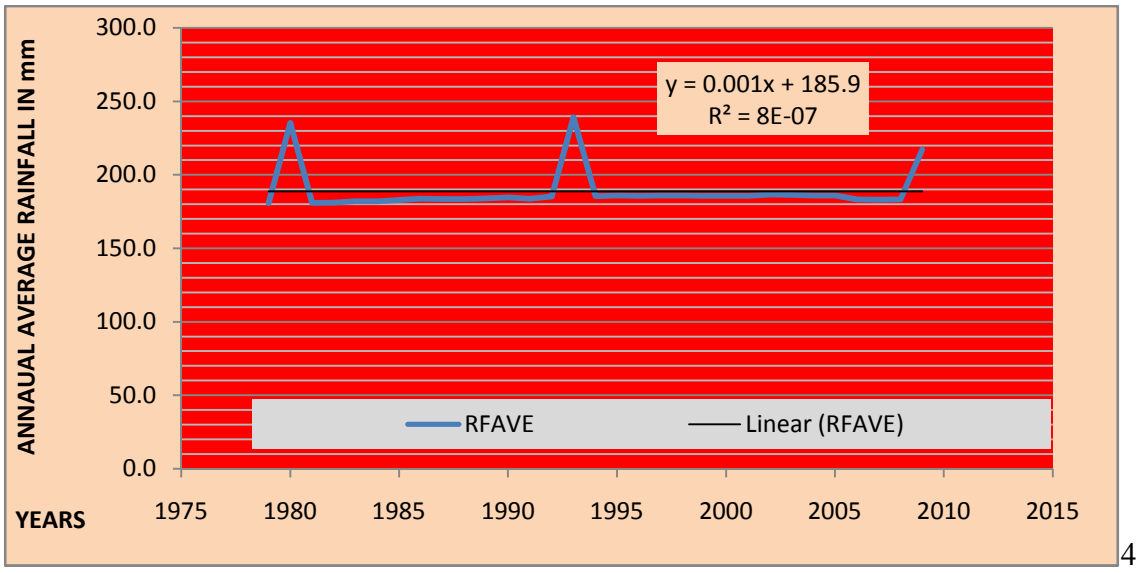
4.7.3. Changes in precipitation

In total, all of the respondents observed changes in rainfall patterns over the past two decade, and 92% noticed a change not only in the total amount of rainfall but in the timing of the rains, with rains coming either earlier or later than expected about 15.11% noted decrease in the amount of rainfall or a shorter rainy season. Almost 5 % of the informants noticed a no change in the total amount of rainfall.



(Figure4.15). percentage distribution of households' perception of raifall change
Sources: field survey (2012)

Many respondents observed that the main rainfall season of, which is kiremt, is coming late and is also lasting shorter. A change in the timing of rainfall was mentioned by national meteorological service agency.



4

Figure 4.16 Annual average rainfall distributions of Ware Jarso district
Source: Computed from NMAS data (1979-2009)

CHAPTER FIVE

Factors affecting communities' perception towards climate variability, change and livelihood adaptation strategies

5.1. Age and perception

In many studies it was observed that age of respondents had a direct association with the awareness of climate variability and change. Young farmers of age 25 to 45 were found relatively better aware about the causes of climate variability and change than the old age (≥46) rural communities.

5.1.1. Relationship between respondents' age and perception about causes of climate variability and change

Table 5.1 shows that among young farmers' all young rural communities , 95.65 %, 88.41%, 85.51%,79.71% reported that they are perceived climate variability and change caused by human action , deforestation ,due to both natural and human action on their environment ,emission of carbon dioxide from industries , Over population , respectively. But relatively small 13.04% of young population perceived that climate variability can be caused due to God's punishment against human wrong actions. On the other hand, old age group (≥46) farmers who accounted for 92.86 % is due to human activities, 87.14% deforestation, it is due to natural process 80.00 % ,74.29 %, due to both natural and human action on their environment, 70.00 % is God's punishment against human wrong actions, and 64.29% argued that climate change and variability is caused due to over population. But God's punishment against human wrong actions and the natural occurrence of climate change and variability indicated by old age respondents in higher percentage than their counter part young farmers.

Table 5.1 Chi-square Distribution of Respondents' in their Age and Perception about the Causes of climate change

Causes of climate variability and change	AGE CATEGORIES				Chi-square	P-value
	25-45		≥46			
	FREQ	%	FREQ	%		
Due to man's action	69	100.00	65	92.86	0.0000	1.0000*
Deforestation	66	95.65	61	87.14	2.1812	0.1397*
Due to both natural and mans' action	61	88.41	52	74.29	9.6736	0.0019**
Emission of co_2,cars,industries	59	85.51	39	55.71	1.9726	0.1602*
It is natural process	36	52.17	56	80.00	1.7544	0.1853*
Over population	55	79.71	45	64.29	12.9305	0.0003**
God's punishment	9	13.04	49	70.00	24.5608	0.0001**

Source:-Field Survey (20112) * statistically not significant ** statistically significant

5.1.2 Relationship between respondents age and perception on the impacts of climate change and variability

Increasing in animal death, loss agricultural production, livestock production and crop cultivation/was indicated by all of the respondents in different age groups. While young age groups of 25 to 45 respondents' seems better in their perception than old age (≥46) in indicating the consequence of land degradation. Among young respondents, which accounted 97.7 percent of them told (increasing the requirement for fertilizers), 98.6 percent Water shortage for; household consumption, small scale irrigation and animal to drink, 92.8 percent reported the increase in the frequency of incidences of communicable human, animal and plant diseases, 88.4 percent perceived the increase in number of people in need of food aid, increase the requirement for fertilizers 82.6 percent and frequent occurrences of drought and famine was reported by 79.8 percent of the rural communities as the consequences of climate variability and change Seasonal migration of people was also perceived by 72.5 percent .

Table 5.2 Chi-square Distribution of Respondents' in their age and perception about the Consequences of climate variability and change.

Consequences of climate variability and change	Age categories				Chi-square	P-value
	25-45		≥46			
	FREQ	%	FREQ	%		
Increasing in animal death ,loss in livestock productivity	69	100.0	70	100.0	0.000	1.000*
Loss of crop production	69	100.0	69	98.6	11.2017	0.0008**
Water shortage	68	98.6	67	95.7	0.5101	0.0476*
Incidences of communicable human, animal and plant diseases	64	92.8	64	91.4	12.3023	0.0005**
Increasing the number of people in need of food aid	61	88.4	61	87.1	3.9663	0.4804*
Increase the requirement for fertilizers	57	82.6	60	85.7	0.0679	0.0464**
Frequent occurrences of drought and famine	55	79.7	66	94.3	0.431	0.6047*
Seasonal migration of people	50	72.5	63	90.0	0.4925	0.5030*
Desertification	47	68.1	61	87.1	0.3671	0.6068*
Conflict over resources/*grazing land and water/*	26	37.7	47	67.1	0.0012	0.9887*
Loss of forest lands	14	20.3	35	50.0	1.3321	0.1957*

Source:-Field Survey (20112) *statistically not significant ** statistically significant

Very small proportion 20.3% but most importantly young age group had less perceived the loss of forest land as a consequence of climate change and variability. A significant association was found between age and perception in issues related to climate variability and change impacts. A significant association means that young age farmers are better aware of the causes and the consequence of climate variability and change.

5.1.3. Relationship between respondents' age and perception on the livelihood adaptation strategies.

Table 5.3 Chi-square distribution of respondent's by perception about livelihood adaptation strategies .

Livelihood adaptation strategies	Age categories				Chi-square	P-value
	25-45		≥46			
	FREQ	%	FREQ	%		
Build water harvesting scheme	69	100.0	70	100.0	0.0000	1.0000*
Cultivating crops have short harvesting season	69	100.0	56	80.0	3.0034	0.1458*
Different planting dates	66	97	44	6.9	4.0572	0.0355**
Shifting from subsistent rain fed agriculture to small scale market oriented irrigation	66	5.7	64	91.4	3.8801	0.0144**
Pooling of resources among societies	58	84.1	21	30.0	5.1531	0.0123**
Use of inter-household transfers and loans	56	81.2	33	47.1	0.8809	0.2404*
Mixed cropping and crop diversification	55	79.7	41	58.6	1.6751	0.0051**
Reduction of consumption amount and frequency	53	78	36	51.4	2.9751	0.0412**
Grain storage and mortgaging of land	53	76.8	24	34.3	0.9896	0.3118*
Change amount of land under cultivation or grazing	51	73.9	44	62.9	4.1974	0.0914**
Selling of assets such as livestock	46	66.7	51	72.9	5.3421	0.0111**
Participating in non agricultural activities	56	81.2	31	44.3	2.8266	0.0371**
Temporary and permanent migration in search of employment	34	49.3	12	17.1	24.5546	0.0001**

***Source**:-Field Survey (20112) * statistically not significant ** statistically significant.*

It shows that young age farmers of age 25 to 45 are better perceive than their counter part in livelihood adaptation strategies. The associations are significant. It implies that the livelihood adaptation strategies would be high, as the rural communities' main activities that is, agricultural activities, are left in the hands of young age communities, farmers who are more active and ready to assimilate new ideas and adopt technologies. The higher youthfulness in an area is an indication of the likely amenability to changes; new technologies and education of the farmers in the study area.

5.2 Educational background and perception

5.2.1. Causes and consequences of climate variability and change

Higher level of education is often hypothesized to increase the probability of adopting new technologies (Wiggins, S. 2006). Indeed, education is expected to increase one's ability to receive, decode, and understand information relevant to making innovative decisions.

Table 5.4 Chi-square Distribution of Respondents' in their level of education and Perception about the Causes of climate change

Causes of climate variability	Educational Qualification						Chi-square	P-value
	No formal educ		Primary educ		Secondary educ			
	FRE	%	FRE	%	FRE	%		
Due to man's action	31	93.94	88	100.0	18	100.0	0.0000	1.0000*
Deforestation	25	75.76	76	86.36	14	77.78	2.4806	0.4030*
Due to both natural and mans' action	16	48.48	45	51.14	17	94.44	9.691	0.0002*
Emission of CO_2 form cars, industries	7	21.21	85	96.59	17	94.44	15.5695	0.0004**
It is natural process	27	81.82	26	29.55	6	33.33	20.3664	0.0001**
Over population	12	36.36	65	73.86	10	55.56	13.514	0.0005**
Allay/God punishment	23	69.70	11	12.50	4	22.22	11.5665	0.0037**

***Source**:-Field Survey (20112) * statistically not significant ** statistically significant.*

Farmers who attend formal education have better perception in the cause and consequence of climate variability and change. The association is significant (Table 5.4 and 5.5). A significant association means that farmers who attend formal schools have had better perception in the cause and consequence of climate variability and change. This finding is supported by the view of Shibru (2003) that education level of farmers has impact on the general awareness of the adverse effect of environmental degradation.

Table 5.5 Chi-square Distribution of Respondents' in their level of education and Perception about the consequences of climate variability change.

Impacts of climate Variability and change	LEVEL OF EDUCATION						Chi-square	P-value
	No formal educ		Primary educ		Secondary educ			
	FRE	%	FRE	%	FRE	%		
Increasing in animal death ,loss in livestock productivity	33	100.0	88	100.0	18	100.0	0.0000	1.0000*
Loss of crop cultivation/ -Water shortage	11	33.3	88	100.0	18	100.0	0.0000	1.0000*
Incidences of communicable diseases	23	69.7	76	86.4	17	94.4	0.809	0.3690*
Increasing the number of people in need of food aid	23	69.7	72	81.8	15	83.3	12.1	0.0015**
Increase the requirement for fertilizers	21	63.6	65	73.9	12	66.7	4.3140	0.0042**
Frequent occurrences of drought and famine	29	87.9	84	95.5	17	94.4	6.8520	0.0070**
Seasonal migration of people	30	90.9	78	88.6	16	88.9	9.1245	0.0030**
Strong winds	25	75.8	45	51.1	13	72.2	1.3420	0.4490*
Conflict over resources	15	45.5	23	26.1	10	55.6	16.315	0.0001**
Loss of forest lands	12	36.4	11	12.5	18	100.0	0.8880	0.5420*
	9	27.3	13	14.8	15	83.3	9.8659	0.0072**

*112) * statistically not significant ** statistically significant*

5.2.2. Livelihood adaptation strategies.

Farmers' ability to perceive climate change is a key precondition for their choice to adapt. These adaptations include practicing shifting cultivation, adopting new crop varieties and modifying grazing patterns. Shifting to high water-use efficient irrigation, adoption of micro-irrigation and rainwater harvesting (Ngigi, 2006) are broad livelihood strategies available for households as adaptive responses. Build water harvesting scheme, to store water during rainy season for dry season, and implementing multi use of water from one source (water recycling) for different purpose, example, for their cattle, irrigation perceived by the entire farmer without considering educational background. While there were differences in percentage distribution among farmers' perceptions on the rest of livelihood adaptation strategies.

Farmers who attend secondary education have perceived than their counter parts. More than 98 % of the respondents who attended secondary school education (9-12) have positive attitude about the livelihood adaptation strategies such as, different planting date, cultivating drought and disease resistant crops that have relatively short harvesting period and shifting from the traditional rain-fed agriculture to small scale market oriented irrigation and engaged in non-farming activities especially after the harvesting season. This implies access to rural services such as extension, credit (loan) and Safety net but it's the only way t hey can survive is perceived by the rural communities as the likelihood adaptation strategies.

Off-farm employments or participating in nonfarm activities are more perceived by farmers attended secondary school that their counter. While off-farm employment may present a constraint to adaptation because it competes for on-farm managerial time (McNamara et al. 1991), the empirical results suggest that off-farm activities increase the likelihood of buying feed supplements for the livestock. This suggests that expanding smallholder farmers' access to off-farm sources of income increases the probability that they will invest in farming activities.

The test result shows that there is significant association. It means that farmers' perception of livelihood adaptation strategies and local adaptation mechanisms increases with attending schools of higher grade level.

Table 5.6 chi-square relationship b/n level of education and uses livelihood adaptation strategies

livelihood adaptation strategies	Level of education						Chi-square	P-value
	No formal educ		*Primary educ*		*Secondary educ*			
	FREQ	%	FREQ	%	FREQ	%		
Build water harvesting scheme	33	100.0	88	100.0	18	100.0	0.0000	1.0000*
Cultivating crops that can resist drought, diseases and have short harvesting season	33	100.0	88	100.0	18	100.0	0.0000	1.0000*
Different planting dates	30	90.9	87	98.9	17	94.4	1.0647	0.5054*
Shifting from subsistent rain fed agriculture to small scale market oriented irrigation	31	93.9	85	96.6	16	88.9	3.8801	0.0144**
Pooling of resource among societies, safety net and social grants from government, free extension service.	9	27.3	87	98.9	18	100.0	5.1531	0.0023**
Use of inter-household transfers and credit services and increasing petty commodity production	12	36.4	85	96.6	15	83.3	0.8809	0.2404*
Mixed cropping and crop diversification and reduction of consumption amount	11	33.3	86	97.7	16	88.9	1.6751	0.0051**
Grain storage and mortgaging of land	24	72.7	78	88.6	10	55.6	0.9896	0.3118*
Change amount of land under cultivation or grazing	9	27.3	81	92.0	13	72.2	4.1974	0.0014**
Selling of assets such as livestock in order to buy food.	16	48.5	67	76.1	6	33.3	1.3421	0.0109**
participating in non farming activities	9	27.3	87	98.9	15	83.3	2.8266	0.0371**
Buy feed supplements	11	33.3	67	76.1	13	72.2	51.3601	0.0001**
Temporary and permanent migration in search of employment	9	27.3	14	15.9	7	38.9	19.2240	0.0001**

***Source**:-Field Survey (2012) * statistically not significant ** statistically significant*

5.3. Perception towards implementation of livelihood adaptation strategies

5.3.1. Age and implementation of adaptation strategies

Table 5.7 shows the relationship between respondents' age and the degree of implementing the livelihood adaptation strategies to adapt issues related to climate variability and change. The result shows that the performance of young age farmers is better than that of old age farmers in 11 of 16 items. The latter practiced the last five strategies in better which are related more with experiences and exposure to the events.

Table 5.7 Relationship between age and implementation of livelihood adaptation strategies

Age Group	LHASs	Response options								Chi-square	P-value
		Very often		often		rarely		never			
		FRE	%	FRE	%	FRE	%	FRE	%		
25-45	LHAS1	26	18.71	63	45.32	11	7.91	5	3.60	1.962	0.0050**
≥46		4	2.88	16	11.51	5	3.60	9	6.47		
25-45	LHAS2	55	39.57	38	27.34	9	6.47	2	1.44	2.461	0.1200*
≥46		10	7.19	13	9.35	7	5.04	3	2.16		
25-45	LHAS3	78	56.12	23	16.55	12	8.63	1	0.72	0.661	0.4180*
≥46		6	4.32	9	6.47	4	2.88	3	2.16		
25-45	LHAS4	44	31.65	46	33.09	10	7.19	1	0.72	1.625	0.2050*
≥46		3	2.16	19	13.67	6	4.32	2	1.44		
25-45	LHAS5	32	23.02	56	40.29	8	5.76	2	1.44	0.3400	1.0000*
≥46		4	2.88	21	15.11	5	3.60	3	0.16		
25-45	LHAS6	38	27.34	48	34.53	12	8.63	3	2.16	1.9620	0.0050**
≥46		8	5.76	12	8.63	4	2.88	6	4.32		
25-45	LHAS7	61	43.88	36	25.90	9	6.47	2	1.44	9.984	0.0020**
≥46		5	3.60	8	5.76	4	2.88	4	2.88		
25-45	LHAS8	52	37.41	31	22.30	4	2.88	3	2.16	1.732	0.0180**
≥46		14	10.07	13	9.5	0	0.00	5	3.60		
25-45	LHAS9	28	20.14	46	3.09	7	5.04	3	2.16	6.888	0.0100**
≥46		3	2.16	17	12.23	3	2.16	5	3.60		
25-45	LHAS10	29	20.86	38	27.34	6	4.32	4	2.8	5.623	0.0200**
≥46		7	5.04	14	10.07	2	1.44	8	5.76		
25-45	LHAS11	34	24.46	39	28.06	5	3.60	2	1.44	12.348	0.0010**
≥46		4	2.88	12	8.63	2	1.44	4	2.88		
25-45	LHAS12	25	17.99	39	28.06	11	7.91			6.622	0.0120**
≥46		9	6.47	9	6.7	6	4.32				
25-45	LHAS13	3	2.16	14	1007	1	0.72			3.098	0.0810*
≥46		9	6.47	52	37.41	4	2.88				
25-45	LHAS14	7	5.04	3	2.16	2	1.44			0.022	0.8820*
≥46		16	11.51	17	12.23	4	2.88				
25-45	LHAS15	4	2.88	3	2.16					0.001	0.0820*
≥46		14	10.07	9	6.47	7	5.04				
25-45	LHAS16	3	2.16	2	1.44					1.0000	0.4820*
≥46		9	6.47	7	5.04	2	1.44				

***Source**:-Field Survey (2012) * statistically not significant ** statistically significant*

The association of age with perception was statistically significant. The significant association means the former groups have positive perception towards exercising the livelihood adaptation strategies climate variability and change.

5.3.2 Educational background and preferences of the adaptation strategies.

The responses of the communities' to each livelihood adaptation strategies varies with their accordance of age and level of education .Accordingly, the farmers who attend primary education (1-8) was exercise better than that those who did not attend formal education in 12 of the 16 items. The latter performed better in five items. Similarly, farmers who attend high school (9-12) were found to be more perceived and used the livelihood adaptation strategies as compared to those who attend primary education.

Table 5.8 relationships between education and uses of the livelihood adaptation strategies

Lele of Educ	LHASs	Response options								**Chi-square**	**P-value**
		FRE	%	FRE	%	FRE	%	FRE	%		
NFE	LHAS1	3.0	9.1	7.0	21.2	9.0	23	14.0	42.4	3.5990	0.0600*
PSE		21.0	23.9	66.0	75.0	1.0	1.1				
SSE		6.0	33.3	6.0	33.3	6.0	33.3				
NFE	LHAS2	7.0	21.2	80	24.2	11.0	33.3	7.0	21.2	1.3560	0.0246**
PSE		47.0	53.4	36.0	40.9	5.0	5.7				
SSE		11.0	61.1	7.0	38.9						
NFE	LHAS3	9.0	27.3	13.0	39.4	8.0	24.2	3.0	9.1	3.3810	0.0680*
PSE		57.0	64.8	19.0	21.6	9.0	10.2	3.0	3.4		
SSE		18.0	100.0								
NFE	LHAS4	15.0	45.5	9.0	27.3	6.0	18.2	3.0	9.1		0.91608*
PSE		17.0	19.3	5.0	2.5	13.0	14.8	3.0	3.4	0.2390	
SSE		15.0	83.3	3.0	16.7						
NFE	LHAS5	8.0	24.2	13.0	39.4	10.0	30.3	2.0	6.1		0.7170*
PSE		25.0	28.4	57.0	64.8	3.0	.4	3.0	3.4	0.1320	
SSE		11.0	61.1	7.0	38.9						
NFE	LHAS6	22.0	66.7	4.0	12.1	2.0	6.1	5.0	15.2		0.0283**
PSE		18.0	20.5	50.0	56.8	14.0	15.9	6.0	6.8	1.2750	
SSE		6.0	33.3	12.0	66.7						
NFE	LHAS7	3.0	9.1	11.0	33.3	13.0	39.	6.0	18.	0.4470	0.5050*
PSE		48.0	54.5	400	455						
SSE		15.0	83.3	3.0	16.7						
NFE	LHAS8	12.0	36.4	8.0	24.2	4.0	12.1	9.0	27.3		0.0020**
PSE		36.0	40.9	52.0	59.1					10.0190	
SSE		18.0	100.0								
NFE	LHAS9	3.0	9.1	10.0	30.3	9.0	27.3	11.0	33.3		0.9660*
PSE		37.0	42.0	50.0	56.8	1.0	1.1			0.0020	
SSE		15.0	83.3	3.0	16.7						
NFE	LHAS10	0.0	0.0	6.0	18.2	4.0	121	23.0	69.7		0.0180**
PSE		23.0	26.1	41.0	46.6	4.0	4.5	20.0	2.7	5.7500	
SSE		13.0	72.2	5.0	27.8						
NFE	LHAS11	0.0	00	4.0	12.1	2.0	6.1	27.0	81.8		0.7010*
PSE		23.0	26.1	44.0	50.0	5.0	5.7	16.0	18.2	0.1480	
SSE		15.0	83.3	3.0	16.7						
NFE	LHAS12	22.0	66.7	9.0	27.3			2.0	6.1		0.8160*
PSE		2.0	2.3	33.0	37.5	17.0	19.3	36.0	40.9	0.0550	
SSE		10.0	55.6	6.0	33.3			2.0	11.1		

NFE	LHAS13	9.0	27.3	20.0	60.6	2.0	6.1	2.0	6.1		0.0080**
PSE		3.0	3.4	33.0	37.5	1.0	1.1	5.0	58.0	7.2430	
SSE				13.0	72.2	2.0	11.1	3.0	16.7		
NFE	LHAS14	14.0	42.4	10.0	303	1.0	3.0	8.0	24.2		0.0220**
PSE		2.0	2.3	2.0	2.3	0.0		84.0	95.5	5.3390	
SSE		2.0	11.1	0.0		6.0	33.3	10.0	55.6		
NFE	LHAS15	9.0	27.3	5.0	15.2	16.0	48.5	3.0	9.1		0.0310**
PSE		1.0	1.1	18.0	20.5	59.0	67.0	10.0	11.4	1.0380	
SSE		2.0	11.1	6.0	33.3	7.0	38.9	3.0	16.7		
NFE	LHAS16	9.0	27.3	5.0	15.2	16.0	48.5	3.0	9.1	0.5370	0.0465**
PSE		1.0	1.1	16.0	18.2	58.0	65.9	13.0	14.8		
SSE		2.0	11.1	6.0	33.3	7.0	38.9	3.0	16.7		

Source:-*Field Survey (2012) * statistically not significant ** statistically significant*

The chi-square test has indicated there is a significant association. It means an increase in the degree of uses and exercises of the livelihood adaptation strategies increase with an increasing level of awareness and education. Perceptions/ awareness / on the livelihood adaptation preference and frequency of practicing the strategies is more likely related to the level of education and exposure of the respondents'. Therefore, attitude appeared to be positive with respect of attending higher grade level of education.

CHAPTER SIX

Summary, conclusion and recommendation

6.1. Summary

This study was aimed to assess rural communities' perception about the climate variability and change their attitude towards the livelihood adaptation strategies. The study was made on the premises that the awareness of the grass root population about climate variability and change and their positive attitude towards the livelihood adaptation strategies can contribute to the reduce the risk of the climate variability and change in the study area.

To have all the necessary information for this study field survey and structured interview were employed. An awareness test and attitude scale were developed and administered to investigate the rural communities' perception and attitude. More than 139 rural households involved in the survey from three agro –climate zones and six Kebeles administrations of Ware Jarso district, North Showa Zone. Climate variability and change has been the most serious problem that has threatened the life of millions of people in Ethiopia. The causes of climate change are complex and diverse in its nature. However it is influenced by natural and socio-economic factors, climate change in Ethiopia is mainly a function of relative location of the country and its growing population heavy reliance on subsistence rain fed agriculture and rudimentary production methods.

6.1.1 Rural communities' perception about the Causes and Consequence of climate variability change.

Climate variability and change is natural processes, it is caused by emission of carbon dioxide, due to over population and it is God's punishment to human beings' wrong actions mentioned as causes by 70.5% 66.19%, 71.94% and 41.73% of the respondents respectively.

The promising level of awareness was observed among the rural communities who took part in this study about the causes and consequence of climate variability and change and the livelihood adaptation strategies. Humans' action, deforestation and it is the result of both natural and human actions has been considered as most important causes of climate change by 96.40%, 91.37% and 81.29% of the respondents respectively.

Climate variability and change leads to increasing in animal death /loss in livestock productivity, loss of agricultural production/crop cultivation/,increase the requirement of fertilizers, Water shortage for ; household consumption, small scale irrigation and animal to drink and increasing the number of people in need of food aid have been perceived by more than 94 % .

The frequent occurrence of drought and famine, seasonal migration of people, desertification and strong wind agreed by more than 67% of the respondents. Some of the most important effects of climate change like conflict over resources/grazing land and water/, incidences of wild forest and loss of forest lands have been mentioned by less than 10 % of the respondents. The far fewer response of this was not unexpected as many of the respondents lack awareness and exposure to the practices and shortage of forest land and pastoral economic activity is less practiced in the study area.

High awareness and frequencies of using livelihood adaptation strategies was also observed. All of the respondents indicate build water harvesting scheme, to store water during rainy season for dry season in ponds, and implementing multi use of water from one source (water recycling) for different purpose, example, for their cattle, irrigation as the most important of all adaptation strategies . More than 95% of the respondents mentioned cultivating crops that can resist drought, diseases and have short harvesting season, shifting from subsistent rain fed agriculture to small scale market oriented irrigation, growing commercial crops and vegetables under irrigation, using inter-household transfers and loans and increasing petty commodity production, mixed cropping and crop diversification, selling of assets such as livestock and agricultural tools in order to buy food.

Moreover, the practices like different planting dates, participating in non farming agriculture, buying feed supplements and temporary and permanent migration in search of employment, has been mentioned by 79.14%, 62.59%, 41.01%, and 33.09 % respectively. However, these adaptation strategies were rarely practiced in the study area.

DAs have been mentioned by 98% of the respondents as source of information in land management practices. Friends and relatives mentioned family member, training and school by 94%, 91% and 82% of the respondents. Radio was mentioned only by 75 % of the respondents' as source of information for climate variability and change .Print media and TV as a source were mentioned by only 46%,and 21 % of the respondents, respectively.

6.1.2 Perception of rural Communities towards preference and uses the Livelihood Adaptation Strategies

In general, rural Communities were found to have positive attitude towards livelihood adaptation strategies. The high average score of 3.51(with a four point scale) for the sixteen statements are the indicator of positive attitude on the livelihood adaptation strategies practiced by the farmers. It was surprising that less than half of the respondents agreed on the statement which states about 'the importance of collecting wild foods ($LHAS_{15}$). And 100% of the respondents agree on the statement which states 'Build water harvesting scheme, to store water during rainy season for dry season in ponds, and implementing multi use of water from one source (water recycling) for different purpose, example, for their cattle, irrigation.' ($LHAS_1$). This can be supported by an average score of 1.84 and 3.51 respectively for ($LHAS_{15}$) and ($LHAS_1$).

6.1.3 Factors Affecting the rural communities' perception and attitude

A chi-square test was used to measure the strength of linear association between the dependent and independent variable .Hence groups of farmers' perception about issues relating to climate variability and change and livelihood adaptation strategies practiced. Therefore, significance association was found between farmers' of young age (25-45) and old ($\geq$46) age groups in their awareness.

Young age farmers who took part in this study had better awareness in most causes of climate variability and change. Out of the total seven possible causes of climate change young age farmers responded in five in higher percentage than their counter parts. Better awareness also observed in young age group in eight items out of twelve possible consequences. Promising awareness also observed in the side of young age group in all of the possible livelihood adaptation strategies than their counter parts.

Higher performance in attitudinal statement in young age group is an indication of as they have acquired favorable attitude than their counter parts in 12 of the 16 items. Respondents who attend schools of higher grades have better awareness than their counter parts in the issues related to causes and consequences of climate change and they have positively perceived towards livelihood adaptation strategies and practicing them in advance.

6.2. Conclusion

Based on the findings of this study, one could infer that there is a remarkable awareness in the issues related to climate variability and the livelihood adaptation strategies practiced in the study area. However, awareness of the communities in the importance of in engaging in nonfarm / off-farm /activities, Pooling of resources through societies, using inter-household transfers and loans and increasing petty commodity production as the means of adaptation is found to be too low.

Even though, mass media, schools and trainings are believed to be among the most important tools for awareness rising in environmental protection and natural resource management, the extent to which this tools has been used and the result of such use has not been adequately investigated rather a great role of these tools is played by local Kebeles' DAs (development Agents).The participants of this study had a positive attitude in most adaptation strategies. Their attitude, however, in some of the practices like growing commercial crops and vegetables under irrigation on the farm, different planting dates and reduction of consumption amount and frequency of agricultural products seems new ideas to the rural communities of the area.

A significant association was found between respondents of different age group in their degree of awareness of causes, impacts and attitude towards the preferences and degree of using the livelihood adaptation. Young farmers of age 25 to 45 seem relatively better aware of the problem the appropriate adaptation strategies on the bases of the existing situations.

6.2.1 Communities perceive climate change

In autumn the farmers in woina dega and kola areas in the study areas have experienced that the climate has changed. Through focus group interviews and questionnaires of a total of one hundred and sixteen households drawn from two local agro-climate zones in the study areas, a very clear picture emerged of how people are experiencing climate change: 94.24% of respondents believe that the temperature has risen over the years; 92.81% believe that it no longer rains as often as before and that rain patterns have changed.

Despite the fact that People in all three agro-climate zones have experienced that there is less water for both humans and animals, the problem is more severe in the kola than the two. Rivers, streams and traditional wells have run dry over a number of years.

6.2.2 Rainy seasons are changing

The short rainy season, Belg, which used to come from late February to mid May depending on location, instead arrives now in June and doesn't stay for long. This change has happened in the last five to seven in study area where communities live by agriculture.

The long rainy season, Kiremt, which normally begins in June and ends in September / October, has also changed. It starts later, stops earlier – and is more intense. According to some old age respondents, "There wasn't much rain in the long rainy season anymore. In the past trees grew very easily, but today they don't grow at all," .These was what they had never been come across with in their area where they live more than 45 years.

Changes in rainfall patterns have resulted in longer periods of drought, causing a reduction in food production for both humans and animals. In kola Jamo Gedera, the kola agro -climate zone, people have experienced drought and shortage of pasture for animals since seven years. The number of cattle has fallen and therefore even more people in their areas have to seek aid. According to the old age groups," New and strange diseases have arisen in our area because rainfall patterns have changed. It is drought that makes our animals vulnerable to disease,".

In Jamo berdada and Faji Ejersa are sample areas from dega and woina dega respectively, groundwater used to be found two to three meters down. People must now bore right down to seven to –nine meters to find water. The lack of rain and higher temperatures also mean a smaller harvest of the local crop, beans, peans teff, barley As a result "new tropical crops are becoming common, such as Maize, Sorghum" which used to grow in the areas very rarely.

The old aged groups' ≥ 46 years old strongly agreed and reported that "When we compare the situation today with before, the climate has changed. This area was very productive in the past. Climate change has affected our areas, community and family for the last six/nine years". In order to survive, the families have had to sell everything they owned. Today peoples have left the area to find work because "We haven't been able to save any of our food for the bad times because we never have any food to spare," said the old aged respondents.

However, respondents who attended formal schooling performed better than those who did not. The association is significant. Literatures also supported that level of education is one of the factors that determine perception and attitude of human choice and decision making about his environment.

6.3. Recommendation

Based on the finding, the following recommendations are proposed:

- As geographically, rugged terrain due to soil erosion, agro-climatically woina dega and kola and economically the poor are the most vulnerable to climate variability and or climate change. So that, some activities that can increase the resilience of local communities' and adaptive capacity should be done by the stake holders; the government, non-governmental organizations, donors and local communities. Therefore, there is a need for the government to plan for an alternative off-farm income generating activities that can minimize the sole dependency on subsistent rain-fed agriculture and further will helps the local communities in
  - increasing and diversifying household incomes
  - improving agricultural methods
  - introducing small scale irrigation
  - accessing the poorest to credit opportunity
- There is a need for more publicity on livelihood adaptation strategies which should be done mostly on mass media especially in radio so as to create more awareness and positive attitude among the rural communities towards climate variability and or climate change.
- The educational/training programme which was provided to farmers of the area should be made include or modified by considering existing local indigenous knowledge and practice in a particular area.
- There is a need for a forestation and or reforestation of the bare lands with indigenous and local trees as some farm lands area were widely covered by eucalyptus trees, which dried the land and decrease soil productivity of the areas.

References

_____ (2007). National Policies on Disaster Prevention and Preparedness Management and the General Guidelines for the Implementation of the Five-Year Disaster Prevention Plan 1998-2002

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 Oromia 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.* Addis Ababa: 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 in Africa: 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', *Philosophical Transactions 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. Socio-economic and Policy Research Working Paper 25. 2nd edition. International Livestock Research 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

Intergovernmental Panel on Climate Change, 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).

Intergovernmental Panel on Climate Change, 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.

Intergovernmental Panel on Climate Change, 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.

Intergovernmental Panel on Climate Change, 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.

Intergovernmental Panel on Climate Change, 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

Intergovernmental Panel on Climate Change, 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 Rural Development 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: UNDP.

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 No. 2 on Globalization, Growth and Poverty. Ottawa: IDRC.

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

Appendix 1

ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES COLLEGE OF SOCIAL SCIENCE DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

A QUESTIONNAIRE COMPLETED BY THE RURAL COMMUNITIES OF WARE JARSO WOREDA

QUESTIONNAIRE FOR HOUSEHOLD HEADS

Dear respondents,

This questionnaire is meant to gather information for a study on climate change, variability and livelihood adaptation strategies perception of the rural communities' of Wore Jarso woreda and to prepare thesis for the partial fulfillment of the requirement for the Master of Art in Geography and Environmental studies.

Hence, taking the above objectives into consideration, you are kindly asked to provide the appropriate answer for the following questions.

N.B.

1. The response you give will not have any negative impact on you.
2. No need of writing your name on the questionnaire.
3. Please respond for in feeling free warty on think is correct.

Yours faithfully

Mesfin Tesfaye

Part -I. INFORMATION ON SOCIO-ECONOMIC CHARACTERSTICS OF HOUSEHOLD HEADS

1.1. Name of RKA's _____

1.2. Age of the head of household _____

1.3. Sex Male _____ Female _____

1.4. Marital status 1,Single _____2,Married _____3,Divorced _____

4,Widowed(er) _____

1.5. Household size 1, Male _____ 2, Female_____

1.6. Educational background of the household head

No	Levels of education	Please put the (x) on your choice
1	I can't read and write	
2	I can read and write	
3	Elementary school (Grade 1-4)	
4	Junior school (Grade 5-8)	
5	High school and above ≥ 9	

1.7. Which religion do you follow?

N	List of Religions	Please put the (x) on your choice
1	Orthodox	
2	Protestant	
3	Islam	
4	Traditional	
5	Others	
6	I have no religion	

1.8. Do you own land? 1, Yes_____2, No _____

1.9. If yes, (the size in hectares)_____

1.10. How long you live in this rural kebele administration _____

1.11. For how many years you have engaged in agricultural activities

N0	Years of experience on agriculture	Please put the (x) on your choice
1	≤5	
2	5-10	
3	10-15	
4	15-20	
5	≥20	

Part –II **Awareness test**

2.1. Do you believe that there is climate variability and change in the areas within your administration? 1, Yes _____ 2,No _____

2.2. If yes what are the indicators of climate variability and change?

No	Indicators of climate variability and change	Please put the (x)
1	Increase in daily temperature	
2	Decrease in temperature	
3	Increase in rainfall amount	
4	Decrease in rainfall amount	
5	Fluctuation of rainy season	
6	Drying of local ponds and springs	
7	Fluctuation of rivers and streams water volume	
8	Drying of wet lands	
9	Flooding	
10	Frequent occurrence of drought	
11	If any specify	
12	Decreasing of rainfall timing	

2.3. According to you what are the possible causes of climate variability and change in your locality?

(If rural communities unable to indicate, the interviewer will provide the following option).

	Causes of climate variability and change	Please put the (x)
1	Biblical manifestation	
2	Deforestation	
3	Diminishing of land holding size	
4	Due to man's action on environment	
5	Emission of CO_2, from cars, industries	
6	It is natural process	
7	It occurs as a result of both natural and mans' action	
8	Over population/population pressure /	
9	Specify if any	

2.4. What are the possible consequence of climate change and variability that you have experienced in your kebele / Got /woreda? (*List in order of seriousness 1,2,3,….)*

	IMPACTS /CONSEQUENCES/ OF CLIMATE CHANGE	orders
1	Conflict over resources/grazing land and water/	
2	Desertification	
3	Frequent occurrences of drought and famine	
4	Incidences of communicable human, animal and plant diseases such as malaria , diarrhea	
5	Increase the requirement for fertilizers	
6	Increasing in animal death ,loss in livestock productivity	

7	Increasing the number of people in need of food aid	
8	Loss of agricultural production/ poor crop yields/	
9	Loss of forest lands	
10	Seasonal migration of people	
11	Strong winds	
12	Water shortage for ; household consumption, small scale irrigation and animal to drink	
13	Water shortage for ; household consumption, small scale irrigation and animal to drink	
14	Incidences of new communicable human, animal and plant diseases such as malaria , diarrhea	
15	Specify if any	
16	Occurrences of wild forest	

Part III- Attitude Test

3.1. Read each of the following statements very carefully and decide whether you 'very agree', 'agree'; 'disagree' and 'undecided', put an (x) mark inside the appropriate box that indicates your opinion.

No	STATEMENTS	V/Agree	Agree	Disagree	Undecided
1	When I compare the situation today with before climate has changed and varied.				
2	There are changes and variation in rainfall patterns.				
3	Less clearly defined seasons (rains sometimes arrive a month late or finish early; rains quickly gave way to sun or dry periods during the rainy season).				
4	Flooding has also occurred more frequently in our areas that it occurs nine or ten years ago and we are becoming more vulnerable to flooding.				
5	Changes in rainfall patterns have resulted in longer periods of drought, causing a reduction in food production both for animals and humans.				
6	The daily range of temperature is increasing (The day time temperature is increasing /warming/and night time temperature is decreasing/cooling/).				
7	Water evaporation from the ground is so fast.				
8	Crops that mature faster than our " the communities' " traditional variety are becoming more dominant than usual as a good alternative in relation to the problem with the unreliability of the rain, which falls less and less.				
9	We haven't been able to save any of our food for bad times because we never have any food to spare as the area				

	affected by drought every two or three years.				
10	Irrigation is good for proper adaptation and secure household food consumption.				
11	It is preferable to keep the land under forest cover rather than securing an additional piece of farmland by deforestation to decrease drought and flooding effects.				
12	Unseasonal rainfall stresses will affect our location; may lead to relocation within and between regions adding to migration pressures.				
13	Rivers/streams in the basin that are tributaries of the River Abay are drying up, with some ceasing to exist anymore.				
14	Hand-dug wells serve as alternate source of water in our communities; have no water in the dry seasons, when the streams are already dry. This makes water extremely scarce.				
15	Many species of plants and animals in our surrounding are becoming extinct new species of are becoming common.				
16	Forests are equally affected by climate change, manifest in the decreasing forest density, poor trees growth and development.				
17	There are incidence of pests and diseases that attack and decimate crops, forest plants and trees, and disruption and reduction of the fruiting intensity of some trees.				
18	Changes in temperature and humidity provide or extend a favorable habitat for insects, such as mosquitoes, tsetse fly, tick, and other pests in areas where they hitherto existed.				
19	The net effect could prove very unsettling for the stability and security of a state.				
20	The vagaries of the climate are a sign of divine anger, "as there are many sinners in our midst and God is trying to punish us; like floods with serious consequences".				

3.2. Read each of the following statements mark on the frequency of your choice

	Livelihood adaptation strategies	V/often	Often	Rarely	never
1	Build a water harvesting scheme, to store water during rainy season for dry season in ponds, and implementing multi use of water from one source (water recycling) for different purpose . e.g., for cattle, irrigation.				
2	Buy feed supplements				
3	Change amount of land under cultivation or grazing				
4	Collection of wild foods				

5	Cultivating crops that can resist drought, diseases and have short harvesting season				
6	Different planting dates				
7	Elder people get social grants from government				
8	Grain storage and mortgaging of land				
9	Growing commercial crops and vegetables under irrigation				
10	Mixed cropping and crop diversification				
11	Participating in non farming agriculture				
12	Participating in safety net				
13	Pooling of resources through societies farm lands and other resources				
14	Reduction of consumption amount and frequency of agricultural products				
15	Selling assets such as livestock and agricultural tools in order to buy food.				
16	Shifting from subsistent rain-fed agriculture to small scale market oriented irrigation				
17	Temporary and permanent migration in search of employment				
18	Use of inter-household transfers and loans and increasing petty commodity production				

3.3. What is your source of information for the above climate change adaptation mechanisms?

No	Sources of information	Please put the (x)
1	Friends and relatives	
2	Development /Extension agents	
3	from family members	
4	Trainings on EP	
5	Radio	
6	around market/town	
7	Print media	
8	Television	

Appendix 2 (interview checklist for key informants)

This interview concern the perception of rural communities towards climate changes variability and livelihood adaptation strategies to the officers and professionals of the district who are works at kebele and woreda level so as to prepare thesis for the partial fulfillment of the requirement for the Master of Art in Geography and Environmental studies. Hence, dear respondents you are kindly requested to respond as much as possible properly the following oral questions. These are

formulated to assess rural communities perception towards climate changes variability and livelihood adaptation strategies collaboration with your the respective local communities.

Thank you for your honorable and time devotions.

1. Have you ever experienced that there is climate change and variability in your area?

2. What are the indicators of climate change and variability you have experienced within the woreda?

I. _____
II. _____
III. _____
IV. _____
V. _____

3. Do you have any work plan to act with local communities on climate change variability and adaptation mechanisms?

4. If yes, can you list down what you have incorporated in your work plan?

I. _____
II. _____
III. _____
IV. _____
V. _____

5. How do you evaluate the perception of rural communities towards climate change and variability?

6. Did you bring awareness training for the communities about climate change adaptation?

7. How to evaluate their performances on the ground?

8. For how long you conduct evaluation and monitoring the performance the communities about climate change adaptation mechanism?

9. What considerable advantages and disadvantages may happen over the participatory climate change adaptation mechanism?

10. Please write any change you have experienced and observed due climate change in yourlocalsurroundingenvironment_____

_____

_____

_____

_____

Appendix 3 (interview checklist for NGOs)

This part of interview question is concern your organization activity on concern the perception of rural communities towards climate changes variability and adaptation strategies. Thus your providing information is essential one to investigate information from your organization day to day activities for the researcher genuine recommendation. So, dear respondents please provide your genuine information.

Thank you for your time devotion in heartily.

1. What are the goals of your organization towards climate changes variability and adaptation mechanisms?
2. Why your organization directly involves in the community towards climate changes variability and adaptation mechanisms?
3. Through what way your organization provides support for communities to adapt and mitigate climate change?
4. Do you expect that is there close relation with local administrators, communities with these regard?
5. Are there problems that limit your organization to fulfill your objectives and mission?
6. If yes, what problems mainly influence?
7. Do you have prepared methods to ease achievements of your mission?
8. What are those methods that will enables you to meet the intended out comes

Annexes -1

LHASs	Livelihood adaptation strategies
LHAS1	Selling assets such as livestock and agricultural tools in order to buy food.
LHAS2	Build a water harvesting scheme, to store water during rainy season for dry season in ponds, and

	implementing multi use of water from one source (water recycling) for different purpose . e.g., for cattle, irrigation.
LHAS3	Cultivating crops that can resist drought, diseases and have short harvesting season
LHAS4	Shifting from subsistent rainfed agriculture to small scale market oriented irrigation
LHAS5	Growing commercial crops and vegetables under irrigation
LHAS6	Grain storage and mortgaging of land
LHAS7	Mixed cropping and crop diversification
LHAS8	Reduction of consumption amount and frequency of agricultural products
LHAS9	Pooling of resources through societies ,safety net and social grants from government
LHAS10	Change amount of land under cultivation or grazing
LHAS11	Buy feed supplements
LHAS12	Different planting dates
LHAS13	Temporary and permanent migration in search of employment
LHAS14	Use of inter-household transfers and loans and increasing petty commodity production
LHAS15	Collection of wild foods
LHAS16	Participating in non farming activities

Annex -2

CAUSES OF CLIMATE VARIABILITY AND CHANGE	AGE CATEGORIES				Chi-square	P-value
	25-45		≥46			
	FREQ	%	FREQ	%		
A=Due to man's action	69	100.00	65	92.86	0.0000	1.0000*
B=Deforestation	66	95.65	61	87.14	2.1812	0.1397*
C= Due to both natural and mans' action	61	88.41	52	74.29	9.6736	0.0019**
D=Emission of co2,cars,industries	59	85.51	39	55.71	1.9726	0.1602*
E=It is natural process	36	52.17	56	80.00	1.7544	0.1853*
F=Over population	55	79.71	45	64.29	12.9305	0.0003**
G=God's punishment	9	13.04	49	70.00	24.5608	0.0001**

Annexe-3

Consequences of climate variability and change	Age categories				Chi-square	P-value
	25-45		≥46			
	FREQ	%	FREQ	%		
ncreasing in animal death ,loss in livestock productivity	69	100.0	70	100.0	0.000	1.000*
Loss of agricultural production/crop cultivation/	69	100.0	69	98.6	11.2017	0.0008**
Water shortage for ; household consumption, small scale irrigation and animal to drink	68	98.6	67	95.7	0.5101	0.0476*
Incidences of communicable human, animal and plant diseases	64	92.8	64	91.4	12.3023	0.0005**
Increasing the number of people in need of food aid	61	88.4	61	87.1	3.9663	0.4804*

F=Increase the requirement for fertilizers	57	82.6	60	85.7	0.0679	0.0464**
Frequent occurrences of drought and famine	55	79.7	66	94.3	0.4531	0.6047*
H=Seasonal migration of people	50	72.5	63	90.0	0.4925	0.5030*
I=Desertification	47	68.1	61	87.1	0.3671	0.6068*
J=Strong winds	34	49.3	56	80.0	0.0065	0.7047*
Conflict over resources/grazing land and water/	26	37.7	47	67.1	0.0012	0.9887*
L=Loss of forest lands	14	20.3	35	50.0	1.3321	0.1957*

Annex -4

LIVELIHOOD ADAPTATION STRATEGIES	Age categories				Chi-square	P-value
	25-45		≥46			
	FREQ	%	FREQ	%		
LHAS1	69	100.0	70	100.0	0.0000	1.0000*
LHAS2	69	100.0	56	80.0	3.0034	0.1458*
LHAS3	66	95.7	44	62.9	4.0572	0.0355**
LHAS4	66	95.7	64	91.4	3.8801	0.0144**
LHAS5	61	88.4	54	77.1	6.3285	0.0061**
LHAS6	58	84.1	21	30.0	5.1531	0.0123**
LHAS7	56	81.2	33	47.1	0.8809	0.2404*
LHAS8	55	79.7	41	58.6	1.6751	0.0051**
LHAS9	53	76.8	36	51.4	2.9751	0.0412**
LHAS10	53	76.8	24	34.3	0.9896	0.3118*
LHAS11	51	73.9	44	62.9	4.1974	0.0914**
LHAS12	46	66.7	51	72.9	5.3421	0.0111**
LHAS13	56	81.2	31	44.3	2.8266	0.0371**
LHAS14	40	58.0	17	24.3	51.3601	0.0001**
LHAS15	34	49.3	12	17.1	24.5556	0.0001**

Annex -5

Age Group	**LHASs**	**RESPONSE OPTIONS**								**(X2)**	**P-value**
		Very often		***often***		***rarely***		***never***			
		FRE	**%**	**FRE**	**%**	**FRE**	**%**	**FRE**	**%**		
25-45	**LHAS1**	**26**	**18.71**	**63**	**45.32**	**11**	**7.91**	**5**	**3.60**	1.962	0.0050**
≥46		**4**	**2.88**	**16**	**11.51**	**5**	**3.60**	**9**	**6.47**		
25-45	**LHAS2**	**55**	**39.57**	**38**	**27.34**	**9**	**6.47**	**2**	**1.44**	2.461	0.1200*
≥46		**10**	**7.19**	**13**	**9.35**	**7**	**5.04**	**3**	**2.16**		
25-45	**LHAS3**	**78**	**56.12**	**23**	**16.55**	**12**	**8.63**	**1**	**0.72**	0.661	0.4180*
≥46		**6**	**4.32**	**9**	**6.47**	**4**	**2.88**	**3**	**2.16**		
25-45	**LHAS4**	**44**	**31.65**	**46**	**33.09**	**10**	**7.19**	**1**	**0.72**	1.625	0.2050*
≥46		**3**	**2.16**	**19**	**13.67**	**6**	**4.32**	**2**	**1.44**		
25-45	**LHAS5**	**32**	**23.02**	**56**	**40.29**	**8**	**5.76**	**2**	**1.44**	0.3400	1.0000*
≥46		**4**	**2.88**	**21**	**15.11**	**5**	**3.60**	**3**	**2.16**		
25-45	**LHAS6**	**38**	**27.34**	**48**	**34.53**	**12**	**8.63**	**3**	**2.16**	1.9620	0.0050**
≥46		**8**	**5.76**	**12**	**8.63**	**4**	**2.88**	**6**	**4.32**		

25-45	**LHAS7**	**61**	**43.88**	**36**	**25.90**	**9**	**6.47**	**2**	**1.44**	9.984	0.0020**
≥46		**5**	**3.60**	**8**	**5.76**	**4**	**2.88**	**4**	**2.88**		
25-45	**LHAS8**	**52**	**37.41**	**31**	**22.30**	**4**	**2.88**	**3**	**2.16**	1.732	0.0180**
≥46		**14**	**10.07**	**13**	**9.35**	**0**	**0.00**	**5**	**3.60**		
25-45	**LHAS9**	**28**	**20.14**	**46**	**33.09**	**7**	**5.04**	**3**	**2.16**	6.888	0.0100**
≥46		**3**	**2.16**	**17**	**12.23**	**3**	**2.16**	**5**	**3.60**		
25-45	**LHAS10**	**29**	**20.86**	**38**	**27.34**	**6**	**4.32**	**4**	**2.88**	5.623	0.0200**
≥46		**7**	**5.04**	**14**	**10.07**	**2**	**1.44**	**8**	**5.76**		
25-45	**LHAS11**	**34**	**24.46**	**39**	**28.06**	**5**	**3.60**	**2**	**1.44**	12.348	0.0010**
≥46		**4**	**2.88**	**12**	**8.63**	**2**	**1.44**	**4**	**2.88**		
25-45	**LHAS12**	**25**	**17.99**	**39**	**28.06**	**11**	**7.91**			6.622	0.0120**
≥46		**9**	**6.47**	**9**	**6.47**	**6**	**4.32**				
25-45	**LHAS13**	**3**	**2.16**	**14**	**10.07**	**1**	**0.72**			3.098	0.0810*
≥46		**9**	**6.47**	**52**	**37.41**	**4**	**2.88**				
25-45	**LHAS14**	**7**	**5.04**	**3**	**2.16**	**2**	**1.44**			0.022	0.8820*
≥46		**16**	**11.51**	**17**	**12.23**	**4**	**2.88**				
25-45	**LHAS15**	**4**	**2.88**	**3**	**2.16**					0.001	0.0820*
≥46		**14**	**10.07**	**9**	**6.47**	**7**	**5.04**				
25-45	**LHAS16**	**3**	**2.16**	**2**	**1.44**					**1.0000**	**0.4820***
≥46		**9**	**6.47**	**7**	**5.04**	**2**	**1.44**				

*Source:-Field Survey (2012) * statistically not significant ** statistically significant*

Annex -6

Educational Background	LHASs	RESPONSE OPTIONS								(X2)	P-value
		Very Often		often		rarely		never			
		FRE	%	FRE	%	FRE	%	FRE	%		
NFE	LHAS1	3.0	9.1	7.0	21.2	9.0	27.3	14.0	42.4		
PSE		21.0	23.9	66.0	75.0	1.0	1.1			3.5990	0.0600*
SSE		6.0	33.3	6.0	33.3	6.0	33.3				
NFE	LHAS2	7.0	21.2	8.0	24.2	11.0	33.3	7.0	21.2	1.3560	0.0246**
PSE		47.0	53.4	36.0	40.9	5.0	5.7				
SSE		11.0	61.1	7.0	38.9						
NFE	LHAS3	9.0	27.3	13.0	39.4	8.0	24.2	3.0	9.1	3.3810	
PSE		57.0	64.8	19.0	21.6	9.0	10.2	3.0	3.4		0.0680*
SSE		18.0	100.0								
NFE	LHAS4	15.0	45.5	9.0	27.3	6.0	18.2	3.0	9.1		
PSE		17.0	19.3	55.0	62.5	13.0	14.8	3.0	3.4	0.2390	0.91608*
SSE		15.0	83.3	3.0	16.7						
NFE	LHAS5	8.0	24.2	13.0	39.4	10.0	30.3	2.0	6.1		
PSE		25.0	28.4	57.0	64.8	3.0	3.4	3.0	3.4	0.1320	0.7170*
SSE		11.0	61.1	7.0	38.9						
NFE	LHAS6	22.0	66.7	4.0	12.1	2.0	6.1	5.0	15.2		
PSE		18.0	20.5	50.0	56.8	14.0	15.9	6.0	6.8	1.2750	0.0283**
SSE		6.0	33.3	12.0	66.7						
NFE	LHAS7	3.0	9.1	11.0	33.3	13.0	39.4	6.0	18.2		
PSE		48.0	54.5	40.0	45.5					0.4470	0.5050*
SSE		15.0	83.3	3.0	16.7						
NFE	LHAS8	12.0	36.4	8.0	24.2	4.0	12.1	9.0	27.3		
PSE		36.0	40.9	52.0	59.1					10.0190	0.0020**

SSE		18.0	100.0								
NFE	LHAS9	3.0	9.1	10.0	30.3	9.0	27.3	11.0	33.3		
PSE		37.0	42.0	50.0	56.8	1.0	1.1			0.0020	0.9660*
SSE		15.0	83.3	3.0	16.7						
NFE	LHAS10	0.0	0.0	6.0	18.2	4.0	12.1	23.0	69.7		
PSE		23.0	26.1	41.0	46.6	4.0	4.5	20.0	22.7	5.7500	0.0180**
SSE		13.0	72.2	5.0	27.8						
NFE	LHAS11	0.0	0.0	4.0	12.1	2.0	6.1	27.0	81.8		
PSE		23.0	26.1	44.0	50.0	5.0	5.7	16.0	18.2	0.1480	0.7010*
SSE		15.0	83.3	3.0	16.7						
NFE	LHAS12	22.0	66.7	9.0	27.3			2.0	6.1		
PSE		2.0	2.3	33.0	37.5	17.0	19.3	36.0	40.9	0.0550	0.8160*
SSE		10.0	55.6	6.0	33.3			2.0	11.1		
NFE	LHAS13	9.0	27.3	20.0	60.6	2.0	6.1	2.0	6.1		
PSE		3.0	3.4	33.0	37.5	1.0	1.1	51.0	58.0	7.2430	0.0080**
SSE				13.0	72.2	2.0	11.1	3.0	16.7		
NFE	LHAS14	14.0	42.4	10.0	30.3	1.0	3.0	8.0	24.2		
PSE		2.0	2.3	2.0	2.3	0.0		84.0	95.5	5.3390	0.0220**
SSE		2.0	11.1	0.0		6.0	33.3	10.0	55.6		
NFE	LHAS15	9.0	27.3	5.0	15.2	16.0	48.5	3.0	9.1		
PSE		1.0	1.1	18.0	20.5	59.0	67.0	10.0	11.4	1.0380	0.0310**
SSE		2.0	11.1	6.0	33.3	7.0	38.9	3.0	16.7		
NFE	LHAS16	9.0	27.3	5.0	15.2	16.0	48.5	3.0	9.1	0.5370	0.0465**
PSE		1.0	1.1	16.0	18.2	58.0	65.9	13.0	14.8		
SSE		2.0	11.1	6.0	33.3	7.0	38.9	3.0	16.7		

*Source:-Field Survey (2012) * statistically not significant ** statistically significant*