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**Community Perception on Climate Change, Its Impacts and
Adaptation Strategies: the Case of Ensaro Woreda, North Shewa
Zone, Amhara Regional State, Ethiopia**

By

Abirham Cherinet

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Advisor: Muluneh W/ Tsadike (PhD)

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This is to certify that the thesis prepared by Abirham Cherinet, entitled: *Community perceptions on climate change, its impacts and adaptation strategies* and submitted in partial fulfillment of the requirements for the Degree of Master of Arts (Geography and Environmental Studies, specialization: climate change adaptation) complies with the regulations of the university and meets the accepted standards with respect to originality and quality.

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Abstract

The study was conducted in three kebeles of Ensaro woreda found in North Shewa zone, Amhara Regional State to assess the communities' perception on climate change, impact and adaptation strategies. The study were used purposive sampling techniques to select both kebeles and household heads. The size of the sample household respondents were 124 out of each 22 participants were female headed households', one FGD in each kebele with six members of participants and one key informant interviews were held. Both qualitative and quantitative methods of data collection and analysis were used. The study used primary data through interview of households, FGDs, key informant interviews, observation and household survey. The study also used secondary data of temperature from 1987 to 2016 years from ENMSA gridded data to examine the trend of climate change/ variability. Binary logit model were used to see the relationships between dependent and independent variables.

The average temperature of the woreda shows an increment by 0.67°c in the past three decades with an annual increment of 0.022°c. Similarly, there is declining trend of rainfall in the past three decades showing high variability. The annual rain fall of the woreda shows decreasing trend by 14.5 %. Based on the result of the study the frequency of drought has increased from time to time, and flood, landslide, pest and diseases are the most impact of climate change in the study area. Terracing, afforestation, rain water harvesting, crop diversification, use of improved crops, income diversification (petty trade, wage laborer etc.), seasonal migration and livestock management (destocking ,cut and feeding system) are the most coping/ adaptation strategies of farmers.

The binary model results revealed that the respondent's age, educational status, access to extension and farm experience have a positive and significant effect on farmer's perception on climate change and adaptation. On the other hand sex of household heads, access to extension services, farm land size, access to market and access to credit have negative and significant effect on farmers perception on climate change and adaptation in the study area. Moreover, farmers living in the kola areas have been aware of climate change as compared to woyinadega and dega areas. This is due to the fact that lowland areas are already hotter and a marginal change in temperature could be perceived easily.

The result revealed that most of the people perceived long-term variability in pattern of rainfall amount and distribution and an increasing trend and variabilities of temperature. Therefore farmers are undertaking different adaptation and coping mechanisms. Providing training, increasing accessibility to infrastructures, credit services, market and introducing new technologies are forwarded as recommendations.

Key words: Climate change, Perception, Adaptation, Barriers

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LIST OF ACRONYMS

CSA	Central Statistical Agency
CIER	Centre for Indigenous Environmental Resources
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GHGs	Green House Gases
GWP	Global Warming Potential
GLCA	Global Leadership for Climate Action
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
LDCs	Least Developed Countries
MEF	Ministry of Environment and Forest
MoFED	Ministry of Finance and Economic Development
MMPNG	Ministry of Mine, Petroleum and Natural Gas
MME	Ministry of Mine and Energy
MDG	Millennium Development Goals
NAPA	National Adaptation Program of Action
NMA	National Meteorological Agency
SPSS	Statistical Package for Social Science
UKCIP	United Kingdom Climate Impact Programme
UNDP	United Nation Development Program
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World meteorology organization
EWADO	Ensaro Woreda Agricultural Development Office
EWWDO	Ensaro Woreda Water Development Office
EWHO	Ensaro Woreda Health Office

CHAPTER ONE

1. INTRODUCTION

1.1 Background

Climate change is the primary environmental issue today and will continue so in the future at a global level. United Nations Framework Convention on Climate Change (UNFCCC) has defined climate changes as a change of composition of the global atmosphere that is attributed directly or indirectly to human activity in addition to natural climate variability observed over comparable time periods. In the past couple of decades climate change has become increasingly apparent that it is already happened, happening, and will continue to happen, bringing with its local impacts on people's livelihoods (Parry et al., 2007).

The threat of global climate change has caused concern among scientist's livelihoods, agricultural production and food security of the smallholders could be severely affected by changes in key climate variables. Climate change is caused by both natural factors such as cycles and trends in the Earth's orbit, incoming solar radiation, the atmosphere's chemical composition, ocean circulation, the biosphere and volcanic eruption and much more, human induced causes like extensive use of land, widespread of deforestation, the major technological and socioeconomic shifts with reduced reliance on organic fuel, and the accelerated uptake of fossil fuels that increases the emission of greenhouse gases concentration in the atmosphere (Temesgen et.al 2014). In fact it is not a new phenomenon, but the warming that is occurring today is unparalleled with respect to the rate of change.

Third assessment report of Intergovernmental panel on climate change (IPCC, 2001) indicates that the least developed countries (LDCs) have contributed the least to the emission of greenhouse gases but the impacts of climate change are expected to be more pronounced in the developing countries particularly in Sub-Saharan Africa because of their livelihood is dependent on nature which is highly sensitive to climate change. Olsen (2006), also indicates that African countries are prone to greater impacts of this change/variability in climate partly because of lack of awareness and adaptive capacity. However, Africa's total contribution to emissions of greenhouse gases which cause the change is less than 7% of the world's greenhouse emissions

(Olsen, 2006). This low capacity is due to the extreme poverty situation of many Africans, and occurrence of frequent natural disasters such as droughts, floods, and agriculture, which are heavily dependent on rainfall. The Intergovernmental Panel on Climate Change (2007) findings shows that, developing countries like Ethiopia will be more vulnerable to climate change. These extreme vulnerability to the impacts of climate change in Ethiopia is due to social, economic and environmental factors. In specific, high levels of poverty, rapid population growth, and high level of reliance on rain-fed agriculture, high levels of environmental degradation, chronic food insecurity and frequent natural drought cycles are the major vulnerability drivers in the country (Aklilu et al., 2009). According to Reilly, (1999); Abaje and Giwa, (2007) expression the most devastating adverse impacts of climate change in Nigeria and other subtropical countries are occurrence of frequent drought, increased environmental damage, increased infestation of crop by pests and diseases that leads to low production of crops, increased migration from both rural and urban areas, depletion of wildlife and other natural resource base in general biodiversity loss will be increased, changes in the vegetation type and forest resources will be decline, decline in soil conditions, increased health risks and the spread of infectious diseases, changing livelihood systems, etc. But, it is possible to reduce adverse effects of climate change and variability by formulating effective and efficient adaptation strategies. Based on IPCC (2001) adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Adaptation to climate change requires that farmers first perceive that the climate is changing, and then identify useful adaptation measures to cope with the problems and implement them effectively and efficiently (Temesgen, 2007).

In fact perception is not the only factor that influence farmers use of adaption measures. Adaptation to climate change takes place in a dynamic social, economic, technological and biophysical context that varies over time, location, and sector. This complex mix of conditions determines the capacity of systems to adapt negative impact of climate change and variability (Kates, 2000). In Ethiopia, twenty priority project ideas were identified to address climate change adaptation needs of the country through the National Adaptation Program of Action (NAPA). The main focus of these projects is in the area of capacity building, improving natural resource management, enhancing irrigation agriculture and water harvesting capacity,

strengthening early warning systems and awareness raising quite relevant areas in improving dry lands livelihood systems (Kidane et al., 2009)

Peoples must build their resilience, including adopting appropriate technologies while making the most of local knowledge, and diversifying their livelihoods to cope the climate stress. These local knowledge and local coping strategies need to be used in synergy with government and local interventions (UNFCCC, 2007).The rural community believed that climate variability and its impacts are the acts of God against human sin (McKee, 2008 cited by Yohannes and Mebratu, 2009). In Ensaro woreda there is a claim on decreasing agricultural productivity and people's failed in practicing adaptation strategies against climate change impact introduced by government. Therefore, the researcher wanted to investigate the local people's perception to climate change, its impacts and their adaptation strategies at Ensaro *woreda*¹, North Shewa zone.

1.2 Statement of the problem

Climate change is the major environmental challenges which faces societies in the world. The poorest countries and the poorest peoples will suffer more than the others, even though their contribution for the change is minimum. Because the economic activities of these countries are mostly depends on natural resource which are susceptible to climate change. As in other regions of the world, climatic and ecological changes caused by global warming have resulted in several negative consequences on people's health, economy and livelihoods in Ethiopia (Eriksson, 2006).

According to National Meteorological Service Agency (NMSA, 2007) climate change/variability affects agriculture, health, water resources and natural resource. Farmers of Ensaro *woreda* are, like farmers in any other part of Ethiopia, is suffering from Climate disruptions which have become common natural catastrophes in the country. In my observation and information gain from the residents, there is more erratic and unreliable rainfall in the rainy seasons, bringing drought, reduction in crop yields, floods, landslides and soil erosion. Second, there has been an increase in temperature which disturbs the physiology of crops and livestock, micro-climate and the soil system on which they produced. Third, the annual river runoff and

¹ *Wereda* refers to the forth tier of government administration unit, which is closely equal to district.

water availability has been decrease year to year (EWADO, 2017). All these climate shocks have aggravated the negative impacts on the livelihood of farmers, as they have the lowest capacity to adapt to climate changes. Generally, this varied climate in the study area influences the livelihood activities of the farming community.

Perception about climate change, its cause, impacts and the necessary response mechanisms to cope with climate calamities are important for any population in a given community. Level of awareness determines the scope of implementation that needs to be taken to tackle the problem. Lower awareness will make intervention mechanisms to be very slow and untargeted. For instance, local peoples have a range of strategies to cope with drought. However, these traditional coping mechanisms are based on local knowledge and not supported by research. Therefore, they may not be able to counter all of the challenges imposed by climate change in the future. Studies have shown that climate change has potential to have several negative impacts on human welfare, natural resources and development activities in the country. However, studies on community perception on climate change have been carried out both at macro and micro-levels, but, Temesgen (2009) impacts of climate change and adaptation options are location specific and policy for adaptation options should be area specific. As site specific issues require site specific knowledge, therefore, it is very important, to clearly understand what is happening at community level. Unless, the impacts of climate change are known and expressed at community level and understood the local people and established the right perception, it would be difficult to convince and motivate local communities to undertake adaptation actions. To fill this gap, this research has been carried out with a focus on assessing the perceptions of local people, on impacts of climate change and adaptation strategies of the in Ensaro Wereda of North Shewa.

1.3 Objectives of the study

1.3.1 General Objective

The study aimed to assess communities' level of perception, impact and adaptation strategies to climate change in the study area.

1.3.2 Specific Objectives

1. To examine the trend of climate in the study area in the period 1987 - 2016.
2. To understand local peoples' perception towards changes in temperature and rainfall trend.
3. To assess impacts of climate change in the study area
4. To identify the existing adaptation strategies used by local peoples in response to climate variability and change in the study area.
5. To identify determinant factors that influences the perception of local peoples in the study area.
6. To identify determinant factors that influences adaptation strategies used by local peoples in the study area.

1.4 Research Questions

To achieve the objectives, the following key research questions were formulated.

1. What has been the state of climate of the area?
2. What is community's perception towards changes in temperature and rainfall trend?
3. What are the impacts of climate change/variability in the study area?
4. What adaptation strategies have been adopted by different actors of the study area to cope with climate change/ variability?
5. What are the variables that determine people's level of perception on climate change?
6. What are the major socio-economic factor that influenced adaptation strategies in response to changing temperature and rainfall?

1.5 Significance of the Study

This study were carried out for academic purpose and contribution to policy making and it confined in a single *woreda*. The findings shall contribute to deepen the knowledge of rural

communities' perception and attitudes on climate change/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. In addition, it will be used to identify the gap that can be filled by material or by training which is required by people in the study area. Moreover, this kind of research is the first time in the areas and even in neighboring *woreda's*, so it may be used to stimulate further research. Results from this study could also be used by other *woreda's* in the region to improve the lives of their people and adaptation strategies.

1.6 Scope of the Study

The scope of the study is limited to Ensaro *woreda*, North Shewa zone, Amhara Regional State. And to assess the level of rural communities' perception towards climate change/variability, and livelihood adaptation strategies practiced at local level 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/variability and adaptation strategies. 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.

Determining factors such as age, sex, educational status and access to information will be taken into account for the sake of these studies. This is due to the assumption of shortage of time and budget constraints for further study of the rest of the factors.

1.7 Limitation of the Study

The study could have been much more interesting had it been possible to include more *kebeles*² in Ensaro and beyond. However, the study relied on three selected *kebeles* only, for practical reasons such as time and financial limitations, some farmers were not willing to fill questionnaires and participation in FGD and shortage of adequate secondary source of data was also another problem.

² *Kebele* refers to the fifth tier of government administration unit.

1.8 Organization of the document

The document is structured in five main chapters. The first chapter has described the introduction of the study that includes the background, problem statement and objectives of the study. Chapter two presents theoretical perspectives and empirical evidences related to the main themes of the proposal. Chapter three discusses the methodological approach of the study that includes the method of data collection and analysis part. Chapter four constitutes the core of the study to analyze quantitatively as well as qualitatively the data gathered through different tools concerning the perception and adaptations to climate change in Ensaro *woreda*. Chapter five contains summery, conclusion, and recommendations.

1.9 Definition of terms and concepts

Climate Change: The most universal definition of climate change is a change in the statistical properties of the climate system over periods of decades or longer, regardless of cause (Houghton, 2001). The term sometimes is used to refer specifically to climate change caused by human activity. For example, the United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods

Climate variability: Variations in the mean state and other statistics such as standard deviations, the occurrence of extremes, etc. of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may result from natural internal processes within the climate system or from variations in natural or anthropogenic external forcing (IPCC, 2001).

Vulnerability: IPCC (2001) describes vulnerability as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including increased variability and downside risk. According to the ENMSA (2001), long-term climate change in Ethiopia is associated with changes in precipitation patterns, rainfall variability, and temperature, which could increase the country's frequency of both droughts and floods.

Adaptation to climate change: Adger et al. (2007) defines adaptation to climate change as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

Adaptation is a process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed, and implemented (UNDP, 2007). UKCIP (2003) also defined adaptation as the process or outcome of a process that leads to a reduction in harm or risk of harm, or realization of benefits associated with climate variability and climate change.

Resilience: Turner et al. (2003) defined resilience as the degree to which an impacted system rebounds or recovers from a perturbation. Climate change impacts necessitate responses and adjustments to the biophysical and social conditions which together determine exposure to climate hazards. These responses may occur in form of autonomous action or through public as well as private planned, individual and institutional mechanisms.

Mitigation: IPCC (2001) defined mitigation as a process of curbing greenhouse gas emissions from human activities, for example emissions from fossil fuels as well as deforestation, with a view to stabilizing greenhouse gas concentration at a safe level.

Adaptive capacity: Mortimore & Manvell (2011) defined adaptive capacity as the potential or capability of a system to adjust to climate change, including climate variability and extremes, to moderate potential damages, to take advantage of opportunities, or to cope with consequences. Therefore, the adaptive capacity of any society or system in the environment invariably describes its knowledge of the events, ability to modify or reduce its characteristics or behavior in order to cope better with the changes in external conditions.

CHAPTER TWO

2. LITERATURE REVIEW

In this chapter I try to present empirical evidences related to people's perception on climate change and its impacts, trend of climate change at global and country level, global response for climate change and what Ethiopians policy says about climate change adaptation and mitigation. As we know climate change is increasingly recognized as a critical challenge to ecological health, human well-being and future development (IPCC, 2007). It is one of the main environmental challenges that affect both the current and future generations. The global community took initial steps in 1992 (United Nations Framework Convention on climate change-UNFCCC) and then Kyoto Protocol in 1997 by formulate rules to limit global greenhouse gas emissions. However, these efforts have produced only modest gains in a handful of countries. The resulting emission reductions are nowhere near, what they should be in order to halt or slow the pace of climate change (GLCA, 2009). In addition, local community based adaptation practice is urgent issue particularly in developing countries. However, little is known about local community perception worldwide. Building on this notion, this research explores public understandings of climate change in Ensaro *woreda*. The capacity to develop a substantial knowledge of the issue is crucial, as it may lead to the development of effective adaptation and mitigation options (Elisapesi, 2014).

2.1 Climate change at a global level

According to IPCC (2001) Climate Change- refers to a statistically significant variation either from the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land-use. In the past few years, climate change has become a core issue in various developmental and political forums at the national, regional and international level. Many regional conferences have discussion sessions on climate change based on the recognition, that global climate change is increasing and this has become more evident in recent years (Aklilu and Alebachew, 2009a).

According to the IPCC (2007) fourth assessment report, warming of the climate system is a real, as an evident, observations and meteorological data's shows that there is an increase in global average air and ocean temperatures, extensive melting of snow and ice and average sea level is rising in global level. The global average temperature has risen by 0.74°C and the global sea level has risen by 17cm during the 20th century because of melting of snow and ice from the mountains and Polar Regions.

Greenhouse gases like carbon dioxide, methane, chlorofluorocarbon and nitrous oxide have been identified as a main factor of global warming (Singh, 2008). It is, thus apparent that the global warming is due to anthropogenic emission of greenhouse gases. The major sources of greenhouse gases are electric power station due to burning of fossil fuels, numerous factories spread all over the world, the transport sector and deforestation. The relative share of carbon dioxide, chlorofluorocarbons, methane and nitrous oxides were 51%, 20% 16% and 16% respectively up to 1990 (Singh, 2008). The increased concentrations of these gases affect agricultural production. In line with this Ellis (2010) argued that, the increased carbon dioxide concentrations in the atmosphere are a key element of climate change that could affect food security.

World Meteorology Organization (WMO,2003) and IPCC (2007) stated that carbon dioxide concentrations have increased from 280 parts per million (PPM) in pre-industrial times (1750s) to 370 PPM at present and it is estimated that, with the present trend, the concentration will range between 540 and 970 PPM in the year 2100.

Based on climate models, global average temperature is projected to increase by 1.4 to 5.8⁰c by the end of the present century (CIER, 2008), sea level is expected to rise 0.09 to 0.88 meter from the 1990 level by the end of this century and precipitation extremes are projected to increase more than the average in the future (WMO, 2003).

2.2 Climate change observations in Ethiopia

According to IPCC (2014) Fifth Assessment Report of Famine Early Warning Systems Network (FEWS NET) there has been an increase in seasonal mean temperature in many areas of Ethiopia.

According to the UNDP climate change country profiles, the average annual temperature of Ethiopia increased by 1.3°C between 1960 and 2006 (McSweeney et al, 2010). The average number of ‘hot’ days and ‘hot’ nights per year are also increased from time to time. Based on, McSweeney et al, (2010) expression, there is no statistically significant trend in observed average rainfall in any season and also daily rainfall records are insufficient to identify current trends in daily rainfall. In addition that NMA (2007) report shows, Ethiopia experienced 10 wet years and 11 dry years over the last 55 years, indicating the strong inter annual variability.

2.3 Causes of climate change /variability in Ethiopia

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. But, the main and direct cause of greenhouse gas (GHG) emissions is 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. Ethiopia's share to global GHG emission is very minimal. However, emissions from agriculture and energy sectors doubled since 1994. MoFED (2010) reports indicates that, these two sectors are the major emitters in Ethiopia which accounting for 85% and 15% of the total gas emission respectively. 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. These are dominated by methane emissions, which account for 80% of the warming potential. Climate scientists now reach an agreement that the human caused pollution mainly from fossil fuels, has added considerably to global warming in the past 50 years (Stern, 2006).

Generally, there were increasing trends of greenhouse gas emissions in Ethiopia in a period of 1990-1995. The relative comparisons of increase indicated that CO₂ has increased by 24% while emission of CH₄ and N₂O increased by 1% and 19% respectively. Aggregate greenhouse gases emissions in terms of CO₂- equivalents have increased by 12 % (NMSA, 2001). 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 increase with the projected increase in population.

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 for 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).

Even so, 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. In this regard, on famine and epidemics, Pankhurst (1985), try to indicate that “several subsequent epidemics and famines were mentioned several times in the literature of the thirteenth and fourteenth centuries which suggests that such outbreaks were regarded as punishments sent down by God”

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. 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).

2.4 Impact of climate change/ variability in Ethiopia

Ethiopia is one of the most vulnerable countries to climate variability and changes due, its high dependence on rain-fed agriculture and natural resources. The country is indeed rated as among the most vulnerable to climate change as a result of its low adaptive capacity. The country has frequently experienced extreme climate events like droughts and floods, and other climate-related hazards. The variability of rainfall and the increasing temperature are blamed for the frequent droughts that at times lead to famine, adversely impacting on the people's livelihood. Since the early 1980s, the country has suffered seven major droughts, five of which led to famines in addition to dozens of local droughts.

At the national level, climate change may reduce Ethiopia's GDP compared to a baseline scenario by 2-6 percent by 2015, and by up to 10 percent by 2045. Ethiopia's extreme vulnerability to the impacts of climate change is also driven by social, economic and environmental factors; and in particular, 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, low levels of awareness on climate change. Past assessments have shown agriculture, water and human health as the most vulnerable sectors. From a livelihood approach, smallholder farmers who depend heavily on rain-fed operations and pastoralists are found to be the most vulnerable. The arid, semi-arid and the dry sub-humid parts of the country are affected most by drought. Vulnerability therefore varies from one region to the other, based on social, economic, institutional and environmental conditions, among other. Pastoralists, for example, tend to be more vulnerable to climate change than (crop) farmers.

Currently climate change and variability is already impose significant challenge to Ethiopia by affecting food security, water and energy supply, health, poverty reduction and sustainable development efforts (Abebe, 2007). Furthermore, extreme weather events, such as droughts, floods, or landslides, may cause death to domestic animals. Livestock suffering and death often means that farmer's wealth is decreased and they lost much of their resources (Pettengell, 2010).

The adverse impact of climate change are not only these particularly climate change/variability also has significant impact on rain fed agriculture (IPCC, 2007). According to IFPRI (2009), agriculture is the most vulnerable sector to climate change. Higher temperatures eventually reduce yields of desirable crops while encouraging weed and pest proliferation. According to reports of the IPCC (2007), the projected yield reduction because of climate change in some poor countries could be as much as 50% by 2020. Under climate change, much agricultural land will be lost, with shorter growing seasons and lower yields. National communications report that climate change will cause a general decline in most of the subsistence crops, example sorghum in Sudan, Ethiopia, Eritrea and Zambia; maize in Ghana; Millet in Sudan; and groundnuts in Gambia (UNFCCC, 2007). Many countries in tropical and sub-tropical regions are expected to be more vulnerable to warming because additional warming will affect their marginal water

balance and harm their agricultural sectors (Mendelsohn, et al. 2000). Agriculture is, contributing about half of the GDP, provides employment opportunity for majority of working force and generates considerable foreign exchange (MoFED, 2006). Despite its high contribution to the overall economy, this sector is challenged by many factors, of which climate related disasters like drought and flood, are the major ones (Temesgen, 2007). As a result of this, the country becomes highly vulnerable to climate change and variability.

Climate change and variability could have significant impact in Ethiopia for various reasons; because its economy mainly depends on small scale rain fed agriculture, which is very sensitive to climate variation. Large part of the country is arid and semiarid and which is highly prone to desertification and drought. There is also a fragile highland ecosystem, which is currently under stress due to population pressure (NMA, 2001). Abate (2009) argued that, climate change affects agriculture and its effect is pronounced on the subsistence farmers, which have low adaptive capacity. Thomas et al., (2007) indicates that under dryland conditions where the biological productivity is low and majority of the poor are found, climate change is manifested not only by increasing temperature but also through changes in hydrological cycles characterized by both increased droughts and flooding. Changes in precipitation patterns increase the possibility of short run crop failures and long run production declines. The overall impacts of climate change on agriculture are expected to be negative.

Climate change, in particular rising temperatures, can have both direct and indirect effects on animal production. Heat stress (caused by the inability of animals to dissipate environmental heat) can have a direct and detrimental effect on health, growth and reproduction. Changes in the nutritional environment (e.g. the availability of livestock feeds, and the quantity and quality of livestock pastures and forage crops) can have an indirect effect (FAO, 2008). Climate change will affect human health and well-being through a variety of mechanisms.

Climate change can adversely affect the availability of fresh water supplies, and the efficiency of local sewerage systems (WHO, 2000). Under climate change, rising temperatures are changing the geographical distribution of disease vectors, which are migrating to new areas, and higher altitudes, for example, migration of the malaria mosquito to higher altitudes will expose large

numbers of previously unexposed people to infection in the densely populated east African highlands (Boko, et al., 2007).

Climate change causes degradation and loss of important natural resources. The increasing occurrence of climate extremes (for example heat waves, droughts, heavy precipitation) is having an impact on land degradation processes, including floods, mass movements, soil erosion by water and wind and Salinization in all parts of the globe. Climate variability and land degradation are intimately linked and are generating unexpected effects on soils, water, forest and wetlands (Sivakumar and Ndiang'ui, 2007). According to the report of IPCC (2007), climate change caused decreasing water availability and increasing drought in mid-latitudes and semi-arid low latitudes. As a result, hundreds of millions of people exposed to increased water stress. Higher water temperatures and changes in extremes, including floods and droughts, are projected to affect water quality and exacerbate many forms of water pollution-from sediments, nutrients, dissolved organic carbon, pathogens, pesticides and salt, as well as thermal pollution, with possible negative impacts on ecosystems, human health, and water system reliability and operating costs (Bates, 2008). Climate change also affects forest resources. Extensive changes in the area of forests due to deforestation can seriously affect the climate in the region of change. Changes in carbon dioxide, temperature or rainfall associated with climate change can have a major impact on the health or structure of forests that can in turn feedback on the climate (Houghton, 2009).

	Sector	Potential impact
1	Agriculture	<ul style="list-style-type: none"> • Shortening of maturity period and decrease in crop yield
2	Grassland and Livestock	<ul style="list-style-type: none"> • Change in livestock feed availability • Effects of climate change on animal health, growth and reproduction • Impacts on forage crops quality and quantity • Change in distribution of diseases • Changes in decomposition rate • Change in income and prices • Contracting pastoral zones in many parts of the country
3	Forests	<ul style="list-style-type: none"> • Expansion of tropical dry forests and the disappearance of lower montane wet forests; • Expansion of desertification
4	Water Resources	<ul style="list-style-type: none"> • Decrease in river run-off • Decrease in energy production • Flood and drought impacts
5	Human Health	<ul style="list-style-type: none"> • Expansion of malaria to highland areas
6	Wild life	<ul style="list-style-type: none"> • Shift in physiological responses of individual organisms • Shift in species distribution from one to the next • Shift in biomes over decades/centuries • Shifts in genetic makeup of population • Loss of key wetland stopover and breeding sites for threatened bird species; and in general endemic and threatened species of flora and fauna are front line victims

Table.1 Impacts of climate change for selected sectors in Ethiopia

Generally, climate changes will most likely increase poverty in Ethiopia (Mideksa, 2010). Long term trends towards reduced rainfall, and recurring droughts, have played a role in weakening of Ethiopian economy (USAID, 2004).

2.5 Local community perception of climate change

Ban and Hawkins (2000) define perception, it is the process by which we receive information or stimuli from our environment and transform it into psychological awareness. Peoples in any community have their own knowledge about their surrounding environment. They perceive there is an increase in temperature and decrease in precipitation but their perception about climate change not evidenced from weather monitoring stations (Maddison, 2006). In most parts of Ethiopia, people perceive declining in rainfall and increased in frequency of drought but it did not confirmed from weather station. Research report from Oxfam (2010) indicated that observations on metrological stations lack congruence with local farmers' perception. This lack of congruence could be due to the fact that farmers' assess rainfall in relation to the needs of particular crops at particular times; small changes in quality, onset, and cessation of rain over days or even hours can make a big difference, whereas meteorological data is more likely to measure totals and larger events. Maddison (2006) also argued that this lack of congruence between farmers' perception and meteorological records could emanate from the analysis of short term climate data and/or due to averaging of record from wider areas.

Perception level towards climate change is differ by sex, education level, age and farming experience, agro ecology and many other factors. According to Norris and Bati (1987) and Maddison (2006) educated persons are assumed to be more perceived than uneducated because education is associated with access to information on climate change, improved technologies and consequences on productivity. Asfaw and Admassie (2004) also argued that female-headed households are often considered to be less likely to get information about new technologies and take risky businesses than male-headed households. Similarly, M. L. Amadou et.al (2015) argued that, the more experience farmers have, the more likely they are to claim that temperatures have increased and the less likely they are to claim there has been no change. Deressa et al. (2008) indicated that farmers living in lowland areas are hypothesized to be more likely to have perceived climate change than the midlands and highlands. Because lowland areas are already hotter and a marginal change in temperature can be perceived more easily.

The degree of farmers' perception on climate change also depends on its impact on farmers' livelihood, their social, institutional and economic background. Mongi et al. (2010) indicated that

farmers in Tanzania were able to note the climate change using different indicators like delay of onset and early retreat of rainfall resulted in shortening of growing period and frequent drought, increased temperature and frequency of flood. However, the degree of perception is different and depends mainly on level of education, livelihood activity, location and age. Moreover, this Perception is strongly related with level of education and sensitivity of the livelihood that the respondent depends on. Maddison (2006) also concluded that most farmers in Africa perceive increased temperature and declined precipitation. Lema and Majule (2009) confirms similar situation in Tanzania. Temesgen et al. (2008) also indicated that majority of contacted farmers in Ethiopia are aware of climate change and perceives an increase in temperature and decrease in precipitation. Local communities' perception about their environment is critical because their perception fundamentally determine socioeconomic activities that can eradicate climate change in their locality. Effective mitigating and adapting to climate change require changes in the behavior of billions of human being, who each day make individual choices that collectively have enormous impact on the Earth's climate (Brechin, 2003: 106 cited in Adane, 2009). Local people have the knowledge and experiences about how to cope with climatic variability and extreme climatic events through their past experience. Local coping strategies are very important elements for adaptation planning. Traditional knowledge can also help to provide appropriate, efficient and time tested methods of advising and enabling the adaptation in communities. According to UNFCCC (2007), farmers have used many traditional techniques in order to adapt climate variability. Some of the techniques are used intercropping, mixed-cropping, agro-forestry and development of new variety of seed to cope with local climate. Furthermore, this result indicated that age of the household head, wealth and information on climate change positively influence farmers' Perception of changes in climatic attributes.

2.6 Global responses to climate change

Climate change is now affecting every country in every continent. It is disrupting national economies and affecting lives, costing people, communities and countries dearly today and even more tomorrow.

Peoples are experiencing the significant impacts of climate change, which include changing weather patterns, rising sea level, and more extreme weather events. The greenhouse gas

emissions from human activities are driving climate change and continue to rise. Therefore Climate change requires an urgent international response. Governments, industries, communities and organizations across the globe are working together to develop and implement measures to reduce greenhouse gas (GHG) emissions and avoid dangerous climate change (office of climate change, 2010). Several international conferences, seminars, symposia and workshops were held in different time and country. The United Nation Framework Convention on Climate Change (UNFCCC) is an international environmental treaty produced at United Nations Conference on Environment and Development (UNCED) held in Rio D'Janeiro in 1992. The objective of the treaty was to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. As a framework treaty, the convention set no mandatory limits to GHG emissions for individual nations and contained no enforcement provisions. It is therefore considered non-binding. Rather, the agreement includes provisions for updates (called "protocols") that would set mandatory emission limits. The principal update is the Kyoto protocol (Aklilu and Alebachew, 2009a). The Kyoto Protocol, adopted in December 1997, is an international agreement, which builds on the UNFCCC and sets legally binding targets for cutting GHG emissions of industrialized countries. Like the UNFCCC, the Kyoto Protocol aims to stabilize GHG emissions in the atmosphere. The major distinction between the two documents is that while the convention encouraged developed countries to stabilize GHG emissions, the protocol commits them to do so. The protocol sets out emission reduction targets for developed countries because they have been responsible for the vast majority of the world's human-induced GHG emissions (office of climate change, 2010). The protocol was entered in to force on 16 February 2005. As of November 2009, 187 states have signed the protocol. The same literature adds that Copenhagen Accord was forged at the 15th Conference of the Parties, held in Copenhagen in December 2009, towards a new agreement beyond the Kyoto Protocol. The accord is significant because it is the first global agreement on climate change, involving the major developed and developing countries. The United States and major developing economies, such as China, Brazil and India, played a key role for the first time.

UNFCCC and the Kyoto protocol have confronted numerous challenges to prosper their prime objectives of reducing emissions. For instance, despite the Kyoto protocol's ambitious goals, even countries that have shown to be its leading advocates, such as Japan, Canada, and the members of the European Union had not able to meet their targeted reductions of emissions. In

addition, the Australian government still refuses to ratify this agreement and along with the United States of America remain the only Annex I countries of the United Nations Convention on climate change to not ratify the Protocol (CamWalker, 2006).

Climate change is one of the all-encompassing global environmental changes likely to have deleterious effects on natural and human systems, economies and infrastructure. The risks associated with it call for a broad spectrum of policy responses and strategies at the local, regional, national and global level. The UNFCCC (United Nations Framework Convention on climate change) highlights two fundamental response strategies: mitigation and adaptation. Adaptation means anticipating the adverse effects of climate change and taking appropriate action to prevent or minimize the damage they can cause, or taking advantage of opportunities that may arise. While mitigation is any strategy that can help to limit climate change by reducing the emissions of GHG and by enhancing 'sink' opportunities, adaptation aims to alleviate the adverse impacts through a wide range of system-specific actions (Fussel and Klein, 2002).

Although these two measures must be pursued to tackle the climate change problem and to create an effective and inclusive international climate change regime, mitigation has received greater attention than adaptation, both from a scientific and policy perspective. One plausible reason for this could be that climate change emerged as a problem related to the long term disturbance of the global geo-biochemical cycles and associated effects on the climate system (Cohen et al. 1998). Given the far-ranging adverse impacts of climate change, adaptation must be an integral component of an effective strategy to address climate change, along with mitigation. Adaptation and mitigation are intricately linked-the when we mitigate more, the less we have to adapt. However, even if substantial efforts were undertaken to reduce further greenhouse gas emissions, some degree of climate change is unavoidable and will lead to adverse impacts, some of which are already being felt (GLCA, 2009).

2.7 Local communities adaptation efforts in Ethiopia

Mixed farming

In the drier areas of Ethiopia, cropping is largely difficult and certainly risk full both with regards to production and environmental degradation (Cooper et al., 2008). In these areas

pastoralism dominates. In other areas of the country, crop production can be mixed with pastoralism and risk can be reduced this way. CEEPA (2006) stated that, owning livestock may buffer the farmers against the effect of crop failure or low yields during harsh climatic conditions. If the farmers have these types of resources it may function as an important safety net and also contribute to extra income, because animal products can be sold, and livestock can also be sold during difficult periods. Selling of livestock is identified as a coping mechanism to climate variability and extremes in Ethiopia (Abebe, 2007).

Selling of assets

Sale of agricultural tools and other assets are identified as coping mechanism to climate variability and extremes in Ethiopia. Farmers may sell some of their resources, and this can be an important extra income, and can also function as a safety net and a coping mechanism. Material assets within the household can be seen as buffer against difficult periods (Chemedda et al., 2006; Abebe, 2007).

Crop diversification

Crop diversification is well known in sub Saharan Africa. This strategy seeks to avoid risks of total crop failure rather than maximizing yields of one particular crop (UNEP, 2006). Also in Ethiopia crop diversification is widespread. Crop diversification is the most commonly used method to overcome the impact of climate change and variability in Ethiopia (Temesgen et al., 2009). Diversification is identified as a coping strategy that has evolved to deal with both expected rainfall uncertainty and seasonal fluctuations in rainfall (Cooper et al., 2008). There are many benefits with crop diversification. It is more secure because if one variety fails, farmers probably still have some other crop varieties that are successful. Secondly, with rotating of crop varieties on each plot of land, soil fertility will be maintained and the soil will not be exhausted (CEEPA, 2006). Maintaining a high level of plant biodiversity within the farm boundaries and in the agricultural landscapes has also been recognized as a good strategy to reduce food insecurity (UNEP, 2006). Crop diversification has become more and more important when the climate is changing.

Irrigation

Rain fed agriculture in sub Saharan Africa will remain vital for food security (Cooper et al., 2008). At the same time, irrigation can be a valuable strategy for making agriculture more stable and safe. Types of irrigation are for example dams and ponds, hand dug wells and other types of wells, flood irrigation, sprinkler irrigation, lifting water using a petrol-fueled pump engine, and irrigation by gravity (CIA, 2011; Joto, 2009). Use of irrigation is one of the least practiced adaptation strategies among the major adaptation methods identified in Ethiopia (Temesgen et al., 2009).

Off-Farm Activities

Farmer's vulnerability to climate change can be mitigated if they have off-farm work on the side. Chemedda et al. (2006) found that, sale of labor was a successful coping strategy among farmers in the Upper Awash Basin of Ethiopia during drought periods because, it reduces dependency on agriculture. Traditional and contemporary coping mechanisms in Ethiopia also include increased petty commodity production (Abebe, 2007). Off-farm activities can for instance be selling of honey, or home made products like mattresses, hot food, beverages, and ropes. Where opportunities exist, working as wage laborers and trading commodities are also common in Ethiopia (Cooper et al., 2008).

Tree Planting

Temesgen et al. (2009) identified that, tree planting to be one of the major methods used by farmers to adapt to climate change in the Nile Basin of Ethiopia. Vegetation like trees and grass are valuable because the roots protect the soil from erosion. Trees are valuable during floods and droughts, and many trees together will give lower temperatures in the near area, a fresh air, and also shadow.

Soil and water conservation

One of the adaptation strategies found in Temesgen et al (2009) research in the Nile Basin of Ethiopia was soil conservation. Many areas of Ethiopia are mountainous and crop fields are rarely flat. Often they are located in a hill side or in a valley side. This creates extra demand for

soil and water conservation to prevent the soil and rainwater from being washed away. Terraces are often built together with soil bunds, stone bunds, deep trenches, and special rainwater harvesting methods. Those are the most common strategies to conserve soil and water in the field. Soil and water conservation strategies are mainly used because of soil degradation and soil erosion, and because farmers due to this, want to rehabilitate their fields. Today these activities are increasingly important because climate change to some extent is accelerating these processes.

2.8 Ethiopia government policy on climate change

Ethiopia is not obliged under the Climate Change Convention to reduce its greenhouse gas (GHG) emissions. Ethiopia's contribution (143 Mt CO₂ e p.a.) to the total global GHG emissions is marginal, representing less than 0.3 percent of total global emissions (34.5 billion tones CO₂) in 2012. Of the 143 Mt CO₂ e in 2013, about 79% of GHG emissions came from the Agriculture, Forestry and Other Land Use (AFOLU) where agriculture produces 55%; (Cropland 26%, livestock 23%, direct and indirect emissions from managed soils and manure managements aggregated to 6%), grassland produces 14% and forestry removed (30%). The energy and waste contribute 15% and 5% respectively and the Industrial Process and Product Use (IPPU) sector only 1%. (MEF, 2015)

Even if the contribution is said to be negligible or minimum, climate change poses serious threat to agricultural production, natural resource base and the livelihood of communities. The threat is particularly severe in the dry lands. In line with this attempts are being made to mainstream potential response measures for reducing the resulting impacts. In reduction of climate change and variability related impacts policy makers are playing an important role. Recently, many countries are mainstreaming climate change in to their development plans. Before climate change have got prior agenda on international level, Ethiopia already approved energy policy that address climate change in 1997. At the higher level, the government has also signed and ratified the Rio Conventions and Kyoto protocol, namely the United Nations Framework Convention on Climate Change and its Protocol, the Bio-diversity Convention and the Conventions to Combat Desertification. After these conventions, through the National Adaptation Plan of Action (NAPA), twenty priority project ideas were identified that address climate change adaptation needs of the country (Kidane et al., 2009). More specifically, the

government of Ethiopia has set adaptation measures in agriculture, roads, and hydropower. 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 fuel efficient vehicles, and usage of fuel efficient stoves are some of the strategic directions to reduce CO₂ emissions that the government promoted in its policy documents.

In addition, the Ethiopian government gives emphasis to climate change adaptation and mitigation in the first five years development plan (GTP) and now in the second GTP this issue inquires more emphasis than the first. The plan has incorporated climate change issues to make national development paths more sustainable as compared to the previous plans. To achieve this plan the government gives 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, geothermal and bio-fuel.

Ethiopia has sufficient amount of water resources and hydroelectric potential, capacity only less 5% of water has been developed for irrigation. 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, 2011).

To address this problem many mega power generating projects are under construction. According to MWIE, Ethiopia planned 17,347 MW electric power at the end of 2012 E.C. from hydro power including EGRD. On the other hand the ministry also plans to construct and distribute 31,400 biogas digesters, 400,000 solar home systems, 3,600 institutional solar systems and 3,600,000 small solar lamps at the end of second GTP period.

Ethiopia has also suitable land for bio-fuel development. The major targets of the government regarding bio-fuel are increasing bio-ethanol from 60 million to 1,288 million liters at the end of second GTP period, increasing bio-diesel up to 212 million liters and increasing the number of blending facility of benzene –ethanol and bio-diesel. By doing this we can reduce around 65 million ton of CO₂ emission from different sources (MMPNG, 2015).

In return, the supply of energy in Ethiopia from renewable sources will reach above 20,000MW at the end of the second GTP period. In general Ethiopia planned to reduce 679.61 million metric ton carbon dioxide at the end of the second GTP period in different sectors. (MEF, 2015)

2.9 Barriers to adaptation and perception on climate change

Many studies argue that adaptations towards climate impact are determined by a number of socio economic and behavioral variables such as, creative management, change of thinking, prioritization and related shifts in resources, climate information, institutions, etc. Adger (2009) argue, many seeming social limits are, in fact, flexible barriers; they can be overcome with sufficient political will, social support, resources, and effort. However, many barriers will make adaptation less efficient or less effective, or require costly changes that lead to missed opportunities or higher costs.

Even though there are several adaptation choices that produce positive results, adoption and assimilation of these has been less. This can be credited to a number of factors that affect or hinder adoption and up-scaling. Some of the main factors are accessibility to resources, market, technological development, information and skills, infrastructure, gender and equity, governance structure, socio-cultural perspectives, environmental and health issues, extension services and incentives, and conflicts among different interest groups (Ngigi, 2009). At household levels some of the constraints have been viewed as a socio-cultural rigidity among farmers themselves, the lack of or restricted access to credit, assets and other resources, as well as any alternative livelihood options in the locality. At institutional levels, a limited understanding of climate risks and vulnerabilities, together with a lack of policy direction and regulatory guidance still account for constraints faced by local farmers resulting in their failure to adapt to climate change (Ngigi, 2009).

A large percentage of Ethiopian farmers perceived changes in rainfall and temperature, but have not made any adjustments to their farming practices (Bryan et al. 2009). This might be due to many reasons. The main barriers to adaptation cited by farmers in Ethiopia were amongst others lack of access to or shortage of land, labor, credit, and information on adaptation methods, poor potential for irrigation, and financial constraints (Bryan et al. 2009, Deressa et al. 2009). Poor adaptive capacity, unresponsive governments, and weak policy mechanisms might also be

barriers to adaptation (Salehyan 2005). Shortage of land has been identified as a barrier to adaptation. It is argued that the Ethiopian land tenure system, whereby all land is owned by the state and must be distributed equally to farmers imposes severe limitations to potential improvements of agricultural activities (Ashebir et al. 2007). There are many who maintain that the equalization of assets in rural communities has led to agricultural stagnation (Hailesellasi 2004).

CHAPTER THREE

3. METHODOLOGY

3.1. Description of the Study Area

Ensaro *woreda* is one of the 24 *woreda*'s which is found in North Showa Zone of Amhara Regional state in Ethiopia. Geographically the *woreda* is located between 9° 35' - 9° 55' N and 38° 50' - 39° 5' E with an average elevation of 2435 meters above sea level. The *woreda* has 1 urban *kebele* and 11 rural *kebele*'s. The capital of the *woreda* is *Lemmi* town which is located at 130km distance in the Northwest of Addis Ababa and 85 km from Debir Birehan. Based on the 2007 national census conducted by the Central Statistical Agency (CSA) of Ethiopia, the *woreda* has a total population of 58,203, of whom 29,888 were male and 28,315 female; 3,164 (5.44%) were urban inhabitants. Ensaro is bordered in the south and west by the Oromia Region, in the north by Jemma River which separates it from Merhabiete *woreda*, in the northeast by Moretna Jiru, and in the east by Siyadebrina Wayu *woreda*'s.

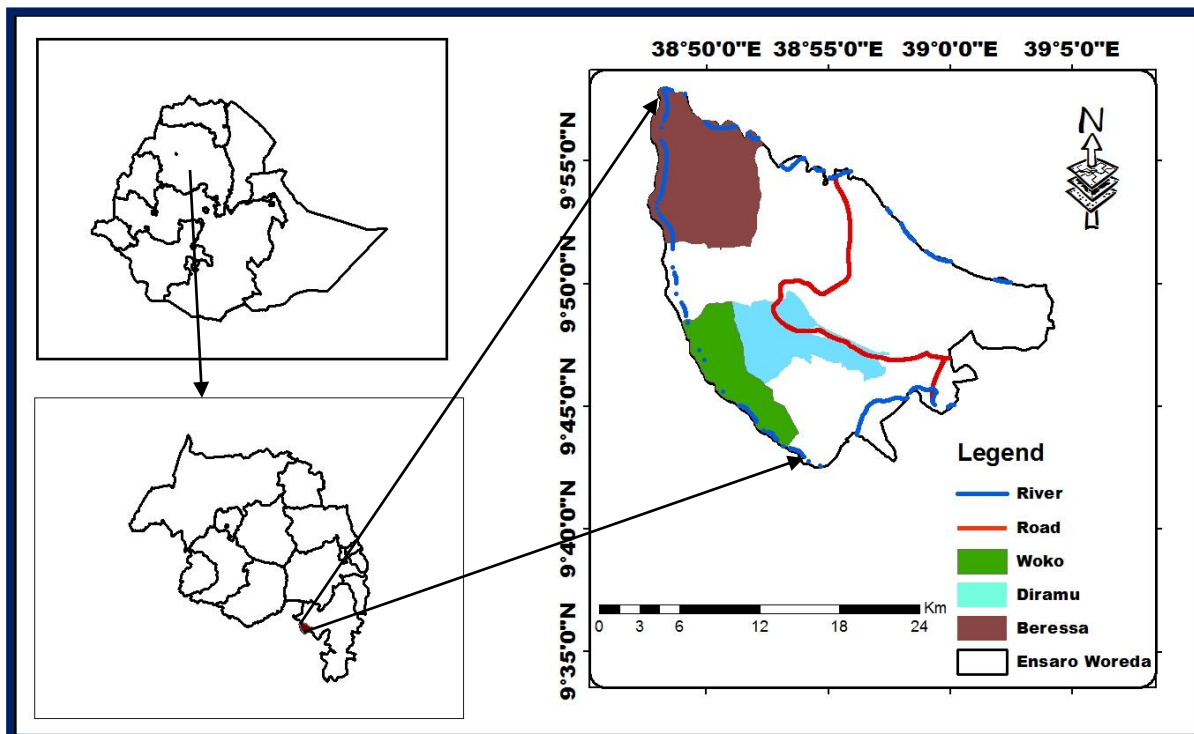


Fig 1. Location Map of the Study area

The *woreda*'s total land coverage is 44,217.6 hectare out of this undulating areas covers about 50%, flat plains 40%, mountainous and others 10%. According to the *woreda* administration and community classification, the *woreda*'s agro-ecology is subdivided in to *kola*³ (33%), *woinadega*⁴ (46%) and *dega*⁵ (21%).

Economic activities

Most of the people in the area are engaged in mixed agriculture. Crop cultivation and livestock production are practiced. Crop production is entirely rainfed, except in very specific and small areas where vegetables are cultivated based on traditional and small-scale irrigation. There are two rainy seasons, *kiremt*⁶ and *belg*⁷, and they are used for the cultivation of long cycle crops. The dominant crops of the study area are *teff*, wheat, barley, maize, sorghum, green paper, bean, *gomenzer*, pea, *neug*, lentils, *shimbra*, *guaya*, *telba*, *suff*, and *abish*⁸ (EWADO 2017). Land preparation is carried on using mainly ox-plowing but tilling by hand occurs in the hilly areas on steeply sloping lands. Recently crop productivity is very low. As a result, many people involve seasonal migration to Addis Ababa and Wolkite to subsidize their livelihoods.

The number of domestic animals found in the wereda include: cattle (30229), pack animals (9657), sheep (13335), goats (14261) and poultry (38819) (EWADO, 2017). Domestic animals usually freely graze, but the middle and better off people also purchase animal feed like hay and crop residues from October to January from the very poor people. This makes the poor to be poorer.

Infrastructures

Regarding distribution of towns, schools, and health services; Ensaro *woreda* has 1 town only. According to Woreda education office Ensaro Woreda has 14 schools, of which 13 are primary and 1 secondary school respectively. Health office also indicates that the *woreda* has 13 health

³ *Kola* refers to a place which is found in between 500-1500 masl

⁴ *Woyinadega* refers to a place which is found in between 1501-2500 masl

⁵ *Dega* refers to a place which is found in between 2501-3500 masl

⁶ *Kiremt* refers to the season which represent months from Jun - September

⁷ *Belg* refers to the season which represent months from February – May

⁸ *Teff*, *gomenzer*, *neug*, *shimbra*, *guaya*, *telba*, *suff*, and *abish* are local name of crops which are cultivated in the area

centers and 4 clinics distributed in the *kebeles* (EWHO, 2017). In addition the area has 4 veterinary posts with very limited service to *woreda's* population. Amhara credit and saving institution is the only institutions who serves credit for the communities and there is also one main road who crosses the *woreda* to the neighboring *woreda* and there is some roads to link *kebeles*.

Soil

According to EWADO, the major soil types in Ensaro *woreda* are clay loam, clay to clay loam and clay to silty clay loam; constitutes about 40.9%, 33.6% and 25.5% of the total area respectively. Clay loam and clay to clay loam soils are the dominant soil type in the area.

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 '*kola*' to '*dega*'. The average annual rainfall amount varies between 900 to 1500 mm and average temperature is in between 18°C-30°C.

Vegetation Coverage

According to EWADO (2017) report, forest lands are found in between the cultivating land and especially in a steep slope area of the study area. The forest land is covered the third highest percentage of the area which covers 15.2% of the *woreda's* total area. This forest and shrubs are used as source of fire wood, forage (fodder) especially for goat, sheep and in the nearest time the people used tree planting of cattle fodder trees like (*Saspania, Trilusern etc.*) this types of trees used for two purpose as forest and their leave used as a fodder for the cattle and forest used the community for different purpose. The trend of forest land is decreased from time to time because the community use for cultivation land.

Drainage and Water Resources

There are three major rivers *Bersina*, *Jema* and *Zegamel* in the border of the woreda. But only *Jema* river is permanent throughout the year. Larger part of the *woreda* is rugged and undulating, which is not suitable for irrigation purpose. Both rivers are not accessible for irrigation at farmer level. They need large capital to use them for irrigation. On the other hand, seasonal streams are dissecting *woreda*'s plain area and form large and deep galleys.

Land use category

According to EWADO, land use system of the area shows the following pattern. Out of the estimated total land area of 44,217.6 hectare; 21,465 hectare (48.5%) is arable land, 3911 hectare (8.8%) is used for grazing, 6,707 hectare (15.2%) is covered with shrubs and afforested plants , 186.1 hectare (0.4%) covered with water, 11,948.56 hectare (27.02%) is allocated for residential and infrastructure development.

3.2 Research design

The study was to assess rural people's perception on climate change, its impact and adaptation measures practices. In order to assess the overall activities at one shot cross sectional research method was used, with purposive sampling techniques to select *kebeles* and households. Data gathering tools like questionnaire, interview, FGD, key informant interview (KII) and observations as well as temperatures and rainfall data from ENMSA gridded data were used.

3.3 Sample size and sampling technique

Sampling technique was used to select the representative sample from the total population under the study and from the total household of the farmer's and *kebeles* administration of Ensaro *woreda*. The study area has eleven rural and one urban *kebeles*. The researcher selected three *kebeles*, namely *Beresa*, *Woko* and *Diremu*⁹. This *kebeles* are purposively selected from different agro climatic zones and which are more vulnerable to climate and prone to risks including drought, famine, high temperatures, and erratic rainfall distribution. The total population of the

⁹ Name of the sample *kebeles*

three *kebeles* are 8353 and 1,232 households, and the researcher has taken 124 male and female household heads purposively, which is greater than 10% of the total households.

Si.no	Kebele Name	Total Household	Sample size	Percentage
1	Beresa	340	34	27.42
2	Woko	476	48	38.71
3	Diremu	416	42	33.87
	Total	1232	124	100.00

Table 2. Sampling HHs

3.4 Data sources

In order to achieve the objective of the study both primary and secondary data sources were employed. Primary data were generated from three types of data sources: questioner, interview, as a major data source and complemented by FGDs and field observation.

Secondary data were collected using available sources of information such as published and unpublished documents. This includes data's from governmental offices, central statistical agency, internet, University and Public Libraries. They also collected from Ensaro *woreda* agriculture, water development and health offices.

3.5 Data collection tools

To get more data from the selected sources, the researcher used the following data collection tools:

3.5.1 Questionnaire

Close ended and open ended questions were prepared to the selected 124 sample households to get data about local communities' perception on climate variability, its impact on their livelihood and adaptations practices.

The closed ended format questions enabled the respondents to select one option that best meet the reviews, while the open ended question was included in order to give opportunity to the respondents to express their perceptions and ideas concerning the problem under study and often

they are only feasible way to reach a number of reviews large enough to allow statistically analyses the results.



Fig 2. Structured interview with female participants

3.5.2 Key informant interview

Key Informant Interviews (KIIs) are aimed to obtain detail information on the issues (Mikkelson, 2005). To get detailed information, the researcher used semi structured interview method because of its flexibility and makes clear any time when there is ambiguity. The key informant interview were conducted with development agents (3), local leaders (3), model farmers (3) and 1 woreda agricultural development office representative, about the cause and impacts of climate variability in the study area.

3.5.3 Focused group discussion

Focus group discussion (FGD) helps to generate data on group dynamics, and allows a small group of respondents to guide by a skilled moderator, to focus on key issue of the research topic (Mwanje, 2001). The researcher selected six respondents in each kebele based on socially respected within society and are known to have better knowledge on the present and past environmental, social and economic status of the study area. At each *kebele*, one focus group discussion were held. The focus group discussions were made with member of selected educated

person (1), local elder (2), religious leader (1), women (1) and 1 young farmers of the sample 'kebele's. The main purpose of focus group discussion was to understand the level of perception of the people about climate change impacts, its cause and their responses. The major discussion topics were on the local community understanding of climate change and its cause, major hazards and their impact and adaptation strategies and barriers to employ them effectively.



Fig 3. Photos during Focus group discussion

3.5.4 Field observation

Robson, (1995) indicates that field observation is used as a supportive technique to collect data that may complement or set in perspective data obtained by other means. In the time of staying in the study area, the researcher observes vegetation covers, topography/relief, major development interventions, people's perception and related things.

3.5.5 Document review

Documents which is found at *woreda* and 'kebeles' were reviewed and used to generate secondary data. Census reports, activity progress reports, relief distribution that contain demographic characteristics, climate distribution, and economic information were reviewed and supplemented the primary data.

3.6 Data analysis and presentation

Data obtained from various sources were analyzed using qualitative and quantitative data analysis techniques. The qualitative information gathered using interview were analyzed using SPSS Version 23.0 statistical software. Errors related to inconsistency of data were checked and corrected during data cleaning, whereas the quantitative data generated by questionnaire and from ENMSA gridded data had been analyzed using descriptive statistics. Descriptive statistics such as mean, frequency and percentage were used to characterize farmer's perception on long-term temperature and precipitation variability as well as various adaptation measures used by farmers, and barriers they face to adapt.

Binary logit model

Logistic regression is used to describe data to explain the relationship between one dependent binary variable and one or more nominal, ordinal, interval or ratio-level independent variables. Many scholars uses different models according to their aim of research. For example Kurukulasuriya and Mendelsohn (2006) employed the multinomial logit model to see crop choice by farmers is whether climate sensitive or not. Similarly, Seo and Mendelsohn (2006) also used multinomial logit model to analyze how livestock species choice is climate sensitive.

But according to Madison's (2006) argument, adaptation to climate change is a two-step process which involves perceiving that climate is changing in the first step and then responding to changes through adaptation in the second step. Therefore, to analyze these two steps this study applied binary logit model. The advantage of this model is that it permits the analysis of decisions across more than two categories, allowing the determination of choice probabilities for different categories (Madalla, 1983).

The parameter estimates of logit model provide only the direction of the effect of the independent variables on the dependent variable, but estimates do not represent either the actual magnitude of change nor probabilities (Deressa, 2010). In this study, independent variables are age, sex, education, family size, occupation, access to extension, access to credit, size of farm land, access to market, farming experience and access to weather information; while the dependent variables are feeling to climate change, rainfall change, drought, feeling of

temperature etc. Independent factors positively affect the perception of farmers on climate change and adaptation.

For statistical analysis, the logit model was employed due to the nature of the decision variable; whether farmers perceived climate change and have adapted or otherwise. For such a dichotomous outcome, the logit model is the most appropriate analysis tool. The logistic model considers the relationship between a binary dependent variable and a set of independent variables that mentioned above, whether binary or continuous. The logistic model for 'k' independent variables (X1, X2, X3..... Xk),

The logistic regression model is given by

$$p(x) = \alpha + \sum_{i=1}^{ki} \beta_i X_i \dots\dots\dots 1$$

(Exp) (β_i) indicates the odds ratio for a person having characteristics i versus not having i, while β_i is the regression coefficient, and α is a constant. Thus the estimated regression coefficient associated with 1 or 0 coded dichotomous predictor is the natural log of the perception of farmers and demographic data associated with climate change.

The logistic model also can be written

$$\ln\left(\frac{P(Y / X)}{1 - P(Y / X)}\right) = \ln\left(\frac{P}{1 - P}\right) = \beta_0 + \beta_1 X \dots\dots\dots 2$$

This implies that the odds for success can be expressed as

$$\frac{P}{1 - P} = e^{\beta_0 + \beta_1 X} \dots\dots\dots 3$$

This relationship is the key to interpreting the coefficients in a logistic regression model

Models relationship between set of variables X_i dichotomous (Yes/No)

$$P("Success" / X) = \frac{e^{\beta_0 + \beta_1 X}}{1 + e^{\beta_0 + \beta_1 X}} \dots\dots\dots 4$$

(Kurukulasurya, P & Mendelson, R, 2006)

CHAPTER FOUR

4. Data presentation and analysis

This chapter discusses and presents observation results of climate change/variability, local communities perception of climate change, impacts of climate change on their livelihood, adaptation practices and barriers to adaptation and perceptions in the study area based on results obtained from household interviews, historical rainfall and temperature records, and qualitative information generated from various groups of the community and concerned officials through FGDs and interviews.

4.1 Demographic and socio-economic characteristics of the respondents

As shown in table 3 from the total household heads included in the sampling, 22 (17.7%) were female-headed and 102 (82.3%) were male-headed households.

Sex	Kebele			Total	%
	Diremu	Woko	Beressa		
Male HHs	35	39	28	102	82.3
Female HHs	7	9	6	22	17.7
Total	42	48	34	124	100

Table 3. Distribution of Sample Households by kebele and Sex

According to Santrock (2011) age group categorization from 20-40 young, 41-60 adult and >60 are elders. In this regard the age distribution of the respondents ranged from 25-65 years and the average age was 48 years. However, 52% the respondent's age were below the average. Although the average household size of the respondents is 6, the absolute size of the respondents ranged from 1 to 8 members. In terms of religious composition, 100% of the survey households are adherent of Orthodox Christianity.

Age	Total					
	Frequency			%		
	Male	Female	Total	Male	Female	Total
20-40	24	8	32	23.5	36.4	25.8
41-60	61	12	73	59.8	54.5	58.9
>60	17	2	19	16.7	9.1	15.3

Table 4. Distribution of Sample Households by age group

As shown in table 5, more than 45.2% of the respondents stated that they could read and write, while 15.3% have completed primary school and only 3.2% completed their high school. While 36.3% of the household heads were illiterate with no formal education. Thus, they are unable to read and write. In general 63.7% and 36.3% of the respondents were literate and illiterate respectively. 86.3% of the households means of livelihood are farming and 13.7% were practiced both farming and off farming activities (wage labor, petty trades etc.)

Literacy Status	Total					
	Frequency			%		
	Male	Female	Total	Male	Female	Total
Illiterate	35	10	45	34.3	45.5	36.3
Read and Write	50	6	56	49.1	27.3	45.2
Primary school complete	14	5	19	13.7	22.7	15.3
High school complete	3	1	4	2.9	4.5	3.2

Table 5. Distribution of Sample Households by educational status and kebele

As indicated in Table.6, about 70.2% of the respondents had 0.51 to 2ha of farmland, while about 12.9% have had 0.5ha of farm land and 16.9% of the respondents have >2.1ha. In general, 46.7% of the respondents have less than 1ha of farmland. About 7.3%, 6.5%, 6.5% and 25.8% of the respondents do not have cattle, oxen, pack animal and small ruminants, respectively.

kebele	Sex	Size of Farmland in ha				Ox				Cow				Ruminant			Total	Pack Animal			
		0.5	0.51-2	>2.1	Total	0	1-2	>2	Total	0	1-2	>2	Total	0	1-2	>2		0	1-5	>5	Total
Diremu	Male	2	24	9	35	-	26	9	35	-	29	6	35	-	8	27	35	5	26	4	35
	Fem	1	4	2	7	1	5	1	7	1	5	1	7	-	1	6	7	2	4	1	7
Woko	Male	8	28	3	39	2	28	9	39	2	34	3	39	2	14	23	39	11	23	5	39
	Fem	2	7	-	9	3	6	-	9	4	4	1	9	4	1	4	9	7	2	-	9
Beressa	Male	2	20	6	28	1	21	6	28	1	22	5	28	-	7	21	28	2	22	4	28
	Fem	1	4	1	6	1	4	1	6	1	4	1	6	2	2	2	6	5	1	-	6
Total		16	87	21	124	8	90	26	124	9	98	17	124	8	33	83	124	32	78	14	124

Source: Field survey, 2017

Table 6. Distribution of Sample Households by wealth Status and kebele

4.2 Climate data analysis

4.2.1 Temperature

According to NMSA (2007), the average annual minimum temperature over the country has increased by about 0.37°C, whereas, average annual maximum temperature has increased by about 0.1°C every decade (NMSA, 2001). Temperature distribution in the study area was characterized by a general trend of increased and annual variability. Temperature is one of the elements that determine weather condition as well as climate of an area. It is recorded as maximum and minimum daily, monthly and annual temperatures. Annual maximum, minimum and average temperatures are presented in Annex 1 and it shows the warmest year was 2015, while the coldest year was 1995. Highest annual range was manifested in 1989, while the lowest range was recorded in 1998. Generally, the trend of temperature shows slight increment from year to year. The average temperature of the study area has increased by 0.67°C in the past 30 years with an annual increment of 0.22°C. On the other hand maximum and minimum temperature increased by 0.71°C and 0.64°C respectively in the past three decades.

According to the data obtained from ENMSA the average temperature of the woreda understudy ranges between 14.45°C and 16.76°C, while the average maximum temperature ranges between 21.43°C and 24.11°C. Accordingly, the annual minimum temperature ranges between 7.13°C and 9.41°C in the past three decades. The annual range of temperature ranges between 13.3°C and 16.36°C showing that the existence of high variability of temperature of the *woreda* (annex.1).

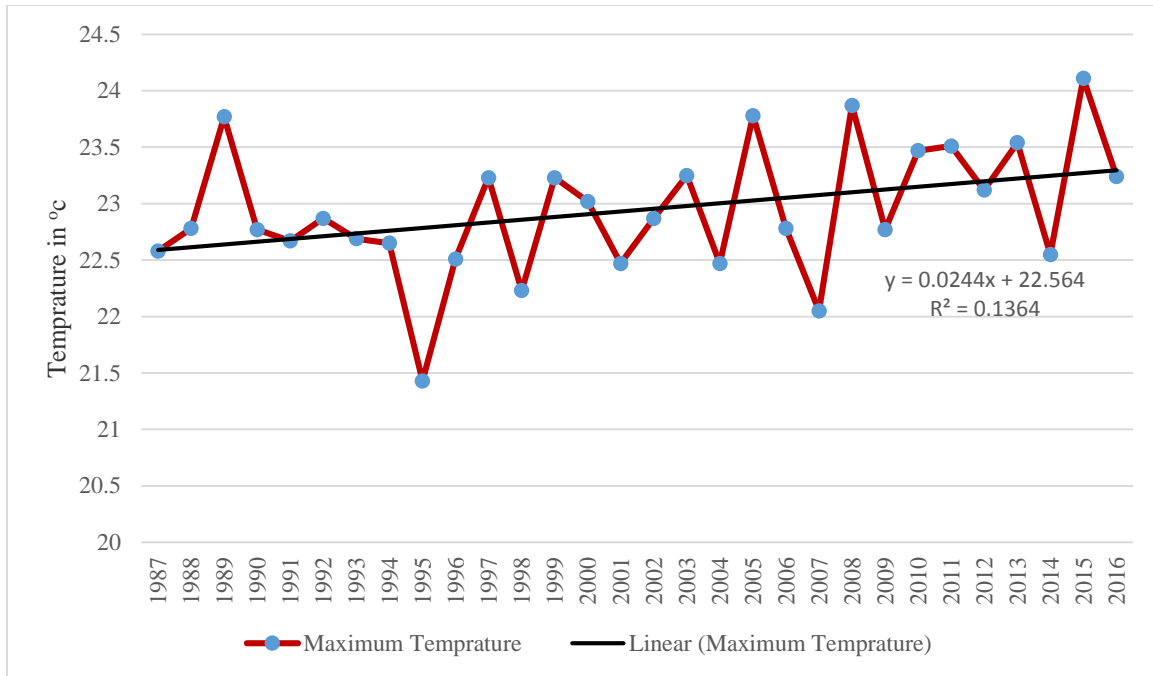


Fig 4. Trend of maximum annual average temperature

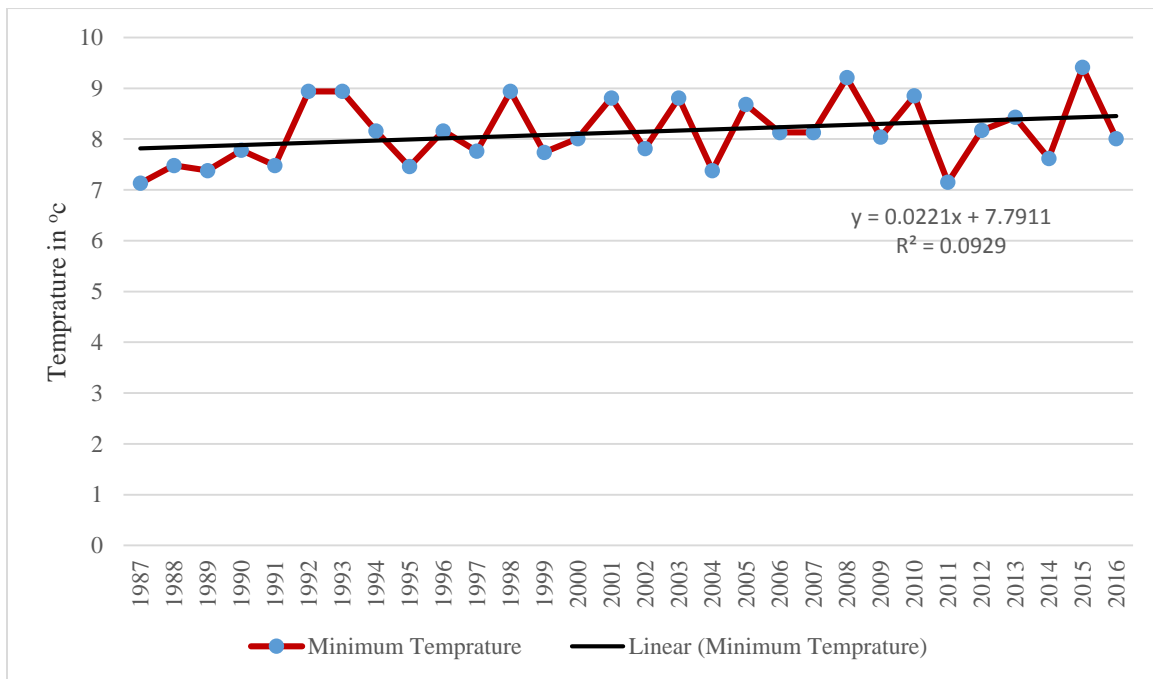
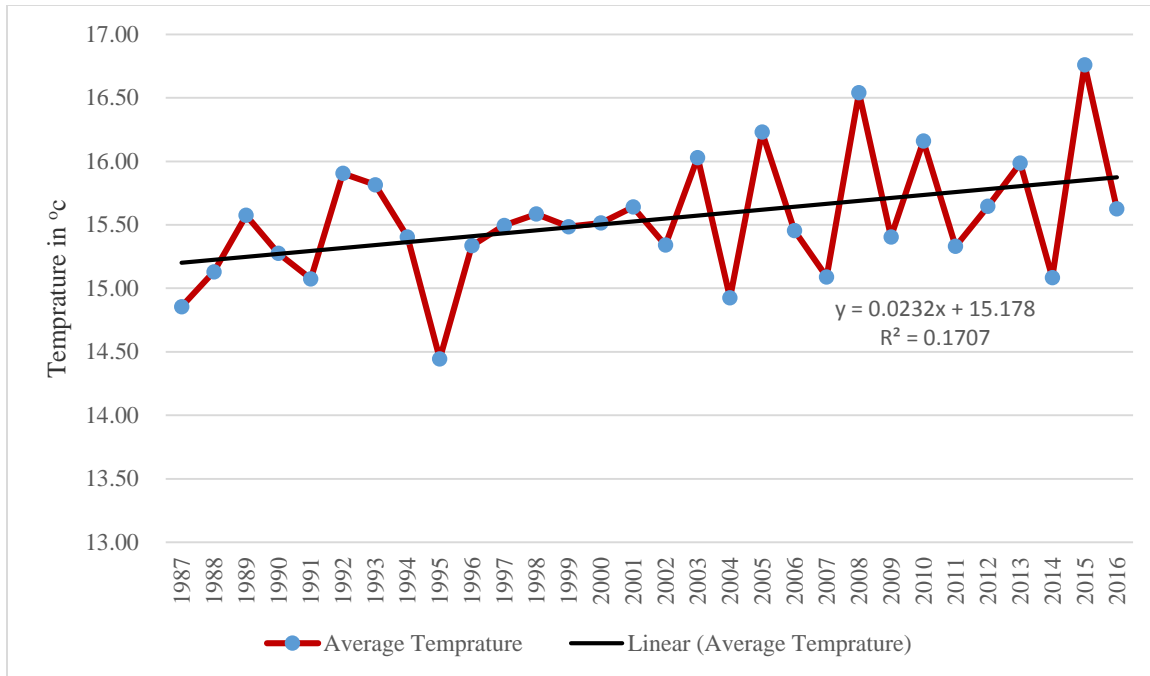


Fig 5. Trend of minimum annual average temperature

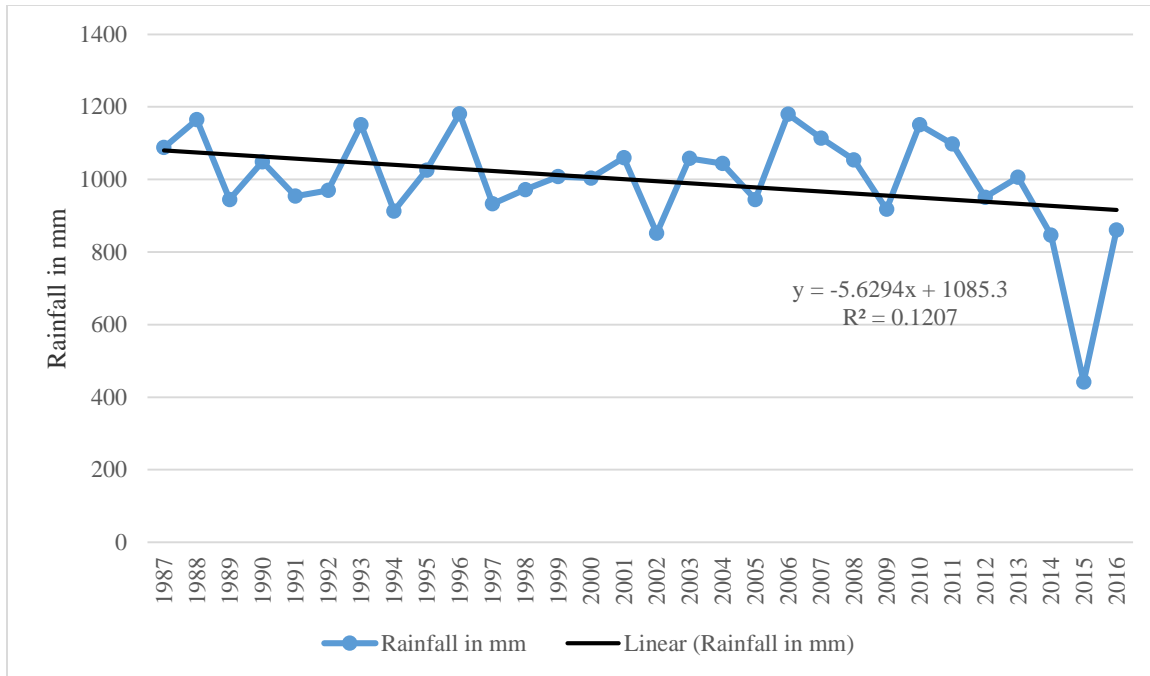


Source: ENMSA gridded data, 2017

Fig 6. Trend of average annual temperature

4.2.2 Rainfall

The annual rainfall of Ensaro *woreda* ranges between 396 mm as the minimum, and 1180mm as maximum, for the past 30 years. Data analysis result shows annual rainfall has a decreasing trend in the past three decades. The amount of rainfall showed yearly fluctuation between 1987 and 2016 (Figure 7). The average rainfall of the *woreda* is 1001 mm in the past three decades. The inter-annual patterns of rainfall distribution showed that annual amounts were below the average in 1989, 1991, 1992, 1994, 1997, 1998, 2002, 2005, 2012, 2014, 2015 and 2016. (Annex 2)



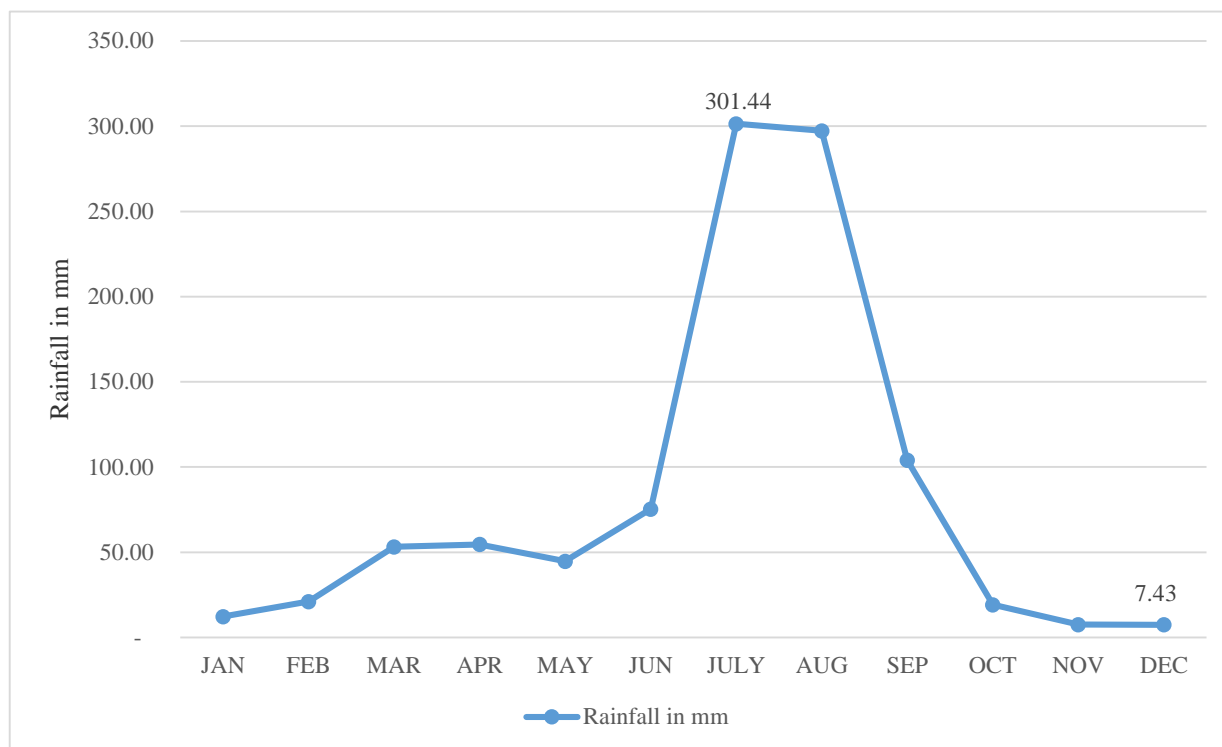
Source: ENMSA gridded data, 2017

Fig 7. Trend of Annual Rainfall

4.2.3 Monthly rainfall distribution and variability

As in most part of Ethiopian *woreda*'s Ensaro *woreda*'s rainy months are Jun, July, August and September while November December and January are the lowest rainy months. As shown in the following figure, the wettest month is August, while the driest month is December with an average rainfall of 7.43 mm. On the other hand, the wettest season is *kiremt* (summer), while the driest season is *bega*¹⁰ (winter). Relatively, *belg* (spring) is the second rainy season in the *woreda*.

¹⁰ A season which represent months from October – January

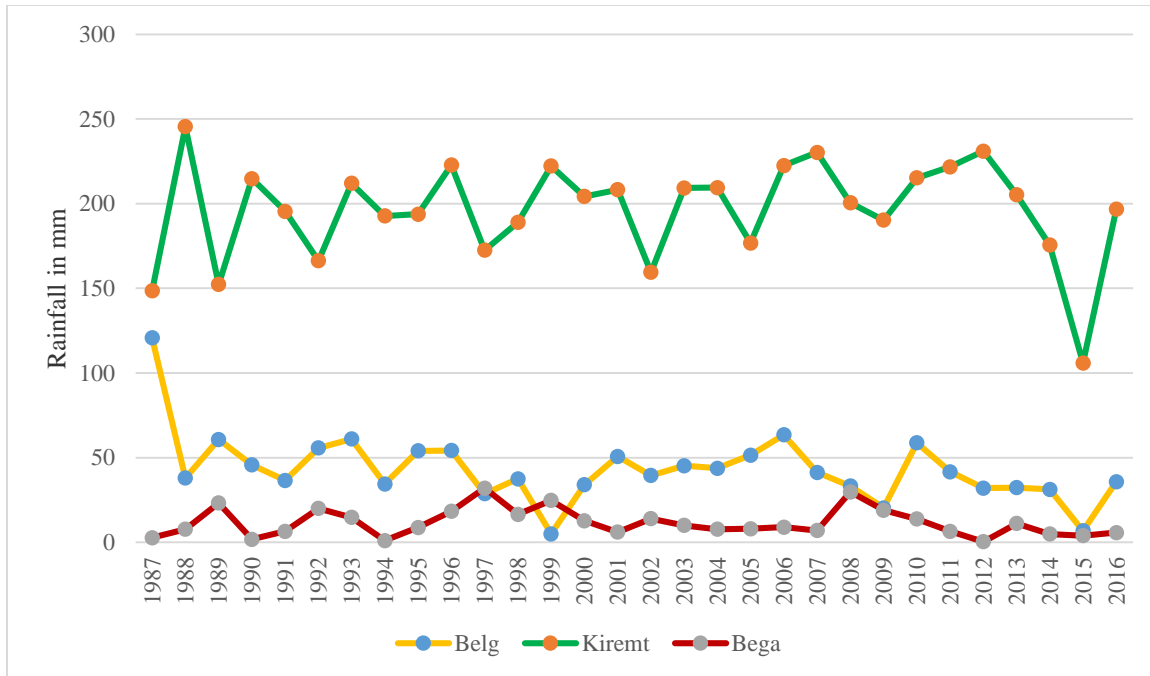


Source: ENMSA gridded data, 2017

Fig 8. Average monthly rainfall distribution

4.2.4 Seasonal rainfall variability trends

Analysis of *belg* rain has shown decline trend from 1987 to 2016. The average rainfall of *belg* in the past three decades was 173.5mm and standard deviation was 81.8. When we compute the coefficient of variance is 47.1% which means this much amount of rainfall is deviated from the mean. Similarly, the mean rainfall of *bega* and *kiremt* was 46.3 and 785.4mm and the coefficient of variance was 71.4% of *bega* and 15% of *kiremt* rain deviated from the mean.



Source: ENMSA gridded data, 2017

Fig 9. Trend of average seasonal rainfall distribution

4.2.5 Inter-annual rainfall variability

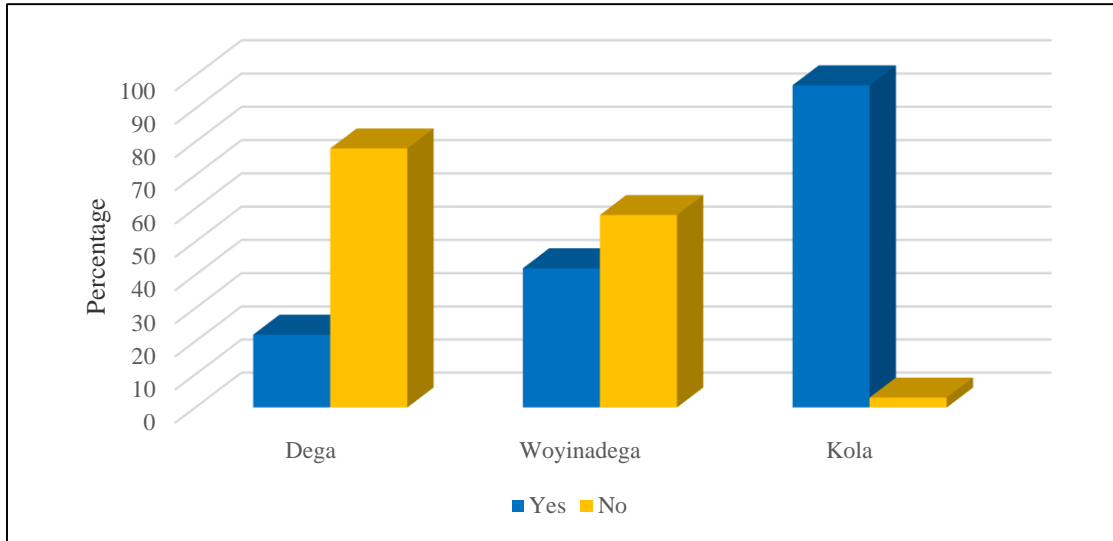
From the table in annex 2 the annual maximum rainfall in the past three decades was 1180mm (1996), while the lowest rainfall was 396mm (2015) showing that the range or the difference between is 784 mm. It shows that there is high variability of rainfall across the years. On the other hand, the average/mean annual rainfall of the past three decades was 1001mm, while standard deviation is about 145.2. Whereas the coefficient of variation of the rainfall in the past three decades was 14.5% which means this much rainfall amount is deviated from the mean. In general, there is high variability in rainfall distribution across the past three decades. The variability of rainfall is more pronounced and the amount shows gradual decreasing trend.

4.3 Descriptive statistics

4.3.1 Local communities perception on rainfall variability

More than 89% of key informant interviewees and participants of the FGDs recognized there were variabilities in rainfall amount, its timing and distribution in the study area over the past 30

years. This was substantiated by household respondents. About 97.4% of the respondents in *kola* area recognized the change (the increase or decrease) of rainfall amount, while only 42.2% and 22.3% of respondents of *woynadega* and *dega* area perceived rainfall change respectively. This shows that climate change is more pronounced in areas already have climatic problem.



Source: Field Survey, 2017

Fig 10. Local people’s perception of rainfall variability by agro ecology

The survey result revealed that all the respondent household heads included in the survey perceived long-term variability in pattern of rainfall amount and distribution. Most of the household heads indicated that rainfall amount in Ensaro *woreda* in the last 30 years showed a decreasing trend and variability whereas only few of the respondents reported that it has increased.

4.3.2 Local communities’ perception on rainfall variability indicators

In the survey, the people were asked to reflect on what indicators they have been using to perceive variabilities in rainfall. Their responses revealed loss of livestock and plant species 11.3%, increased frequency of occurrence of temperature and 92.7% of the respondents says decreasing in rain fall and spread of human population and animal disease 56.5%, shortening of growing period 94%, rainfall comes lately and goes early 100%, decline of agricultural yields

94.4% and decreased available water 100% were reported as indicators of variability in rainfall in the area over the past three decades.

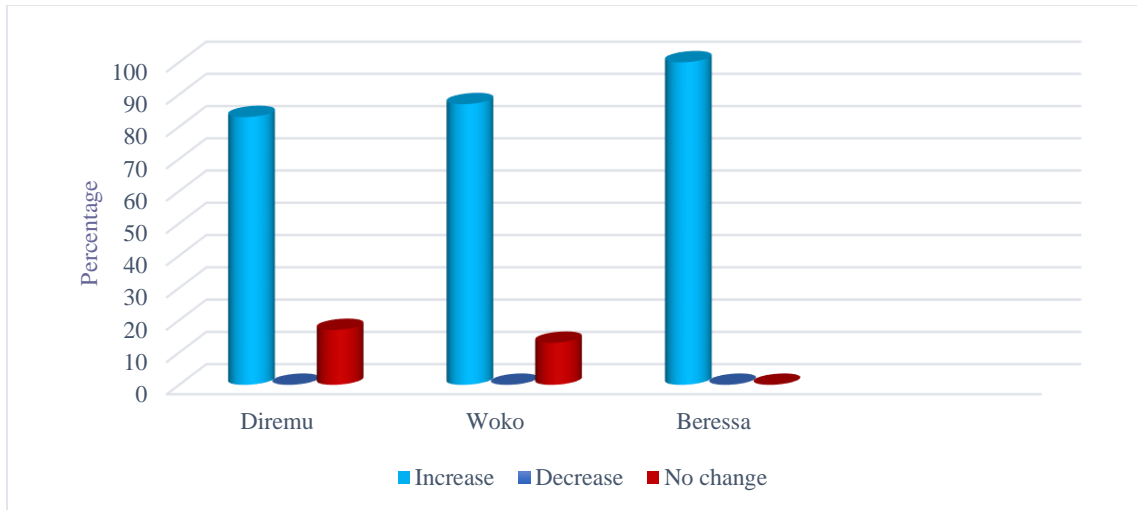
Perception on		Frequency			Percent		
		Male	Female	Total	Male	Female	Total
Loss of livestock and plant species	Increased	12	2	14	11.76	9.09	11.3
	Decreased	90	20	110	88.23	90.90	88.7
Rainfall	Increased	6	3	9	5.88	13.63	7.3
	Decreased	96	19	115	94.12	86.36	92.7
Shortening of growing period	Increased	95	17	112	93.14	77.27	90.3
	Decreased	7	5	12	6.86	22.73	9.7
Rainfall comes late and goes early	Increased	102	22	124	100.00	100.00	100
	Decreased	-	-	-	-	-	-
Agricultural productivity	Increased	5	2	7	4.9	9.09	5.65
	Decreased	97	20	117	95.10	90.91	94.4
Availability of water	Increased	-	-	-	-	-	-
	Decreased	102	22	124	100.00	100.00	100
Expansions of human and animal disease	Increased	56	14	70	54.90	63.64	56.5
	Decreased	46	8	54	45.10	36.36	43.6

Source: Field survey, 2017

Table 7. Local people's perception on rainfall variability indicators

4.3.3 Local communities perception of temperature variability

The people, experts and interviewers indicated that within three decades, the temperature has variability and showed an increasing trend in amount and intensity. The survey result revealed that out of the total household heads included in the survey, all of them perceived that a long-term variability in temperature in Ensaro *woreda* over the past three decades. Out of which, 100%, 87.5% and 83.3% of *kola*, *dega* and *woyinadega* area respondents perceived that temperature is increased year to year respectively, 12.5% and 16.7% of the *woyinadega* and *dega kebele* respondents felt that there is no change in temperature.



Source: field survey 2017

Fig 11. Local people's perception of temperature variability

4.3.4 Local communities perception on temperature variability indicators

Respondents were also asked to identify some of variabilities they have observed in the environment resulting from variabilities in temperature over the past years. Prevalence of newly introduced human and animal disease 61%, drying up of rivers and streams 96% and damage of crops caused by pests 76%, were some of indicators in the environment reported by the respondents as a result of variability of temperature over time. FGD and key informant interview participants also showed, decreasing of water availability and loss of biodiversity and land degradation as indicators of increasing temperature in the area.

4.4 Local communities perception of climate change

Having better understanding of local people's perception on climate change/variation is crucial to design appropriate adaptation and coping strategies (Maddison, 2006 cited in Demeke, 2010). Therefore, it is important to have an insight of local people's view on temperature and rainfall trends of change to dig out locally available climate change and variability adaptation options. In line with this, FGD participants, key informants and respondents were asked their understanding of climate change and source of information. 95.1% of male and 54.5% of female respondents confirm that there is climate change/variation in their locality. More than 69.6% of male and 59.09% of female respondents have had information on climate variation. About 54.03% of the

respondent's major sources of climate change information is radio, and the rest 12.9% and 4.03% of the respondents get information from development agents and market place respectively.

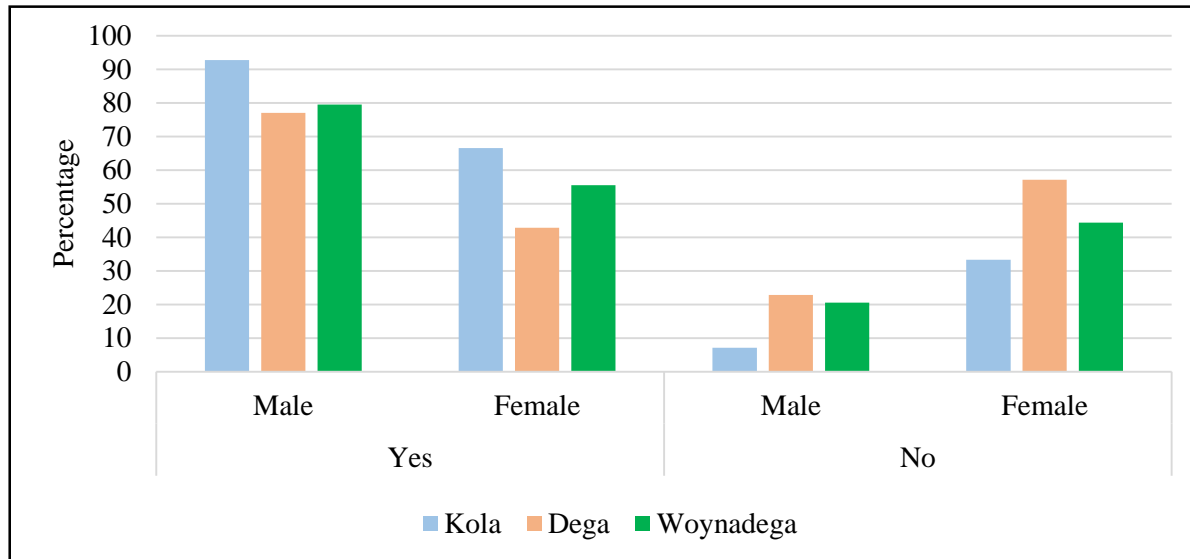
Questions		Frequency			Percentage %		
		Male	Female	Total	Male	Female	Total
Do you think that there is climate Change in your local area?	Yes	97	12	109	95.1	54.5	87.9
	No	4	9	15	3.92	40.9	12.1
Have you heard of the word "climate variability" before?	Yes	71	13	84	69.6	59.1	67.7
	No	31	9	40	30.4	40.9	32.3
From which source you heard about climate variability?	Radio	59	8	67	57.8	36.4	54.0
	DAs	14	2	16	13.7	9.1	12.9
	Market Place	2	3	5	1.96	13.63	4.03
	NGO	-					

Source: Field survey, 2017

Table 8. Local people's perception on climate change

Perception by agro-ecology and sex of HHHs

Deressa et.al (2008) kola area farmers perceived more because lowlands are already hotter and a marginal change in temperature can be perceived more easily. In line with him, the result of this research also shows that *kola* area farmers (92.8% of male and 66.7% of female from the sample) are more aware on climate change than farmers of *woynadega* (79.5% of male and 55.6% of female). 77.1% of male and 42.8% of female respondents are aware of climate change in *dega* area. From the result female headed households are perceived less because they are less access to information, technology and mobility. In contrary male headed farmers have access to information due to mobility, decision makers and their participation in local institutions. In general, about 95.1% of male and 54.5% of female or from the total 87.9% the respondents in both climatic zones are aware of climate change, while 12.1% of respondents perceive either there is no or do not have the knowledge of climate change (fig.12).



Source: Field Survey, 2017

Fig 12. Farmers climate change perception by kebele/agroecology and sex

Perception by age group

According to M. L. Amadou et.al (2015), farmers with high experience are more perceive climate change. In line with his argument table 8 shows that, 60% and 89% and 94% participants those found under age 20-40 (young), 41-60 (adult) and >60 (aged) have understood the existence of climate variability in their *kebele* respectively. Even if adult and youngsters assumed to perceive climate change due to their access to education and information but in this research most of adults were belongs to illiterate, therefore elders perceived very well due to their experience than them (Temesgen et al, 2008).

No	Is there cc in your locality?	Age category of participants (N=124)					
		20-40		41-60		>60	
		No	%	No	%	No	%
1	Yes, there is	25	78.2	66	90.4	18	94.7
2	No, there isn't	7	21.8	7	9.6	1	5.3
Total		32	100	73	100	19	100

Source: Field Survey, 2017

Table 9. Participant's perception of climate variability by age

Perception by education level

Table 9 shows that, out of 45 illiterate participants, 64.4% observed the existence of climate variability. 75%, 89.5% and 100% of participants who are read and write, primary and secondary educational level perceived the existence of climate variability respectively. The result shows that majority of (35.6%) respondents that didn't perceive existence climate variability, are illiterate and followed read and write (25%).

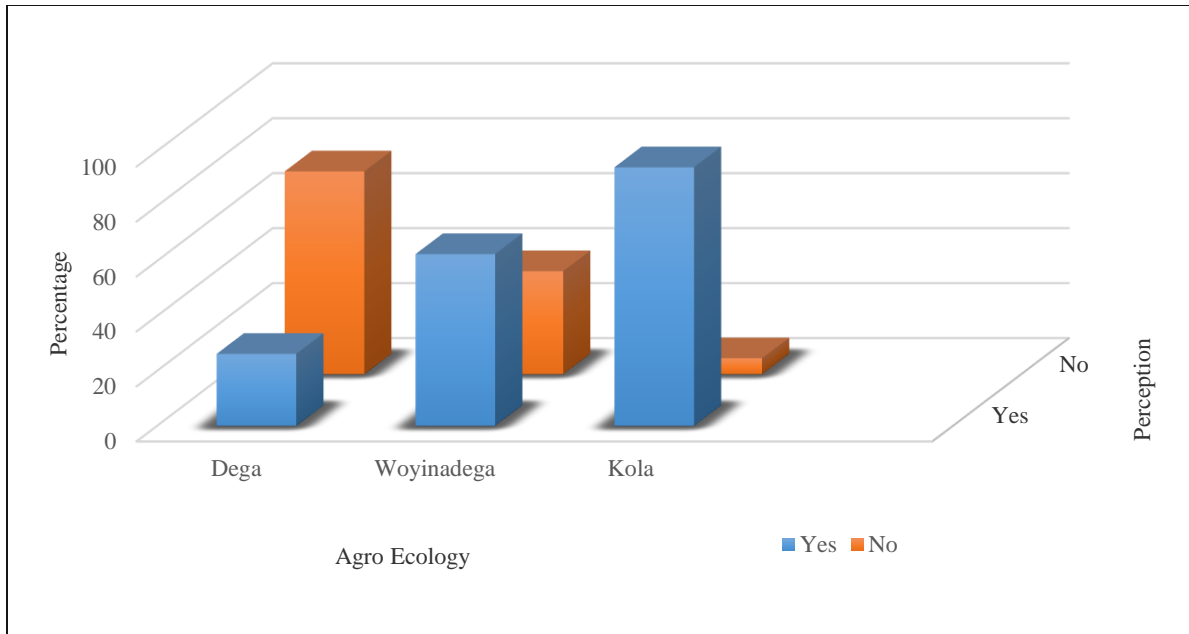
The educational level of farmers has a direct link with the perception to climate variability. Farmers with relatively higher education levels have opportunities to get information from schools, environmental clubs and other sources of information. Thus farmers with higher educational level have better perception than farmers with lower levels of education.

No	Is there cc in your locality?	Educational status of participants (N=124)							
		Illiterate		Read and write		Primary school		High school	
		No	%	No	%	No	%	No	%
1	Yes, there is	29	64.4	42	75	17	89.5	4	100
2	No, there isn't	16	35.6	14	25	2	10.5	-	-
Total		45	100	56	100	19	100	4	100

Source: Field Survey, 2017

Table 10. Participant's perception of climate variability by educational status

From the sample households, about 94.1% are well recognized the existence of drought in *kola* region, while 62.5% of *woynadega* and 26.2% of *dega* respondents have perceived existence of drought. (fig.13). On the other hand, the increment of the frequency of drought is more perceived by *kola* sample respondents (88.9%) than *woynadega* sample respondents (59.5%) and 22.7% of *dega* area respondents perceived the increment of drought. From this one can conclude that climate change was not a problem of the *dega* area of the *woreda* understudy.

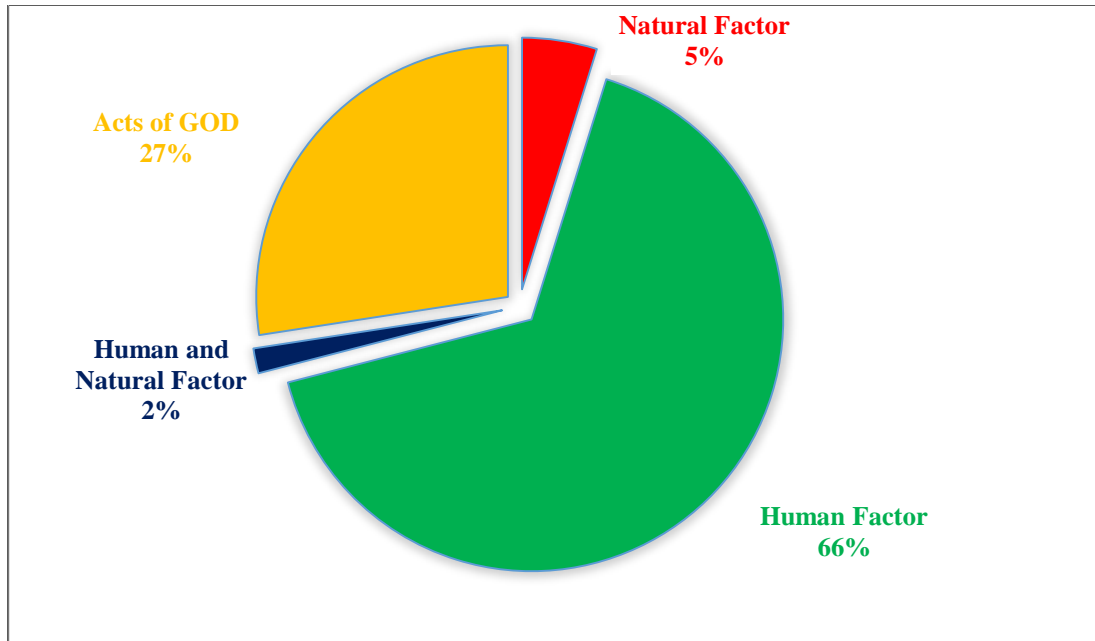


Source: Field Survey, 2017

Fig 13. Perception on the existence of drought by kebele

4.5 Local communities causal attribution of climate change

Most peoples in Ethiopia consider climate change as an act of God, which is regarded as punishment for people’s wrong doings. However, a few people associated climate change with anthropogenic factors. In the contrary most of the respondents in the study area associated climate change with human action. The responses disclosed that more than 66% and 5% of them associated climate change with human factor and natural factor respectively. The remaining 27% of the respondents consider climate change as an act of God, which is a punishment for peoples wrong doings and the remaining 2% respondents consider that climate change is occurred because of both natural and human factor (see Figure 14).



Source: Field survey, 2017

Fig 14. Perception on Causes of climate change/variation

According to table 11 the respondents listed down some of human activities, which affected the local climate to vary. More than 95.2% and 71.8% of the respondents showed that deforestation and population pressure are the main cause of climate variability in the study area respectively. In addition about 91.2% of the respondents also considered over cultivation is the major factor that caused by human activity but they gave little credit to the contribution of fossil fuels and air pollution to climate variability.

Cause of climate change		Frequency	Percentage
Over cultivation	Yes	113	91.2
	No	11	8.87
Deforestation	Yes	118	95.2
	No	6	4.83
Population Pressure	Yes	89	71.8
	No	35	28.3
Air Pollution	Yes	11	8.9
	No	113	91.1

Source: Field Survey, 2017

Table 11. Local people's perception on causes of climate variability from human activities

Most of FGD and key informant interview also identified deforestation, population pressure, shortage of land, poverty and over cultivation as causes of climate variability in the study area.

4.6 Local communities perception on impacts of climate change

Climate variability hazards are events or occurrences that have the potential for causing injury to life, or damage to property or the environment on which the community depends for its social and economic existence. In addition to distinct events that occur at specific points in time and space, the definition of hazards has been extended to include embedded features of the physical, social, political and economic environment with effects that gradually cause disastrous outcomes. Hazards can be sudden events (such as epidemic dysentery, landslide and flood) or things that accumulate gradually (for example soil erosion and population growth) (IPCC, 2007). In the study area pests and disease, variability of rain fall and temperature are recurring problems affecting agricultural activities and human wellbeing.

Climate variability has impacts on livestock, crop production and human health in Ensaro *woreda*. Both crop production and animal husbandry are practiced in the study area. Those activities are climate sensitive; hence, livelihood of the people is affected by climate variability. The main natural constraints to accessing food and generating cash income include pest infestation, weed, insect and disease. According to climate variability early cessation and late onset of rain, heavy and unseasoned rain and pests have caused massive crop failure. Respondents asked to rank the major hazards affecting their livelihood in the *woreda* and they ranked as follows:

Drought: - Drought is not a new phenomenon in Ethiopia as well as in Ensaro *woreda*. The area experienced occurrence of several droughts over the past years. More than 52.7% of the respondents reported that, the re-occurrence interval of drought has changed in recent periods. The re-occurrence interval became shorten and more frequent and takes only 2 to 4 years, giving no sufficient time to recover from its past impacts. Drought, which can include both insufficient amount of rainfall and uneven distribution over the rainy season, is the single most important cause of acute food insecurity in the zone.

Ensaro *woreda*'s rainfall is characterized as a bimodal type. Despite the fact that 2014 *belg* rain was started on time, but it was poor in distribution and insufficient in amount. This poor

distribution and insufficient amount has negatively affected land preparation for summer crop productions and sowing of long cycle crops. The summer rain, on the other hand, was late by one month in all areas of Ensaro *woreda*. However, the distribution of meher rain has remained favorable for the remaining period for the *dega* and the *woyinadega* agro ecologies but in the lowland parts of the *woreda*, where rainfall has been poor in quantity and distribution.

Pests and diseases: - climate change has direct and indirect impacts on prevalence and spread of pests and diseases (Aklilu & Alebachew, 2009a). Community representatives and experts indicated that the study area is exposed to human diseases, livestock diseases and crop pests. Livestock diseases are mainly anthrax (cattle and goats), sheep and goat pox, black leg, internal and external parasites (cattle and goats), pasteurellosis (human disease), African horse fever and lamp skin. Crop pests are a chronic problem in the administrative zone of North Shewa Zone , of which the most hazardous are stalk borer (sorghum and maize), Aphids (all crops), cut worm, root rot, shoots fly (*teff*), African boll worm and late blight, Striga (sorghum and maize) (EWADO, 2017). Human diseases like Helminthiasis, infection of skin, malaria, diarrhea and typhoid are the common diseases which occurred in the *woreda* and some of them like Helminthiasis shows an increasing trend (EWHO, 2017). In view of this, 39.3% of HHs claimed pest and disease as a major threat in their area mainly from *dega* and *woyinadega* agroecology.

Human and livestock diseases and crop pests are not new for the study area. However, climate change resulted in an increase in the frequency of occurrence of pests and diseases in recent years. A small increase in temperature and change in precipitation can result in measurable impacts on pests and diseases (Haines, et al., 2006 cited in Aklilu & Alebachew, 2009a).

Landslide: - landslide is the movement of rock, debris or earth down slope, which result from failure of materials which make up the hill slope and are driven by the force of gravity. It is now commonly occurs everywhere and very recently land slide occurred in Ensaro *woreda*. Accordingly, 3.2% of the respondents answered it as the major disaster. As Disaster Prevention and Preparedness (DPP) case team of Ensaro *woredas* report indicated that the area has encountered landslides in 2015. DPP reported around 46.15 ha cultivated and grazing land area was destroyed in two *kebeles* of the *woreda* from which 36.15 ha area in *woko*. In the report the

experts indicated that peoples in *Woko* and *Diremu kebeles* assume that the land slide occurred because of “their sin as a punishment of GOD”.



Fig 15. Field photo of land slide which occurred in 2015

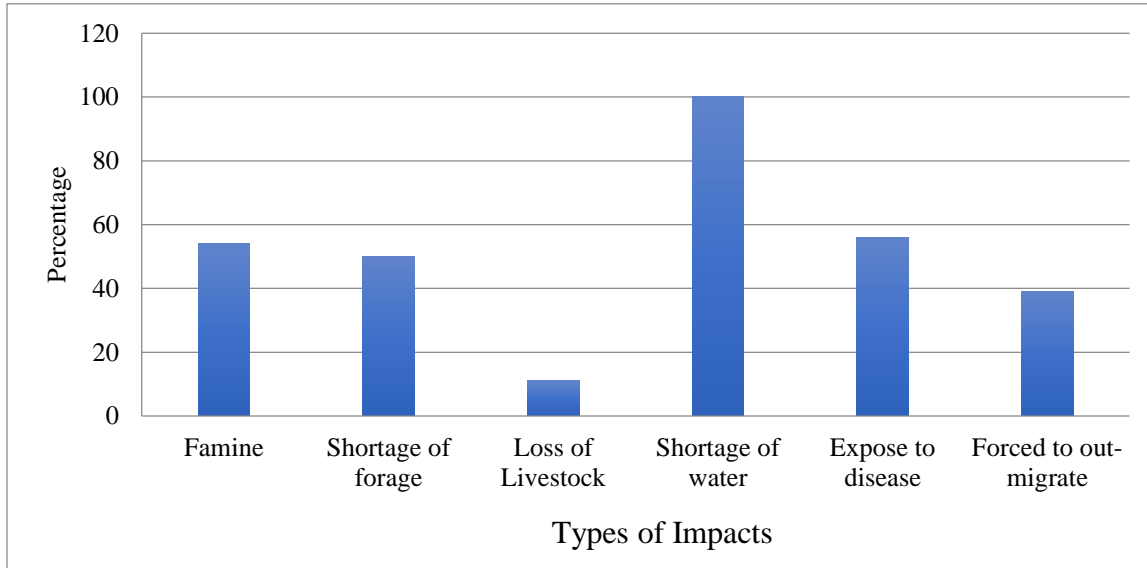
Flood: - flood is one of climate change induced-hazards in Ensaro. Floods are common among those who live near riverbanks, inside valleys, at bottoms of mountains and on hillside of rugged terrain in the study area. About 4.8% of the respondents replied they are suffering from the flood that erode their farm and grazing land in the *woreda*.

Impacts on livelihood

Most people follow traditional cultivation practices that rely on seasonal rain water. Erratic rainfall patterns and hailstorm contributing to soil erosion, soil fertility loss, and crop damage are having an adverse impact on livelihoods of most of these communities, thus increasing risk to food security. Climate change and variability have had serious impacts on livestock and crop production in Ensaro *woreda* recently. Both crop production and animal husbandry are practiced in the area. The livelihood of the people is sensitive to climate change. The main natural constraints to accessing food and generating cash income include drought, pest infestation and livestock disease. According to Ensaro *Woreda* agricultural development office report, climate

change and variability particularly reoccurrence of drought, early cessation and late onset of rain, heavy and unseasoned rain and pests have caused massive crop failure.

As the results shown below, the most commonly mentioned impacts of climate change were shortage of water (100%), expose to disease (56.5%), shortage of feed of animals (50%), forced to out-migrate (39.5%), famine (54.03%), loss of livestock (11.3%).



Source: Field survey, 2017

Fig 16. Most commonly mentioned impacts of climate change (Multiple answer)

The household survey on performance of crop production over the past ten years data shows that there is declining trend in the production and availability of crops in Ensaro *woreda*. According to table 12, about 20.9% of the respondents reported that there was better crop productivity before the past ten years. Beside this, 68.5% considered as medium while 10.5% told crop productivity was indicated as poor compared to recent years (2015). The respondents indicated that in the year 2016, 4.03%, 59.7% and 36.3% of the respondents characterized the productivity as good, medium and poor respectively. As researcher noted earlier, climate variability early cessation, late onset, heavy and unseasoned rain and pests were the major reasons for the reduction of crop production. For instance, this variability of rainfall in Ensaro *woreda* has affected crop production and some impacts on livestock husbandry.

How do you see crop production in time		Frequency	Percentage
Performance of crop production before 10 years ago	High	26	20.96
	Medium	85	68.54
	Low	13	10.48
Performance of crop production in 2016	High	5	4.03
	Medium	74	59.67
	Low	45	36.29

Source: Field survey, 2017

Table 12. Performance of crop production over the past 10 years

According to table 13 an assessment of livestock possession of the sample households was conducted in the area in the past 10 years. Average ownership of livestock per household shows that the number of domestic animal assets decreased over time. For instance, now/2016 the average number of livestock per household in the study area has declined from three oxen to two, four cows to three, sixteen sheep's and goats to eleven and three pack animals to two respectively. This shows a declining trend of animal assets.

Livestock	Before 10 year total number of	Total number in 2016
Oxen	362	273
Cow	498	371
Horse	17	2
Donkey	343	221
Sheep	1192	778
Goat	791	623

Source: Field survey, 2017

Table 13. Domestic animal possession of sample household heads before 10 years and 2016

Generally, the households in Ensaro *woreda* are facing declining trend of crop and animal production in *Woko* and *Beressa kebele* because of variability of rainfall, pests, diseases, and increased and variability's of temperature. As a result, some considerable portions of the households were exposed to reduction of food crops and expansion of disease. They also told that the situation has worsened over time. Shortage of forage is the main reason to decrease their

livestock, in addition that 34.1% of the respondents says, they sell their animals because of they can't pay back the money that they borrow from credit institution and from relatives. So, their resilience towards climate impact is decreasing.

Impacts of climate change on natural resources and the environment

The household assessment of the state of environmental resources in the area shows that about 95.2% and 100% of the respondent households in the study area indicated that the forest cover and water availability have decreased over time respectively. About 92% of the respondents observed increment of problems of soil erosion in Ensaro *wereda*. Generally, 84.67% of the respondents showed that land degradation is serious problem of the society now a days. FGDs and KII participants also confirmed that some plant species like *zigiba*, *wanza*, and *koso*¹¹ are highly decreased in number and some wild animals like *midaqua*, *suse* and *dikula*¹² are totally disappeared from the study area.

How do you see		Frequency	Percentage
Change in forest cover	Increased	6	4.8
	Decreased	118	95.2
	No change		
Soil erosion over time	Increased	114	91.9
	Decreased	10	8.3
	No change		
Water availability	Increased		
	Decreased	124	100
	No change		
Land degradation	Increased	105	84.7
	Decreased	16	12.9
	No change	3	2.42

Source: Field survey, 2017

Table 14. Household's assessment of the state of environmental resources

¹¹ *Zigiba, wanza and koso* local name of trees

¹² *Midaqua, suse and dikula* Are wild animal species which looks likes goats

More affected social groups by climate variability

World Bank, 2010 states that the poor, landless, disabled's, women's, children's, and elders are among the most vulnerable social groups in the community due to lack of access to resources mobility, decision making etc. In view of this, FGD and KI participants indicates that poor peoples are more vulnerable to the impacts of climate change because they don't have enough farm land and livestock's. Accordingly, about 89.7% of respondents said that, women and children are the most affected social groups in the community due to they have several household responsibilities. They are responsible to do all home activities including fetching water, collecting firewood.

4.7 Responses to Climate Change

4.7.1 Community's adaptation mechanisms

Recently, the livelihood of peoples of the study area have been affected by the impact of climate variability. In order to adapt the impact of climate variability hazards, which are noted in the preceding sections, the communities have been applying different strategies. However, increased intensity of climate variability impacts have reduced the capacity of people to adaptation and to cope with the problems.

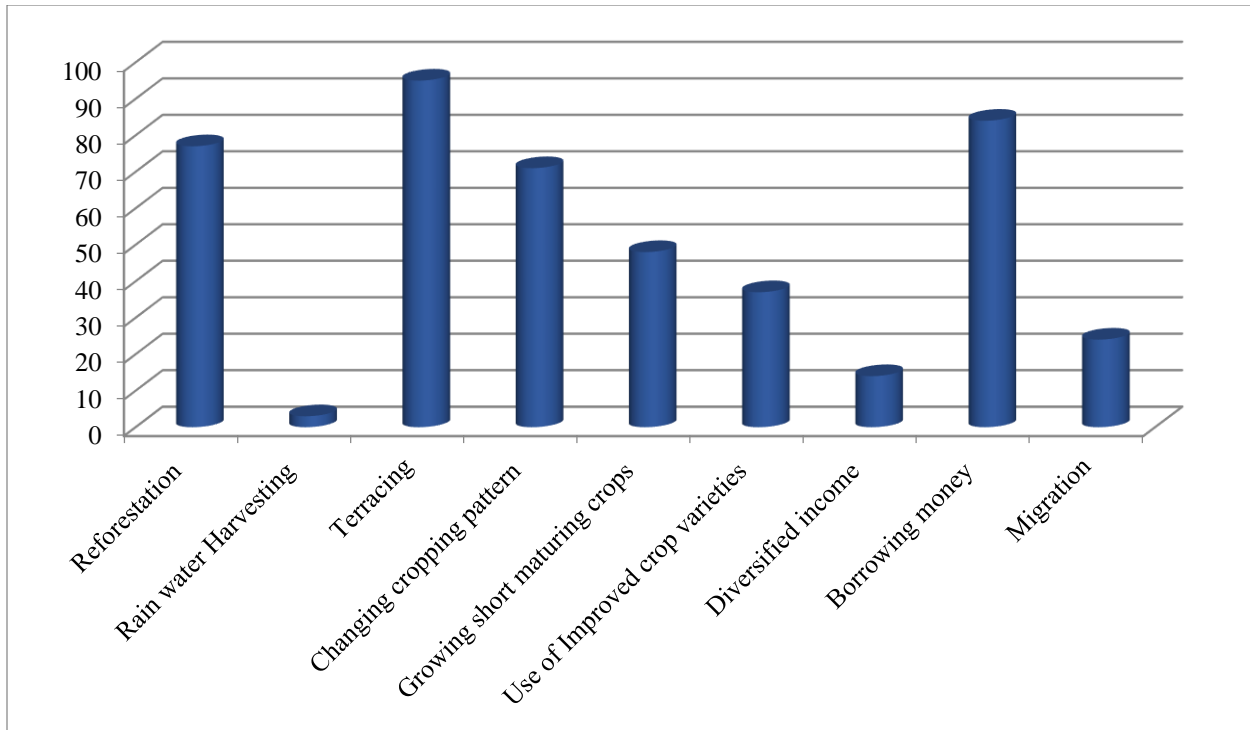
The household survey indicates that it is possible to adapt with some of the impacts of climate variability induced-hazards. About 70% of the respondents confirmed the same responses. In line with this, household respondents were asked responsibility for the adaptation practice. About 20.2% of them considered as it was the responsibility of governmental organization, and 66.7% of the respondents considered the responsibility of governmental organization (GO) in collaboration with the community; whereas, 13.1% of the responses indicated that adaptation to climate variability was the responsibility of local community respondent (Table 15). Key informants and FGD participants reflected that almost similar answer.

Who is responsible for the adaptation practice	Frequency			Percentage		
	Male	Female	Total	Male	Female	Total
Government Organization	11	6	17	16.92	31.57	20.2
Local community	8	3	11	12.3	15.78	13.1
Government Organization and Local community	46	10	56	71.87	52.63	66.7

Source: Field survey, 2017

Table 15. Respondents perception of responsibility for adaptation practices (N=124)

Respondents were also asked whether they were engaged or not in activities with the purpose of coping with local impacts of climate change. About 86% of them were engaged in activities related to adaptation with local impacts of climate change. Local peoples adopted a wide range of response measures to counteract the impacts of climate change induced-hazards. The household head were asked to identify their major adaptation strategies. Their responses are described in Fig 19. In concrete terms, more than 72.7% engaged with reforestation, terracing, growing short maturing crops and change in cropping pattern, while 26.3 % abandoned cultivation of steep slope areas, 3.2% harvest rainwater and 14.2% of them diversified their household income. 84 % of the respondent's choices for adaptation is borrowing many from relatives and credit institutions and the other 24% of the respondent's choice of adaptation option is migration. Reducing mill size and frequency and selling of fire wood and charcoal are also practiced by farmers when there is deficit of food.



Source: Field survey, 2017

Fig 17. Farmers Adaptation options (Multiple answers result)

Terracing : Participants of FGDs and key informants confirmed that soil erosion by running water affects them by reducing their land fertility and lead them to poverty, in addition that increased temperature also forced them to reforest hilly areas so that they protect their farm land from soil erosion by flash flood. Such method is viable in increasing agricultural productivity and assists to control increasing temperature. Moreover, more than 95.2% of the respondents also indicated that they practice terracing along the hilly areas and on farm land to control soil erosion. About 41% of the respondents reported that reforestation and terracing were practiced by stopping free grazing of sloppy areas.



a) Terracing and afforestation the degraded land

b) Terraces which constructed on farm land



c). Construction of soil bund integrated with biological conservation

Fig 18. Field Photo of terracing

Reforestation: refers to the establishment of forest on land that had recent tree cover. In this regard 76.6% of the respondents said that they reforested hill sides and deforested areas in their locality. They explained that soil erosion by flood, rainfall variability and increased temperature are serious problems. Therefore, the only solution for this problem is keeping away their environment from degradation and reforesting the deforested area and afforested the new area which is not planted before.



a) Afforested area

b) Closed area to rehabilitate the graded land

Fig 19. Field Photo of Afforestation and area closure

Water harvesting and small scale irrigation: Water harvesting for growing crops is another viable option to compromise scarcity of water. However, only 3.2% of the respondents practiced water harvesting to curb the problem of climate variability that resulted from erratic rainfall by growing vegetables in homesteads because of water scarcity, increased evaporation and low level of awareness. In this regard participants from *dega* and *woyinadega kebel's* practiced small scale irrigation in a very small area. They got the water from rain and springs.



a) Rain water harvesting



b) Water harvesting from springs



c). Sugarcane plantation



d). Gesho & Enset plantation

Fig 20. Field Photo of water harvesting and small scale irrigation

Change in cropping pattern: From the household survey result 32.4 % of the respondents indicates that, change in cropping pattern is dominantly practiced by farmers in *kola* and *woyinadega* area. Recently, rainfall in the study area has shown variability. As a result, farmers could not be certain about rainfall condition, even after the onset of rain. According to them, even after the onset, rainfall could be heavy or light or it may stop earlier than the expected time. Through experience farmers are aware about the type of crops planted in accordance with the characteristic of the rain. As a result, the cropping pattern of the study area grown in their order of importance *masho*¹³, *teff*, sorghum, wheat, barley, *guaya*, *telba*, *nuge*, chick bean and bean dominant according to their decreasing importance (EWADO,2017). But before 10 and 15 years farmers priority was planted sorghum, *teff* and sesame in *kola* area and wheat, barley *teff* and others are grown widely in *dega* and *woyinadega* area. Although soil fertility decrement, government policies, land scarcity and market situation are the cause of cropping pattern change, most of the respondents have had the opinion that the contribution of climate variability was considerable in the past.

Growing short maturing crops: about 84% of *kola* and 50% of *woyinadega kebele* households uses early maturing crop types. According to FGD participants and key informant interview,

¹³ A type of crop

early maturing crop are planted due to shortening of growing season in the study area. For instance, *belg* season is shortened from three to one month. As a result, recently selective seed of *guaya*, wheat, barley, beans and potato in highland became more common crops recently. In the lowland area also they start grow *masho* (a kind of crop which looks likes sorghum in size) which is totally not cultivated before 3 and 4 years. This crop needs maximum of 3 months to be harvested and have low uptake of water as compare to other crops.

Diversification of income sources: Diversification of household income is a method used by local people to increase their income to compensate the amount of earnings lost due to decreased agricultural productivity. The respondents asked whether they were engaged in diversifying sources of household income or not to cope with climate change impacts. Some households reported that they have diversified their income sources. The household survey showed that only 13.7% of the total households were engaged in non-farm activities (Fig 17). Of the total respondents 11.3% engaged in wage labor whereas, 2.4% of them engaged in pity trade.

Livestock management: In relation with change in rainy time early and late planting, with the increasing depletion of grasses, 53.2% and 39.5% of the respondents practices of reducing the number of livestock and feed their animal's by cut and carry system of leaves and branches of trees respectively. Acacia pods are also used as important sources of dry season feed for goats, and cattle. Some better-off people's also buying hay from the poor people's when there is shortage of forage and feeds their animals.

4.7.2 Coping mechanisms

Borrowing money from credit institutions and relatives: about 84% of the respondent's adaptation options are borrowing money from institutions and relatives to cope the impacts of climate change. From this only 36.4% of the respondent's source of credit is institutions the others chooses borrowing from their relatives because credit institutions has so many criteria to get the money and also to pay back.

Seasonal migration: one of people's adaptation options to cope the climate change impacts are migration. Especially peoples in *woyinadega kebeles* chooses migrate to Addis Ababa and Wolkite to get works as a daily laborer. As we seen from the above graph around 24% of the

respondents say's migration is their coping mechanisms to the impacts of climate change. Most of the time peoples who migrate are above the age of 20 to get jobs. By doing this they reduce vulnerability of their family and after they get some money they back to their home.

Selling fire wood and charcoal: Selling fuel wood and charcoal is another adaptation strategy which is used by farmers to cope up with incoming impact of drought. In the study area poor people cover their house consumption by selling fire woods and charcoals to the urban dwellers.

Reduce meal size and frequency: According to the individual interview reports 11.6% of the respondents reduce the meal size and frequencies of eating during shortage of food occurs. This system is implemented on adult household members commonly eat two times per day whereas children are commonly eating three times. In other way, during the serious food scarcity periods the community has confirmed that the size of meal and frequency will be decreased for all household members.

4.7.3 Government responses

Developing nations that lack the infrastructure or resources to respond to the impacts of climate change will be particularly affected. It is clear that many of the world's poorest people are likely to suffer the most from climate change. Long-term global efforts to create a more healthy, prosperous and sustainable world may be severely hindered by changes in the climate. The task of planning and implementing strategies to adapt to the consequences of climate change will require worldwide collaborative inputs from a wide range of experts, including physical and natural scientists, engineers, social scientists, medical scientists, those in the humanities, business leaders and economists.

To minimize the impacts of climate change the government of Ethiopia has adopted national policies, sector strategies and programs. The priorities of the national policies, sector strategies and programs of the government are primarily targeted at promoting rural and agricultural development and poverty reduction. Ethiopia has no clear policy on climate variability until 2016. As a result, climate variability and adaptation issues are often treated indirectly in sector specific policies and programs since climate impacts are considered as a sub-component of the overall development goal particularly in relation to natural resources and environmental

protection (NMSA, 2007). Government responses related to climate variability and its impact in the study area are disseminating energy saving technologies, emergency aid, protection and livelihood enhancement and disaster risk reduction.

Energy Saving Technologies: Governmental organizations are making various efforts to introduce and disseminate improved stoves to the communities at household level in the *woreda*. In this regard 246 improved stoves were distributed for the communities. This helps to reduce charcoal and firewood consumption by up to 25 percent compared to the conventional charcoal stoves. This will go a long way to conserve forests by reducing deforestation. In addition to that two biogas digesters are under construction and 330 solar technologies' for lightening and mobile charging are already in use (EWWDO, 2017).



Fig 21. Improved stoves before distribution

Asset protection and livelihood enhancement: Protection of household and community assets will reduce vulnerability to the impacts of climate change and variability. If households lost their agricultural products and livestock due to drought and outbreak of disease may face serious challenges that could eventually expose them to destitution (Aklilu and Alebachew, 2009). The government of Ethiopia attempted to solve the problem by providing veterinary facilities and assigning professionals to provide extension services to the local people. However, 77 % of

respondents reported that awareness creation regarding to climate change and other adaptation measure is low. Similarly, key informants added the government intervention with asset protection and livelihood enhancement is far behind as compare from the prevailing problems.

Emergency aid: Is given to help populations affected by unpredictable natural disasters or human conflicts. In this regard the government of Ethiopia has long history in supplying emergency aid to victims of various types of disasters like droughts, floods, landslides and fire occurs. In Ensaro *wereda*, the government has been supplying food and non-food items when drought occurs. The majority of FGDs participants and key informants reported that the government supports those critically food insecure households when there is drought and crop failerity occurred.

Disaster prevention and management: Most respondent households of the study area 41.3% reported that government responses to the impacts of climate variability were not effective. FGD participants and key informants indicated that they are not satisfied with responses of the government particularly against climate variability, disease and land degradation which affected the livelihood of the people in the area. They also indicates, the early warning system is poor and informed after they already affected by climate variability. In fact, Agricultural Development Office carried out disaster prevention and preparedness programs to reduce the vulnerability of climate change caused disasters and environmental rehabilitation programs to improve natural resources. But, most of these activities were not effective due to material and capacity limitation and lack of sustainability.

4.8 Barriers to Perceptions and Adaptations to climate change

4.8.1 Barriers to perceptions in the woreda

A large number of local people consider that climate has become hotter and drier. All the respondents and most of the FGDs participants, experts and interviewed informants perceived changes in temperature and precipitation. Even with the higher level of perception, only 80% of the respondents for changes in rainfall patterns and temperature changes took remedial actions. Even, 67.72% of those who practiced adaptation confirmed that the adaptation options they employed were not successful. In other words, local people adaptation options were not successful due to various perceived limitations.

The results of analysis examining the factors influencing the farmer's perceptions of climate change are depicted in table 16. The results revealed that age, educational status, sex, family size, access to extension services, wealth (farm size, number of farming oxen, cattle, ruminant animals and pack animals), farming experience and exposures to mass media have significant relationship with farmer's perception to climate change.

Sex of household heads

Female-headed households are often considered to be less likely to get information about new technologies and take risky businesses than male-headed households (Asfaw and Admassie, 2004). In support of this, Tenge et al. (2004) argued that female-headed households may have negative effects on the adoption of soil and water conservation measures because they have limited access to information, land and other resources due to traditional social and many other barriers. As indicated in Table 16, sex has negative and significant impacts on the perception of climate change. Therefore, the negative implies the perception of female household toward climate change. Females in the study area are more affected by climate change as observed from focus group discussion. As a result of climate change, there is scarcity of water and firewood in the *woreda*. On the other hand, women have responsibilities of fetching water and firewood and women must travel long distances to get these two important things.

Age of the household heads

According to some studies, the influence of age on perception of climate change and adaptation to change of climate are mixed in nature. Some of them concluded that age had no influence on perception of climate change and adaptation, while others found that age is significantly and negatively related to perception of climate change. The result of this study shows, the age has positive and significant effect on the perception of farmers in the study area towards climate change, temperature, rainfall change, and occurrence of drought and crop failure due to shortage of rainfall. Thus, increasing the age of household head by one unit increases the probability of perceiving change in climate by 19.7%. For example, the perception of aged farmers toward rainfall in their local area is higher than the farmers of others less aged group. All sample farmers aged above 40 understand about the increment or decrement of rainfall and occurrences of drought in the past 16 years. They also feel there is an increment of temperature in the past 16 years.

Education level

Higher level of education is assumed to be associated with access to information on improved technologies and productivity consequences (Norris and Bati, 1987). Evidence from past sources indicates that there is a positive relationship between the education level of the household head and the adoption of improved technologies and adaptation to climate change (Maddison, 2006). As observed from the study, education has positive and significant effect on perceiving climate change, crop failerity and occurrence of drought. If the education level the household heads increases by one unit the probability of perceiving to climate change will be increased by 78.4%. Similarly, education has positive and significant impact on the occurrence of drought, and crop damage due to drought. Therefore, from the result we can conclude that, farmers with higher levels of education are more likely better perceive climate change/variability.

Family size

According to the result indicated in Table.16, family size has positive (12%) and significant (0.351) impact on perceiving drought and encountering of crop failure, while has negative and insignificant impact on having awareness of climate change. In general, household with large

family size has positive and significant effect on the awareness of rainfall change, drought and drought frequency and damage of crop due to climate change. For example, if the family size increases by one unit the perception of farmers on the encountering of crop failure will be increased by 61.7%

Farm land size

According to this study, farm land size has negative and significant effect on climate perception, temperature, rainfall change and occurrence of drought. But even in most cases it has insignificant impact on the farmer's perception of drought and temperature. It is due to that farmers with large farm land have an alternative of diversifying their livelihood.

Access to credit

Nhemachena & Hassan, (2008) indicated that affordable credit increases financial resources of farmers and their ability to meet transaction costs associated with various adaptation options they might want to take. In this research access to credit has a positive and significant effect on climate change perception and rainfall change but has a negative and significant effects on perceiving temperature, drought and crop failure.

According to Madison, (2006), perceived change in climate variables and access to climatic change information are also important pre-conditions to take up adaptation measures. According to the study of Nhemachena and Hassan (2007), farmers that perceive change in climatic conditions and farmers who have access to climate change information have higher chances of taking adaptive measures in response to observable changes. Credit by its nature is expected to relax the financial constraint of farmers and makes the farmers to have a positive influence on climate change risk in order to adapt the existing condition. However, this is applied only as far as it is profitable and accepted by farmers.

Access to market

Market places serves as a source of information. Results from the logit model indicates that access to market has a negative and significant effect on feeling of rainfall change, rainfall,

climate change and crop. This may be there is one market place in the woreda which is far from the *kola* and *woyinatadega kebeles*.

Farming experience

Farming experience has positive and significant effect on perceiving climate change, rainfall, occurrence of drought and crop failerity. This result shows that if the farming experience increases peoples can understand the climate condition.

Access to extension

Access to extension also has a positive effect on perceiving climate change, crop failerity and occurrence of drought but has a negative and significant effect on feeling of temperature and rainfall change. In this regard if farmer's getting good extension services increases by one unite farmer's feeling of temperature and rainfall change can increase by 12.5 and 10% respectively.

Factors	Attitudes on Climate Change		Feeling of Temperature		Rainfall Change		Encountering of Crop failure		Occurrences of Drought	
	B(S)	Exp(B)	B(S)	Exp(B)	B(S)	Exp(B)	B(S)	Exp(B)	B(S)	Exp(B)
Age	0.197(.550)	1.302	.033(.490)	1.356	.759(.622)	2.135	.334(.735)	1.396	1.883(.074)	6.572
Sex	-1.015(.292)	.759	-0.029(.975)	.029	-0.527(.599)	.694	-.469(.432)	.626	-0.536(.346)	.710
Education	0.784(.018)	2.062	-.069(.865)	.934	-.969(.225)	.379	.611(.082)	1.842	.200(.574)	1.222
Family size	-0.617(.111)	.854	.103(.712)	1.108	.044(.890)	1.045	.612(.003)	1.542	.120(.351)	1.887
Access to extension	.937(.308)	1.392	-.125(.903)	.883	-.100(.894)	.905	.273(.587)	1.314	.897(.063)	2.453
Farm land Size	-0.257(.826)	.293	-.640(.488)	.527	-.407(.709)	.502	-.661(.277)	.516	-.352(.551)	.703
Access to information	-.310 (.745)	.364	-1.272(.022)	.569	.393(.683)	1.481	.409(.527)	1.506	-1.269(.048)	.281
Access to credit	0.888(.398)	2.431	-.479(.659)	.619	.970(.339)	2.639	-.724(.353)	.485	.354(.090)	1.258
Farm experience	.289(.881)	1.336	-.991(.539)	.371	1.343(.461)	3.832	.239(.816)	2.787	.784(.461)	1.456
Extra income	1.286(.402)	3.617	-.501(.552)	.606	-.057(.966)	.058	1.256(.077)	3.513	.715(.291)	2.043
Access to market	-.086(.919)	.917	-.761(.433)	.467	-.803(.360)	.232	-.105(.867)	.900	.702(.252)	2.017
Constant	-4.338(.365)	.013	2.079(.680)	7.999	-8.895(.051)	.000	1.326(.684)	3.767	-2.059(.463)	.128

Exp(B) =====odd ratio

S=====significant

Table 16. Analysis of Variables that affect Farmers perception on climate change from binary logit model

4.8.2 Barriers to adaptations in the woreda

As noted in section 4.7.1 there are so many factors that hinder the perception of peoples on climate change. This section assesses what local people's perceived the barriers to use various adaptation options. From the results obtained from household respondents, FGDs, experts and key informants on barriers to taking up adaptation options indicate that sex of household, age of household, education level, farm land size, access to market, lack of information about weather, access to affordable credit, access to extension, farm experience and number of livestock's were major constraints of adaptation for many people in the study area.

Bewket (2010) conducted a research in Choke Mountain, East Gojjam, and he identified that lack of access to water, market, information, and knowledge are the barriers of appropriate adaptations. In line with him a study made by Bryan, et al. (2010), reported that lack of access to information and land scarcity are the barriers to adaptation to climate change in Ethiopia.

Sex of household heads

According to Wilson and Million (2011), female-headed households in Ethiopia are less likely to adapt due to their limited access to information, inputs and other resources as a result of traditional and social barriers. In line with this, Abay and Assefa (2004) stated that male households are likely to adapt, because male households are more likely to get information about new technologies and undertake risky businesses than female headed households. Hassan and Nhemachena (2008) also argue that, male headed households were more likely to adapt to climate change than female headed households. This study also finds that sex of household heads has a negative effects on adaptation. The negative results indicates that the responses of female headed household participants. The reason for this is that much of the farming activities are done by male while female are more involved in processing different activities in the house.

Age of Household heads

Age has been observed positively and significantly affects the decision to take up climate change adaptation measures in the study area. It increases the probability of using crop diversification, improved crop varieties and using of early maturing crop variety.

Education level of household heads

High level of education is associated with access to information on climate change, improved technologies and productivity consequences (Norris and Bati, 1987; Maddison, 2006). Evidences from various sources indicate that there is a positive relationship between the education level of the household head and adoption of improved technologies to climate change (Igoden et al., 1990; Lin, 1991; Maddison, 2006).

Therefore, farmers with higher level of education are more likely to adapt climate change. The study had hypothesized that farmers with higher levels of education should more likely to adapt climate change. In line with this the result of this study shows that, education has a positive and significant effects on adaptation. If an increase in number of literacy by 1 unit the probability of using of improved crop varieties, early maturing crop variety, and crop diversification increase by 165.5%, 15.7% and 32.8% respectively.

Access to credit

It is considered that the provision of saving and credit service is essential in enhancing the adaptive capacity of farmers through saving and accumulating wealth. Nhemachena and Hassan (2008) reported that, access to affordable credit increases financial resources of farmers and their ability to meet transaction costs associated with various adaptation options they might want to take. This means there is a positive relationship between credit and level of adaptation to climate change and variability. In line with this, the result of this study also shows access to affordable credit has a positive relationship on use of improved crop varieties and use of early maturing crops. But negative on use of crop diversification this may be because of more fear of risk.

Access to extension

Several studies results shows a strong positive relationship between access to information and the adoption behaviors of farmers. It creates access to information about climate change and adaptation methods through extension visits and increases the probability of up taking adaptation measure. In this regard, Maddison (2006) and Nhemachena and Hassan (2007) showed that access to information through extension increase the chance of adapting to climate change. In

this research access to extension have a positive and significant effect on using of improved crop varieties and early maturing crops. This means if farmers getting of good extension service's increases by one unite the use of early maturing and improved crop varieties increases by 85.7% and 90.4% respectively. This may be explained by the fact that increased participation in extension advisory helped the farmers to better adapt to climate change.

Access to market

From the result, access to market has a negative and significant effect on both crop diversification and using of early maturing crop varieties but positive and significant effect on use of improved crop varieties. Greater distance to the market diminishes the probability of adaptation. Markets allow farmers to acquire the inputs they need such as different seed varieties, fertilizers and irrigation technologies. At the other end, access to markets provides farmers with positive incentives to produce cash crops that can help improve their resource base and hence their ability to respond to changes in climate (Mano et al., 2003). Hassan and Nhemachena (2008) identified that distance to markets negatively and significantly affected the use of soil and water conservation technologies. Proximity to market is an important determinant of adaptation, because the market serves as a means of exchanging information with other farmers (Maddison, 2006). In the study area especially the *kola* and *woyinadega kebele* respondents reported that they travel long distance to reach market place.

Farm land size

In this study farm land size, number of livestock and non-farm income represent wealth status of the respondents. In order to adopt agricultural technologies farmers requires sufficient financial well-being (Knowler and Bradshaw, 2007). In line with this argument, other studies, indicates that, income has a positive correlation with adoption (Franzel, 1999). This study hypothesized large farm size increase the probability of using adaptation to climate change. The result shows a positive and significant effects on using of crop diversification but has negative effects on using of improved crops and early maturing crop varieties. If an increase of farm land size by 1 hectare, the probability of using of improved crop and early maturing crop increases by 12.8%

and 8.8% respectively. This can be explained as, households with large farm size motivated on farm level adaptation measures in order to increase their crop productivity.

Family size

We can see the influence of household size on use of adaptation methods from two sides. The first assumption is that households with large family members may be forced to divert part of the labor force to off-farm activities in an attempt to earn income in order to ease the consumption pressure imposed by a large family size (Yirga, 2007). The second assumption is that large family size is normally associated with a higher labor endowment, which would enable a household to accomplish various agricultural tasks (Dereessa, 2007). However, this study shows family size has negative and insignificant impacts on the using of these methods of adaptation by farmers of the study area, because as family size increases farmers have other options to adaptation like off-farm activities.

Farm experience

Farm experience also has positive and significant effect on using of both Crop diversification, improved crop varieties and early maturing crop variety. This indicates that as they become more experienced in farming they adapt climate change/variability.

Extra income

Temesgen et al. (2008) reported that non-farm income increases the probability of using agricultural technologies as adaptation options. In line with this extra income has a positive and significant relationships on using of improved crop and early maturing crop varieties. This means if the farmer's income increase by one unit the use of crop improved crop and use of early maturing crop varieties increase by 32.7% and 40.2% respectively.

Table 17. Analytical result of adaptation mechanisms from binary logit model

Factors	Crop diversification		Use of improved crop varieties		Using of early maturing crop variety	
	B(S)	Exp(B)	B(S)	Exp(B)	B(S)	Exp(B)
Age	.454(.662)	1.574	1.555(.410)	1.211	.755(.433)	1.470
Sex	-.447(.446)	.640	-.102(.918)	.903	-.170(.768)	.844
Education	.328 (.343)	1.388	1.655(.028)	5.235	.157(.669)	1.170
Family size	-.473(.017)	.623	-.128(.705)	.880	-.088(.641)	.916
Access to extension	-.346(.491)	.708	0.904(.008)	8.254	.857(.087)	2.424
Farm land Size	.951(.145)	1.386	-1.156(.262)	.315	-.777(.228)	.460
Access to information	-.566(.360)	.762	2.991(.001)	9.913	.661(.267)	1.936
Access to credit	-1.045(.182)	.352	0.937(.560)	1.392	.174(.822)	1.190
Farm experience	.860(.444)	1.423	2.853(.134)	7.339	.211(.839)	1.234
Extra income	-.199(.758)	.220	.327(.276)	1.265	.402(.532)	1.669
Access to market	-.069(.908)	.933	3.286(.001)	6.741	-0.229(.690)	.795
Oxen	1.928(.018)	6.879	-.584(.665)	.557	.173(.817)	1.189
Cattle	-.403(.504)	.668	2.359(.053)	10.584	-.182(.764)	.834
Ruminant	-.491(.551)	.612	-.642(.696)	.526	.948(.255)	2.579
Constant	4.825(.126)	124.609	-13.774(.022)	.000	2.976(.333)	19.610

Exp(B)====odd ratio

S=====significant

CHAPTER FIVE

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The main objective of this study was to assess community perception on climate change/variability, its impact on their adaptation measures in Ensaro woreda. Climate variability is causing the greatest environmental, social and economic threats to all of mankind and across borders in many nations. Perception about the cause, impacts and necessary response mechanisms to cope with climate change impacts is important for any population in a given community. In view of this fact therefore, this study assessed local communities' perception of climate variability, its impact on their livelihoods and adaptations measure.

The study was conducted in three kebeles of Ensaro woreda found in North Shewa zone, Amhara Regional State, Ethiopia. It relied on both qualitative and quantitative methods of data collection and analysis. The primary data were collected by using data gathering tools such as FGDs, key informant interviews, observation and household survey. The study also used satellite image data of rainfall and temperature from 1987 to 2016 to examine the trend of climate variability. The analysis was used to show trend of temperature and rainfall.

The finding of the study showed that both maximum and minimum temperature had increased and variable; *bega* and *belg* rainfall had decreased and showed fluctuation whereas annual rainfall amount had showed inter annual and seasonal variation. Local people perceived climate variability induced hazards such as drought, land degradation, deforestation, flood, pests and disease, heavy rainfall affected the environment and the livelihood of the people.

The most common adaptation options include: reforestation, terracing, water harvesting, and change in cropping pattern, use of improved crop varieties, growing short maturing crops and diversification of income. Other local adaptations like reducing the meal size and frequency, seasonal migration and selling fire woods are practiced as a coping mechanisms. However, poverty, shortage of water, shortage of farm land, market problem, lack of information about weather and climate variability, lack of accessible credit and access to extension were the major constraints of adaptation for many people in the study area. As a result decline of crop

production, expansion of disease and scarcity of available water occurred in the study area which leads them to be more vulnerable to climate change impacts.

5.2 Conclusion

From the study the following major conclusions were made possible:

- Both maximum and minimum temperature had increased and rainfall shows a decreasing trend.
- The survey result revealed that most of the people perceived long-term variability in trend of rainfall and temperature. As the result farmers are undertaking different adaptation and coping mechanisms.
- Communities of Ensaro *woreda* have been facing climate variability impacts like drought, famine, pest and disease, landslide, environmental degradation, flood, decreasing agricultural output etc.
- Poor, landless, disabled's, women's, children's, and elders are among the most vulnerable social groups in the community.
- Age, Educational status, access to extension, Farm experience and extra income ,Sex, farm land size, Access to credit, access to information and access to market has a positive and negative impact on perception and adaptation to climate change impact.

5.3 Recommendations

Based on the outcomes of the study, the following recommendations are forwarded to local communities and government representatives.

- The government should increase local people's perception on the causes and adaptation on climate change through training.
- To improve their adaptation capacity they the government introduced and enforced the community to use new agricultural technologies.
- The government should increase the integration between institutions and also with the communities.
- The government should increase meteorological station, infrastructures, and make climate information available to local community.

- To conserve and restore natural resources and protect the environment the government should assert the ownership of the community towards natural resources.
- Improve the accessibility and services of credit institutions to solve the financial problem of the farmers
- Finally I would like to recommend similar studies to be conducted which adequately address the issue of vulnerability to climate change, and the relative value of each adaptation option to better guide policy options for adaptation to climate change and to develop a locality specific adaptation menu, which is able to account for impacts of climate change and variability.

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ANNEX

Annex. 1. Annual Distribution of Temperature

Year	Maximum	Minimum	Average	Range
1987	22.58	7.13	14.85	15.45
1988	22.78	7.48	15.13	15.30
1989	23.77	7.38	15.57	16.39
1990	22.77	7.78	15.27	14.99
1991	22.67	7.48	15.07	15.19
1992	22.87	8.94	15.90	13.93
1993	22.69	8.94	15.81	13.75
1994	22.65	8.16	15.40	14.49
1995	21.43	7.46	14.44	13.97
1996	22.51	8.16	15.33	14.35
1997	23.23	7.76	15.49	15.47
1998	22.23	8.94	15.58	13.29
1999	23.23	7.74	15.48	15.49
2000	23.02	8.01	15.51	15.01
2001	22.47	8.81	15.64	13.66
2002	22.87	7.81	15.34	15.06
2003	23.25	8.81	16.03	14.44
2004	22.47	7.38	14.92	15.09
2005	23.78	8.68	16.23	15.10
2006	22.78	8.13	15.45	14.65
2007	22.05	8.13	15.09	13.92
2008	23.87	9.21	16.54	14.66
2009	22.77	8.04	15.40	14.73
2010	23.47	8.85	16.16	14.62
2011	23.51	7.15	15.33	16.36
2012	23.12	8.17	15.64	14.95
2013	23.54	8.43	15.98	15.11
2014	22.55	7.62	15.08	14.93
2015	24.11	9.41	16.76	14.70
2016	23.24	8.01	15.62	15.23

Annex 2: Seasonal and annual rainfall distribution

Year	Belg					Kiremt				Bega			Total
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	
1987	4	27	178	112	166	73	168	271	82	0	0	7	1088
1988	19	57	13	77	5	64	409	348	161	12	0	0	1165
1989	10	43	84	105	11	43	194	295	77	23	0	60	945
1990	2	94	39	47	3	14	376	300	169	3	0	2	1049
1991	13	35	71	10	30	89	298	320	75	7	0	6	954
1992	33	63	59	77	24	43	238	277	109	36	6	5	970
1993	10	33	37	111	63	73	318	293	164	49	0	0	1151
1994	0	1	76	43	18	66	298	282	125	0	4	0	913
1995	0	28	45	101	42	36	308	333	98	0	0	35	1026
1996	44	14	70	42	91	118	326	289	108	5	22	2	1131
1997	26	1	54	29	31	121	298	240	31	73	29	0	933
1998	13	22	50	25	53	62	274	306	114	52	1	0	972
1999	12	0	12	2	6	56	337	428	68	85	0	2	1008
2000	0	0	15	92	29	48	329	346	94	19	24	8	1004
2001	1	14	91	22	76	118	408	240	67	10	4	9	1060
2002	38	31	71	37	19	63	231	251	93	0	0	18	852
2003	23	32	60	84	5	102	343	282	110	3	3	11	1058
2004	7	7	47	99	22	126	289	285	138	22	1	1	1044
2005	31	1	55	62	88	91	267	243	106	0	1	0	945
2006	6	27	97	76	54	85	410	279	116	11	4	15	1180
2007	20	45	34	40	46	129	352	310	130	7	1	0	1114
2008	8	3	0	48	82	67	297	316	122	34	74	3	1054
2009	15	5	30	33	13	25	366	302	68	39	1	21	918
2010	19	31	56	55	93	60	365	317	119	11	17	8	1151
2011	6	3	67	45	70	113	288	354	132	0	20	0	1098
2012	0	4	42	29	53	49	454	359	62	0	2	0	1054
2013	0	2	52	38	49	53	300	387	81	38	6	0	1006
2014	5	6	44	35	40	63	214	298	127	15	0	0	847
2015	0	0	9	11	7	45	150	150	8	13	2	1	396
2016	1	3	38	49	53	117	289	285	96	9	4	9	953
<i>Max</i>	44	94	178	112	166	129	454	428	169	85	74	60	1180
<i>Min</i>	0	0	0	2	3	14	150	150	8	0	0	0	396
<i>Ave</i>	12.20	21.07	53.20	54.53	44.73	73.73	306.47	299.53	101.67	19.20	7.53	7.43	1,001
<i>SD</i>	12.36	22.86	33.77	31.62	36.04	31.98	71.83	50.99	36.46	22.36	15.00	12.73	145.2

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 ENSARO WOREDA

QUESTIONNAIRE FOR HOUSEHOLD HEADS

Dear Respondents: My name is Abirham Cherinet, a graduate student of Addis Ababa University. I am conducting a research for the partial fulfillment of master degree in geography and environmental studies. The main objective of this questionnaire is to understand Ensaro Woreda's Farmer's perception toward climate change, its impact and their adaptation strategies. This type of study is important for planners as well as decision makers at different level. Therefore, the information that you provide is believed to help the concerned bodies in understanding farmers' knowledge on climate change, its impacts and their adaptive strategies.

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.

Thank You In Advance

Abirham Cherinet

Part I Background information of household head

You can ask the researcher any questions if there is an ambiguity and expect to receive satisfactory answers.

Date of Interview _____ Questionnaire Number _____

Name of enumerator _____

Kebele-----

1. Sex of household head: _____
2. Age of household head _____
3. Religions of household head _____
4. Marital Status A. Married B. Single C. Divorced D. Widowed
5. Educational Status A. Illiterate B. Read and write C. Primary education completed
D. High school complete E. Higher education complete
6. Family size Male..... Female..... Total
7. Do you have your own farm land? If yes how many hectare _____
8. Type of agriculture practiced A. Rain fed B. Irrigated C. Both
9. If you used irrigation estimate the size of cultivated land _____ hectare
10. For how long did you practice farming? _____
11. Do you have livestock? A. Yes B. No
12. If yes on question number 11 how many livestock do you have?

Animal type	No of Animals before 10 years	No of Animals right now	Reason of decrement
Oxen			
Cow			
Horse			
Donkey			
Sheep			
Goat			

13. Do you have access to credit from any sources? A. Yes B. No

If your answer is yes where you get the credit?

14. Do you have extra income other than farming? A. Yes B. No

If yes please specify_____

Part II People’s Perception of Climate change

15. Do you believe that there is climate change /variability in the area? A. Yes B. No

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

(Multiple answer is possible)

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	Decreasing of rainfall timing	
12	If any specify	

16. Are you heard about climate change before? A. Yes B. No

17. From which source you heard about climate change? A. Radio C. School

B. Television D. Government Organization E. Non-government Organization

18. What do you say the main cause of climate change? A. Natural factors B. Human factors

C. Human and natural factors D. Acts of GOD E. If other (specify) -----

19. If your answer on question number 18 is “Human factors” which of the following do you is the major causes of climate change?

A. Over Cultivation B. Population pressure C. Deforestation D. Air pollution

20. Is there change in duration of rain? A. Yes B. No

21. If your answer to question number 20 is “Yes” how do you characterize it?

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

B. Comes late and goes late D. Seasonal disturbance

Part III Assessment of the impact of climate change induced-hazards

22. Are there any climate variability induced serious impact in the past 10 years?

A. Yes B. No

23. If your answer is yes on question number 22 what are the impacts of climate change induced hazards? (Multiple answers is possible)

A. Expose to disease B. Land degradation C. Loss of livestock

D. Shortage of water E. Shortage of feed of animal

F. Loss of Agricultural productivity G. list if there is another impact

24. What are the major hazards affecting the livelihood in your locality?

Please rank them based on their severity.

Rank 1 _____, rank 2 _____ and Rank 3 _____

A. Drought B. extreme heat C. livestock diseases D. Human diseases

E. flood F. pests and herb infestations G. shortage of water H. other (specify)

25. What about change in forest cover in your area?

A. Increased B. Decreased C. No change

26. How do you see about problem of soil erosion over time?

A. Increased B. Decreased C. No change

27. Is there change in water availability? A. Increased B. Decreased C. No change

28. from your family member who participate to fetch water and collect firewood? (Multiple answers is possible)

A. Female adult C. Male children E. Women

B. Male adult D. Female children

Part IV The major adaptation practice and challenges

29. Do you think that it is possible to adapt the impacts of climate variability induced-hazards?

- A. Yes B. No

30. Who is responsible to adaptation practice? (Multiple answers is possible)

- A. Government Organization C. Local community
 B. Non-government Organization D. Local Community and GOs

31. What is your coping mechanism when you encountered long period drought?

(Multiple answer is possible)

Adaptation and coping mechanisms	Please put the (x)
Terracing	
Reforestation	
Selling cattle	
Migration	
Reduce Meal size and frequency	
If others please specify	

32. Do you use crop diversification? A. Yes B. No I do not C. I do not know

33. Do you use different varieties of crops? A. Yes B. No C. I do not know

34. Did you apply short season growing crop and drought tolerance varieties?

- A. Yes B. No C. I do not know

35. Do you practice water harvesting technique A. Yes B. No

36. How did you judge the trend of crop productivity in your life time?

- A. Increased B. Decreased C. No change.

37. Have you made adjustment in livestock management? A. Yes B. No,

38. If your answer is yes, the kind of adjustments

- A. Destocking B. Changing type of livestock C. Other specify_____

39. What are the hindrances for use of adaptation options of combating climate change?

- A. Lack of money to finance B. Lack of technical knowledge
 C. Lack of irrigation D. Lack of weather information

- F. Lack of improved seed variety G. If any other specify_____
40. What are the determinant factors that hinder the perception of climate change/ variability?
- A. Distance from market B. Lack of infrastructure
- C. Poor communication with DAs D. Lack of information
- F. If any other specify_____
41. What activities are done by government and non-government institutions to cope with the impacts of climate variability at your area? -----

Appendix 2

Questions for Key Informant Interview (KII)

1. Is there any variability of temperature and rain fall in Ensaro Woreda in the past 10 years?
A. Yes B. No
2. What do you think the causes of climate change/ variability?
3. What are the observed indicators of climate change/ variability?
4. How do you understand the impacts of climate change/ variability on your livelihood?
5. What are the main impacts of climate change/ variability on the community, on the livestock and the environment? List down
6. Who are the more vulnerable livelihood sector in climate change/ variability?
7. Who is responsible to give response to the variability of climate?
8. What are the impacts of climate change/ variability on people's health?
9. What are the responsibility of the peoples?
10. What is the response of government organization?
11. What are the local peoples coping mechanisms used to reduce the impacts?
12. What are the main challenges and how do you think they can be improved?

Appendix 3

Questions for Focused Group Discussion (FGD)

1. What does climate change mean?
2. Do you think there is climate change/ variability in your area?
3. What do you think the local indicators of climate change/ variability?
4. What are the main causes of climate change/ variability?
5. What are the major impacts of climate change/ variability induced-hazards up on the people's health, the livestock and the environment?
6. Who are more vulnerable to the effects of climate variability? _____
7. Do you think climate variability affect your livelihood? If the answer is yes how?
8. To adapt what is the response of peoples, government and non-governmental organization?
9. What are the barriers that hinders the perception of climate change/ variability?
10. What are the barriers to cope with the impact of climate change/ variability?

Appendix 4

Check list for Field Observation

The researcher will observe if there is:

1. Land degradation
2. Crop production and livestock husbandry
3. Government and Non-government activities on environmental conservation
4. Tracing and small scale irrigation
5. Major people economic activities in their environment