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SMALL HOLDER FARMERS' ADAPTATION TO CLIMATE CHANGE AND VARIABILITY: THE CASE OF SEGLAMEN KEBELE LAELAY MACHEW WOREDA, TIGRAY REGION, ETHIOPIA


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This is to certify that the thesis prepared by Brkti Asayehegn entitled the Adaptation to climate change and variability the case of seglamen kebele, Laelay Machew woreda, Northern Ethiopia and submitted in partial fulfillment of the Requirement for the Degree of Master of Art in Geography and Environmental Studies (Specialization: Climate Change and human Adaptation) compiles with regulation of the university.

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Table of Contents

Content **Page**

List of Figures

Figure **Page**

List of Tables

Table **Page**

Acronyms

AEASS	Asian Economy and Social science
ADOSK	Agricultural Development Office Seglamen Kebele
A/kolakul	Adi -kolakul
A/serawat	Adi-serawat
CGIAR	Consultative Group for International Agricultural Research
DA	Development agent
EEA	Ethiopian Economic Association
ENMSA	Ethiopian National Meteorological Statistical Agency
EPRDF	Ethiopian People Revolutionary Democratic Front
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
FTC	Farmer Training Center
GDP	Gross Domestic Product
GHGs	Green House Gases
HHS	Households Survey
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
KAO	Kebeles Agricultural Office
KII	Key Informant Inter view
LWAO	Laelay Machew Agricultural office
M.a.s.l	Meter Above Sea level
MoFED	Ministry of Finance and Economic Development
NAPA	National Adaptation Program of Action
NGO	Nongovernmental organization
NMA	National Meteorological Agency
SPSS	Statistical Package for Social –science
SSA	Sub-Sahara Africa
TEK	Traditional Ecological Knowledge

UNDP	Unite nation development program
USD	United State Dollar
USAID	United States Agency for International Development
WNRO	Woreda Natural Resource Office

Abstract

Climate change and variability is one of the greatest challenges facing the Ethiopian agrarians. Climate change has a drastic impact on agricultural output, with total crop Failure and massive livestock deaths. The aim of this study is to assess adaptation to climate change in the local livelihood of Laeley Machew Woreda Seglamen kebele. The study was conducted in one rural kebeles. And also the main argument of the research is small farmer holder indigenous and introduced climate change adaptation strategies. Significance of the study is to document local climate change and adaptation practices of farmers, to contribute a comprehensive and in depth understanding of rural community livelihoods in the framework of climate change, serve as input to the strategy of assuring food security and sustainable resource management and some research gaps. The study attempts to solve negative impacts of climate change in general, vulnerable community in particular. The general findings of the study shows that the climate of the study area has variability and in turn this climate change and variability has impact on the study area livelihood sources like: crop production, cropping pattern, availability of long cycle crops, and availability of livestock feed, loss of livestock and availability of ground and surface water source were the major ones. To minimize the impacts of climate change and variability the farmers of the study area had use different local and introduced types of adaptation mechanisms, Like; selling labor, food aid, selling livestock and other assets, early maturing crop varieties, water and soil conservation, rehabilitation of gullies and mountain were long term adaptation practices applied by farmers and woreda office of agriculture. Even if it has some gaps in the process of implementation such as lack of information and knowledge in implementing introducing practice, lack of targeting problem to address to the vulnerable community etc.

Keywords: Climate change/variability, Adaptation system, Vulnerability, Perception

CHAPTER ONE

1. Introduction

1.1 Background

Climate change and variability are long term environmental issues that pretense serious threats to vulnerable and impoverished agro pastoral communities worldwide (FAO 2009). Global climate change encouraged by increased green house gas attention would be extensively accepted by the international community (IPCC, 2007). Scientist observing the global climate show collective picture of changing climate and warming world. The world is currently experiencing average high temperatures and low precipitation, frequent droughts and scarcity of both ground and surface water. Developing countries are depends rain-fed agricultural production, on low-input and their low adaptive capacity, due to this predicted to high damaging effects of global climate change. Due to the erratic rainfall and high occurrence of droughts which form crop production not adequate, the greater part of third world countries rural population depends on livestock production for their livelihoods. Climate variability and change is highly vulnerable to livestock sector according to (AEASS, 2012).

According to the 2006 Stern Review, third world countries are not only likely to have the least capacity to adapt to these changes due to poverty but also geographically vulnerable, located where climate change is damaging impacts.

Climate change is feasible to be the most sever in developing countries, ultra poor, located in tropical and sub tropical region or in semi desert zone with disadvantaged economy which are predominantly vulnerable to uneven weather pattern and rising temperature (Joachim, 2008).

Africa is previously vulnerable continent of climate change sever and is highly exposed to the impacts of climate change. Many areas in Africa are recognized as having climate that is among

the most variable in the world on seasonal and decadal time scales. Also Africa dry lands are described by low and erratic precipitation, high temperature and high rates of vapor-transpiration. The rural poor excessively bear the burden impacts of climate change and variability, for example, variability in rain fall amount, pattern and temperature variation and other extreme weather events such as drought, famine, floods, storms, ecosystem degradation, epidemic and disagreement which has previously been in play with the disastrous condition of the poor (Getachew,2010).

Several adequate facts show that, the average rising temperature in Africa and global is more rapidly rise in Africa than the world and expected to keep on to the future (Hulme.2000). Frequent floods, droughts and changing in marginal agricultural systems are already negative consequences of climate change in Africa (Collier et al., 2008). Agriculture is the most important sector mainly in Sub-Saharan Africa (SSA). According (Kandjiet. et al .2006) 40%, GDPs of the region contributes by its employs more than 60% of active labor population and also the negative impacts of climate change on agriculture in SSA are likely to be highly important.

In several climate analyses, the East African region is considered that it will be drier, through decrease in the length of the growing season. In Africa, Ethiopia is one of from the symbols to the vulnerability to climate change in with least capacity to respond (Thornton et al, 2006).

Ethiopia is characterize by undulating geographical location, topography and heavily dependent on rain-fed agriculture, under-development of water resources, high population growth rate, low economic development level, inadequate road infrastructure in drought prone areas, weak institutions in combination with low adaptive capacity, as a result Ethiopia is one of from the most vulnerable east African country to the adverse effects of climate change (NAPA, 2007).

Ethiopia is highly vulnerable to drought which is the most important climate related natural hazard impacting the country from time to time. Drought occurs anywhere in the world but it is damages are not as severe as in Africa in general and in Ethiopia in particular. Flood is additional climate related hazards that affect Ethiopia. The reason why Ethiopia is vulnerable to climate change is, because of its greater reliance on climate sensitive economic sector like subsistence crop cultivation and livestock production. Study of national climate trend from the 1960s shows temperature in Ethiopia have enlarged by 0.5-1.3 degree centigrade and it is predicted to increase by 0.9-1.1 degree centigrade in 2030, 1.7-2.1 degree centigrade by 2050 and 2.7-3.4 degree centigrade by 2080 over compared to the 1961-1990 normal(NMA.2007).

(World Bank 2008) provide that Poverty in Ethiopia is a constant problem and about two-thirds of its 72 million people live on less than $2 a day. Consequently, Ethiopia is one of the most food-insecure countries in the world, a situation compounded by droughts and famine that cycle in and out.

Basically, there are two factors that directly or indirectly influence climate change in Ethiopia: natural and anthropogenic factors. For that reason, Ethiopia's climate is highly influenced by general atmospheric and oceanic factor that affects the weather system and the time of beginning and strength of rain (Bekele, 1997).

Climate change causes a massive challenge to Ethiopia's government and also its people. It has faced with increasingly erratic rains, and sometimes the complete failure of seasonal rains – problem linked to climate change. Accordingly, millions of Ethiopians often face harsh food scarcity (Kaur , 2013).

Broad area of Ethiopian history is interrupted and affected by drought and famine, covering country hundreds of thousands of square kilometers, and millions of households,

(MCKeej.2008). Largely the eastern and northern parts of the country are the most vulnerable and have the highest food insecurity.

The degree of climate change effect varies from region to region with the ability of different societal and environmental system to adapt changes. Yohannes GebreMichael (2010) sharing idea, climate variability needs flexibility in resources use (grasping opportunity and coping with shortages) also high degrees of adaptability to repeatedly change situation.

1.2. Statement of problem

Climate change is a key emerging danger to the lives and livelihood of the rural poor in Ethiopia. Since dominate livelihood in agriculture the country has historically been affect by climate variability and related drought and social, economic and environmental costs of extreme climate incident have always been immense. Similarly, the current climate change and variability largely weaken the economic and social development of countries is massive (World Bank, et al 2009).

Many study point to the increased frequency of metrological drought, unseasoned flood, human and livestock disease in many parts of rural Ethiopia. Recent drought event, flush flood and disease ought break in the northern part of Ethiopia are in sensitive conditions of how food and water scarcity and rural livelihood approach are still largely dependent on the climate system also vulnerable to its seasonal variability as well as long term change. A high dependence on natural resource and climate sensitive livelihood coupled with the existence of out of control poverty and natural variable weather pattern put Ethiopia in an extremely vulnerable position. It is expected that the country will come across impact of climate variability in the form of drought, floods, strong wind and heat waves, frost, pests with disease affecting livelihood and health of the people and the natural ecological system (NMA, 2007).

The country's major economic sectors such as agriculture, forestry, and energy as well as natural resource like water and range resource, biodiversity are vulnerable to current climate variability and will be affected even more by future climate change. The impact range from repeated drought and loss of biodiversity, declining water, range resources and soil nutrient to catastrophic floods and declining animal and food production according (NMA, 2007).

The majority of the region and people all over the country are living through a period of rapid in addition to spectacular change in ecological and land use pattern the pace of change in the patterns of climate and different form of environmental hazards in the country of exceeds the capacity of local institution to adapt to or mitigate the effect of such change. On the other hand , the negative impacts associated with climate variability and change are also compounded by non climatic stressors , such as depleting natural resource, poverty, logistical and institutional capacity etc which increases vulnerability more (Alebachew, 2011)

Current climate change is already impressive a large challenge to Ethiopia by affecting food security, water and energy supply, poverty reduction and sustainable development efforts, as well as by causing natural resource degradation and natural disasters (Abebe, 2007).

Repeated and extended droughts have maintained to lives millions of people contributed to the death of much life and destroyed crops. Currently; Ethiopia has supplied main concern for environment. The main environmental harms of the country are climate change, land degradation, soil erosion, deforestation, loss of biodiversity, desertification, repeated drought, flood and water also air pollution. Most part of Ethiopia is dry, sub-humid, semi-arid, and arid, there for it is lying on front of desertification and drought (NAPA, 2007).

Still with the challenges, Ethiopia looks forward to take advantage of its current economic growth by becoming more resilient to the impacts of climate change through the development of community based adaptation strategies. The government, non-governmental organizations and households made an effort to adapt a variety of coping mechanisms. In the farming areas, large numbers are shifting to more drought tolerant crops and varieties, improved adaptation practices to protect land degradation and climate variety hazards. The manifestation of climate change, such as ongoing resource decreasing or pasture reduction, drought, flood, wind storm, wide spreading of animal disaster and conflict over the utilization of natural resource wants to start adaptation practices or integrated development program (Hassan Yusuf, 2011).

In Ethiopia the most degraded region is Tigray which located in the Northern Ethiopia. Regardless of this, a number of encouraging changes have documented, like different soil/water conservation, water recharging, and water harvesting structures have been constructed in Tigray. The overall activity is moving from soil/water conservation to water harvesting, in addition to other natural resources management (Kifle, 2012).

In the study area Laelay MachewWoreda (district) with semi-arid agro-ecology, known by recurrent drought, flood and food insecurity problems. Many people live in conditions of constant famine with a low average calorie supply. Therefore, this study is proposed with an intention of understanding the vulnerability and adaptation strategies to climate change among the small farming holder households.

1.3. Objective of the study

The overall aim of this study is to assess the vulnerability and adaptation strategies of small farming holder households to climate change and variability.

The specific objectives are:

I. To identify the community problem of needs and priorities;

II. To understand community perception on climate change;

III. To assess impact of climate change induced hazards on local people;

IV. To investigate the cause of vulnerability to climate change;

V. Identify adaptation strategies of the local community to climate change.

1.4. Research questions

In order to achieve the above objectives this study attempt to answer the following research questions:

I. What are the community problem of needs and priorities?

II. What are the local perceptions of community on climate change?

III. What are the impacts of climate change induced hazards on local people?

IV. What are the main cases that intensify local people's vulnerability to climate change?

V. What types of adaptation measures are employed by community?

1.5. Significance of the study

This study is important; to document local climate change and adaptation practices of farmers. In other words this research is expected to contribute a comprehensive and in depth understanding of rural community livelihoods in the framework of climate change. Accordingly this may serve as input to the strategy of assuring food security and sustainable resource management in arid and semi-arid areas of Ethiopia and some research gaps.

1.6. Delimitation of the study

The study confined to two villages of Seglamen Kebele Laelay MachewWoreda. And this study emphasized on assessing local adaptation to climate change of the community. Therefore the

researcher preferred to delimit the scope of the study only to two small village of Seglamen Kebele. But the study has much implication to semiarid areas of small farming household so, vulnerability to risk and resilience of climate change.

1.7. Limitation of the study

One of the fundamental challenges is how to differentiate the impact of climate change from other socio-economic and political factors as climate is put in the whole compel. Secondly due to the influence of safety net programs in the study area and high dependency syndrome the reliability of the information from the community might be based on the high expectation of support. However, the researcher has designed different strategies' from making clarity of the objective of the study, using different triangulation methods to minimize the gaps.

1.8. Organization of the thesis

This study is organized in to five chapters. Chapter one includes background, statement of the problem, objectives, research questions, and significance of the study, delimitation and limitations. Chapter two mainly concern with review of some relevant literature. Chapter three presents profile of the study area and methods for the analysis. Chapter four explains the finding of the study in line with research objective. Finally Chapter five concludes the ideas discussed in preceding chapters and forward the possible recommendation for policy implication as well as for the implementers of the intervention.

CHAPTER TWO

2. Review of Related Literature

A number of studies were conducted in different parts of the world regarding climate change and variability, adaptation to climate change, local livelihood and adaptation strategies, and some other climate induced hazards which have been affecting the lives and livelihood of many people across the world in general and developing country in particular. Particularly, those previously conducted studies become very helpful for the researcher to consecontalize various methodologies used at different periods and different places that showed varied results and also to observe the conceptual gapes that needed to fill.

2.1. Climate change terminologies

The following terminologies are constantly use in the analysis of this study;

- **Climate change:** refers to shifts in the mean state of the climate or in its variability, persisting for an extended period (decades or longer).
- **Climate variability**: refers to variations in the mean state of climate on all temporal and spatial scales away from that of individual weather events.
- **Vulnerability:** is a function of exposure to climate situation, the degree to which a system is powerless to cope with adverse effect of climate change.
- **Sensitivity**: is a degree to which a system is affected, either adversely or beneficially by climate related stimuli.
- **Resilience**: resilience is the amount of change a system can undergo without changing state.

- **Adaptation:** are actions taken to help communities and ecosystems moderate, cope with, or take advantage of actual or expected changes in climate conditions.

Definitions are based on USAID August 2007.

2.2. Concept of climate change

Worldwide, climate change is the main challenge of the twenty-first century. Rising temperatures, changes in seasonality and amount of rainfall, rising sea levels and the associated physical impacts of climate change make threats to adversely affect the happiness of human beings across the globe. Poverty, poor infrastructure and governance institutions, and too much reliance on primary sectors of production render Africa the most vulnerable continent. Climate change, as defined by the IPCC, is a change in the state of the climate that can be recognized by changes in the mean and/or the variability of its belongings and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC Forth Assessment Report, 2007). Based on IPCC, Africa is expected to have an increase of 5-8% of arid and semi-Arid land due to climate change.

2.3. Causes and evidences of climate change

At this time fossil fuel combustion and deforestation are major Climate change motivated, as a result suitable threat to lives and livelihoods in each part of the world (Ackerman**,** 2009**).** The role of human activity; In its recently released Fourth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC), concluded that over the past 250 years have warmed our planet is more than 90 percent a large probability through human activities. The industrial activities in the developed nations caused rise in atmospheric carbon dioxide levels from 280 parts per million to 379 parts per million in the last 150 years. In addition the Panel generalized

that more than 90% alternative human created GHGs such as carbon dioxide, methane and nitrous oxide have caused much of the observed increase in Earth's temperatures over the past 50 years. Scientists who support the global warming and climate change usually incorporate the challenges to develop a better suggestion to make clear the environmental data. Beside the disbeliever, IPCC and other scientists who support human induced climate change are nearby different evidence. Calvin, (2008 cited Nigus G.medhn, 2011), contribute to the idea of human bring climate change; because our planet to run disturbance and now we have come in to a time of consequences. The scientific evidence is clear: global climate change caused by human activities is happening currently; also it is increasing risk to society.

2.4. Local Perceptions of Climate change

Developing countries are depends on natural resource particularly the poorest people are vulnerable to climate variability and change (Morton 2007). So now we need to realize how people experience and take action to such variability to manage climate change adaptation strategies. Rural societies already have in depth knowledge of local climate variability and change as part of their traditional ecological knowledge (TEK), i.e., their knowledge, acquired and transferred through generations (Berkes et al. 1995, 2000). According to (Byg and Salick 2009, Vignola et al. 2010) local perceptions indicates to the system local people explanation and concept interpret.

Even though climate change may bring conditions beyond previous experience, local knowledge and perceptions remain the establishment for any local reply. Climate deal with temperature and rainfall, i.e. amount, annual distribution, start and end dates are indicators of local perception, through majority of studies (Deressa, 2009 et al Fisher et al. 2010). Perceptions of climate change, not considering of whether these are correct or not, are already causing some farmers to

change their agricultural practices and have important consequences for their livelihoods. Other studies have similarly shown that farmer perceptions of climate change are an important factor driving the adoption of different livelihoods strategies and adaptation measures.

2.5. Impacts of climate change in Ethiopia

Developing countries particularly the rural poor, many of whom are already food insecure, are expected to familiarity the most severe effects (IPCC 2007) as well as in greatest require of adaptation strategies and increase assistance to cope with changing weather patterns (Keane et al. 2009).

Developing countries are strong economic dependent on natural resources and rain-fed agriculture, there for climate change and variability are among the most important challenges. Different farms act in response differently to climate variability and climate change. At farm level, some factors, like farm concentration, size and land use, can give some suggestion of the capacity to adapt. On the other hand, in different regions the impact of these factors may be different and for that reason difficult to generalize (Reidsma et al., 2009).

Several factors supply and compound the impacts of present climate variability in Ethiopia and will have negative effects on the country's ability to cope with climate change. These include poverty, illiteracy and lack of skills, weak institutions, limited infrastructure, lack of technology and information, low levels of primary education and health care, poor access to resources, low management capabilities and armed conflicts. Deforestation, increases in population, desertification and land degradation are some of from the overexploitation land resources create additional threats (UNDP 2006).

Economic impact of climate change

According to IFPRI (2009), agriculture is extremely vulnerable to climate change. Higher temperatures finally decrease yields of desirable crops while encouraging weed and pest proliferation. Changes in precipitation patterns increase the likelihood of short run crop failures and long run production declines. The overall impacts of climate change on agriculture are expected to be negative.

Ethiopia's half the GDP, depends on agriculture supplied employment chance to the foreign exchange earnings (MoFED, 2006). Regardless of its high contribution to the overall economy, this sector is affected by many factors, of which climate related disasters such as drought and flood so, often causing famine, are the major ones (Temesgen, 2007).

Social impact

In addition, climate change can bring a challenge with it health threats that put pressure on quality of life and on health expenditures (Emerta Asaminew, 2013). Infectious diseases may become more prevalent as their reach increases and seasonality expands; the frequency and intensity of heat waves and natural hazards such as droughts, floods, and cyclones may increase, causing adverse health effects; and levels of air pollution may increase. A key factor in reducing future risks in developing countries is the strengthening of public health systems, including monitoring and surveillance, public health infrastructure, and the development of effective adaptation measures (Burton, et al 2006). According to the World Health Organization, 68% of Ethiopians are already living in areas at risk from malaria, where transmission is unstable and characterized by large scale epidemics. Climate change causes displacement of people in several ways, the most obvious--and dramatic--being through the increased number and severity of weather-related disasters which destroy homes and habitats causing people to seek shelter or

livelihoods elsewhere. Effects of climate change such as desertification and rising sea levels gradually erode livelihood and force communities to abandon traditional homelands for more accommodating environments according IPCC.

Environmental impacts

Changes in plant flowering dates and bird migrations and distributions have already been widely recorded accordingly changes in natural ecosystems are among the first observable impacts of climate change. Natural ecosystems are greatly adapted to specific climatic conditions in specific localities (Burton, et al 2006). Climate change is expected to have significant impacts on water supplies, creating or exacerbating chronic shortages and on water quality. There is already widespread acceleration of glacial retreat and in many areas stream flow is shifting from spring to winter peaks. If the problem is continued, these shifts could affect the availability of water for agriculture and other uses (*Burton et al. 2006*).The impact of climate change on the hydrological cycle has been extensively modeled, and various possible scenarios identified relating to changes in the spatial and temporal distribution of water resources and seasonal availability in a given locality. The impact of climate change on water source through warming accelerates the rate of surface drying, leaving less water moving in near-surface layers of soil. In addition less soil moisture leads to reduced downward movement of water so less replenishment of groundwater supplies (Nearing et al 2005).

2.6. Climate change and agriculture

The variability of seasonal temperature, precipitation and the sub-seasonal statistics of these and other climate variables play a key role in the quality and quantity of agricultural output since agriculture characterizes one of the largest part weather needy productive sectors according to Oram (1989). In addition to that, it is also the largest consumer of water resources due to the

extensive surface that crops utilize during their development. The possessions of climate change on agricultural give way differ by region and by crop. Probable impacts of climate change on agriculture are broad and not completely understood. Regardless of the potential challenges such as increased disease pressure and more frequent occurrence of extreme climate events, climate change may also bring opportunities for the introduction of new crops and increased yields.

Climate change tended to have adverse impacts on livestock production, e.g. low milk production due to both declining forage quality and increased temperature. There is evidence that intensively managed livestock systems are potentially more adaptable to climate change than crop systems because they are better able to adapt to extreme events. Some studies of mid to high latitude grasslands found higher productivity under climate change (IPCC, 1996). Direct impacts of climate change on agriculture, delayed farming operations, in order to maintain productivity, and in some cases the optimum type of farming may change. Indirect may be through impacts of warming or drought on the resistance of crops to specific diseases and through the increased pathogen city of organisms by mutation induced by environmental stress.

2.7. Trends of climate change in Ethiopia

Rainfall patterns are highly complex due to the varied topography of the country: the seasonality, duration, and regularity of rainfall vary by both latitude and longitude (CGIAR, 2012). According to (Conway et al., 2004; IPCC, 2007b) some studies indicated that since the 1970s, warming has occurred across much of Ethiopia, at a variable rate.

There are a number of ways extreme climate events can be defined, such as extreme daily temperatures, extreme daily rainfall amounts, large areas experiencing unusually warm monthly temperatures, or even storm events such as hurricanes. Extreme events can also be defined by the

impact an event has on society. That impact may involve excessive loss of life, excessive economic or monetary losses, or both. Increases in seasonal mean temperatures have been observed across Ethiopia over past 50 years, and the length of the growing season has reduced by ~15% in the region. For the past four decades, the average annual temperature in Ethiopia has been increasing by 0.37ºC every ten years, which is slightly lower than the average global temperature rising. During the second half of the 1990s the time of majority temperature rise observed (EEA, 2008). And also temperature rise is more distinct in the dry and hot spots of the country, which are located in the northern, northeastern, and eastern parts of the country. The lowland areas are the most affected, as these areas are largely dry and exposed to flooding during extreme precipitation in the highlands. Extreme climatic and weather conditions have become increasingly common and costly in Ethiopia in the last few decades. The geographic coverage, intensity, and frequency of drought increased recently. Desertification in the lowlands of Ethiopia is also expanding due to the country's location in the Sahara desert influence area. Over-flooding due to periodic and unprecedented over-precipitation in the Ethiopian highlands is damaging the human as well as physical capital of the lowlanders. The socio-economic and stability impacts of unprecedented flooding will continue in the future.

2.8. Causes of vulnerability to climate change in Ethiopia

Vulnerability: system of exposed, its sensitivity and its adaptive capacity to climate change and variation (IPCC 2007b). This can either be quantitatively measured or qualitatively characterized. These dimensions or measures can be defined as follows:

• Exposure is a measure of the magnitude and extent (i.e., spatial and temporal scales) of exposure to climate change impacts.

• Sensitivity is a measure how a system is likely to respond when exposed to a climate-induced stress.

• Adaptive capacity is a measure of the potential, ability, or opportunities available to decrease exposure or sensitivity of a system to a climate induced stress (i.e., adapt). These definitions are informed by Metzger (2005).

Small-scale farmers and pastoralists in Ethiopia are likely to bear the burden of the negative impacts of climate change in the region, which will include increased poverty, water scarcity, and food insecurity, according to a new Oxfam International report released today. Definitions of vulnerability is cannot review them all but for a summary of definitions and approaches to vulnerability the reader is directed to Adger (1999). Broadly speaking, the vulnerability of a system, population or individual to a threat relates to its capacity to be harmed by that threat. Social scientists and climate scientists often mean different things when they use the term "vulnerability". Whereas social scientists tend to view vulnerability as representing the position of socio-economic factors those hinder people's capacity to cope with pressure or Change (Allen, 2003).

Causes of vulnerability: Ethiopia is vulnerable to the impacts of climate change because of interlinked several factors: poverty, recurrent droughts, high population growth, inequitable land distribution, over exploitation of natural resources, subsistence rain-fed agriculture, etc. Vulnerability assessment based on existing information and rapid assessments carried out under NAPA has indicated that the most vulnerable sectors to climate variability and change are Agriculture, water and human health. In terms of livelihood approach, smallholder rain-fed farmers and pastoralists are found to be the most vulnerable. The arid, semiarid and the dry sub-humid parts of the country are affected most by drought.

The agriculture sector is obviously very vulnerable to climate change. Some reasons can be mentioned:

The IPCC concluded that poor communities can be especially vulnerable as they tend to have more limited adaptive capacities, and are more dependent on climate sensitive resources such as water and food supplies from agriculture. A vulnerability approach to climate change is therefore necessary to identify, delineate, and understand those driving forces that increase or decrease vulnerabilities.

2.9. Adaptation to Climate change in Ethiopia

The term “adaptation procedures” separated in to eight categories: such as bearing losses (doing nothing), distribution losses, modifying the threat and thus preventing effects, changing use, changing location, accessing new research based technologies, disseminating knowledge through education to change behavior, and restoration according to Burton et al (1993). Adaptation as functional to climate change is a very broad concept, and the concept is defined differently.

Adaptation to climate change is important process for two things, reduce the adverse effects of climate on their health, well-being as well as obtain advantage of the opportunities that their climatic environment supplies (Burton 1992).

Adaptation adjustment can make whether passive, reactive or anticipatory, that is planned as a means for the expected adverse consequences associated with climate change (Stakhiv 1993). And also the term adaptability refers to the degree to which modifications are probable in practices, processes, or structures of systems to expected or real change in climate. Adaptation can be spontaneous or planned, and can be carried out in respond to or in probability of changes in situation (IPCC 1996).

From these concepts of adaptation to climate, it generalized as the following major principles:

- Adaptation is a continuous and learning process.
- Adaptation is a response to actual or expected risks; and adaptation take place before, during or after any external risk.
- Adaptation mixes prevention or mitigation in its system.
- Adaptation can be spontaneous and planned.
- Adaptation can be a practice, management practice or process.

Adaptation to climate change is already practiced throughout human history by altering settlement and agricultural patterns and other facets of their economies and lifestyles. Human-induced climate change lends a complex new dimension to this age-old challenge.

According to (Burton, 1996) there are six reasons of adapt to climate change at present.

I) Climate change cannot be totally keep away from.

II) Anticipatory and precautionary adaptation is more effective and less costly than forced

III) Climate change may be more rapid and more definite than current estimates suggest.

IV) Better adaptation is source of immediate benefits

V) Immediate benefits also can be gained by removing maladaptive policies and practices.

VI) Climate change brings opportunity as well as threats.

Different adaptation activities are identified by the Ethiopia's National Adaptation Program of Action which includes a food guarantee program, enhancing early warning systems for both drought and floods, small scale irrigation and water harvesting systems, better management of both rangelands in pastoral areas and wetlands, community-based carbon sequestration, natural resource management which enable to improve the livelihood of the community (NAPA, 2007).

2.10. Adaptation capacity to climate change

Adaptive capacity refers to the potential, capability, or ability of a system to adapt to climate change stimuli or their effects or impacts. Enhancement of adaptive capacity represents a practical means of coping with change and uncertainty in climate including variability and extreme. Reduces vulnerability and promotes sustainable development is gained by improvement of adaptive capacity (Barry Smit, 2006).

According (Burton et al 2006) collectively the way of enhancement of adaptive capacity these efforts must meet a variety of interrelated needs were list below:

Information: refers for the best available data on the nature and severity of likely impacts over different time structure in given locales and on the cost and efficiency of possible response measures.

Capacity: an overriding priority is strengthening capacities in the technical and planning disciplines most Relevant to understanding potential climate impacts and devising response strategies.

Financial Resources: poorer countries will require resources to progress capability, accept specific adaptation measures, and cope with impacts as they occur.

Institutions: while adaptation must be integrated across existing institutions, main points are needed at the national and international levels to acquire expertise, develop and coordinate comprehensive strategies, and advocate for broad-based planning and action.

Technology: as in climate mitigation, adaptation achievement depends in part on access to and, in some areas, development of technologies matched to the specific needs and conditions of different countries.

Experience with how society copes with current climate variability and extreme events provides a valuable foundation for longer-term adaptation, as it offers familiarity with climate and its socioeconomic impacts. Decision support tools and methods that are used for addressing today's Challenges could also be used under a changing climate. In this regard strengthening capacity in terms of developing methods, tools, institutions and individuals to produce, disseminate and apply climate information is highly essential. Traditional and contemporary coping mechanisms to climate variability and extreme in Ethiopia include changes in cropping and planting practices, reduction of consumption levels, collection of wild foods, use of inter-household transfers and loans, increased petty commodity production, temporary and permanent migration in search of employment, grain storage, sale of assets such as livestock and agricultural tools, shortage of land, credit from merchants and money lenders, use of early warning system, food appeal/aid, etc. Adaptation can occur before, during, or after any external stimulus or threat. Thus it is quite potential to obtain adaptive actions in expectation of climate change. Such adaptation measures are called preventative or self-protective adaptation (Smith, 1997).

2.11. Barriers to climate change adaptation

The literature summit too many reason which affect farmers' capability to adapt to climate change. These factors contain accessibility and usefulness of climate information (Roncoli et al., 2002), policy and institutional environment (Eakin, 2003, Agarwal, 2008), and the socio-economic position of the household (Ziervogel et al., 2006), and others. According to (Deressa *et al.*, 2008), Adaptation to climate change is costly and the need for intensive labor use may contribute to this cost. Thus, depends on the capacity of farmer's sufficient family labor or the financial means to hire labor. As well as shortage of land has been related with high population pressure, which forces farmers to intensively farm a small plot of land and makes them

powerless to prevent further damage by using practices, like continuous and multiple cropping that compete for agricultural land. Poor access to market requires poor relationship to input and an output market; also this hinder farmers' adaptation to climate change.

2.12. Livelihood and livelihood assessment

Theoretically, livelihood refers to the means, assets by which people make a living. Asset, in this context, includes 1) natural such as land, water, common property resources, flora, fauna, 2) social community, family, social network, participation, empowerment, 3) human: knowledge, creation by skills and 4) physical: road, market clinics, schools, bridges (Balgis Osman Elasha, 2005). Livelihoods consist of the capability and material and social assets essential for a mean of living: comprise the idea of coping with improvement from external stresses, and the sustainable of resources base on which livelihood depends (ArunAgrawal, 2008). Assets include tangible capital (natural, physical, and financial) as well as intangible (human and social). These five capitals assets are identified below:

Natural capital: this capital type consists of land, water and biological resource such as trees, pasture, and biodiversity. The productivity of these resources may be degraded or improved by human management and affected by climate change.

Financial capital: this capital types consists of stock of money or other saving. In this sense it does not include financial asset only but should also include easily disposable assets such as livestock, which in other sense may be considered as natural capital. It includes income level, variability over time, and distribution within society of financial saving, access to credit and debit level.

Physical capital: physical capital includes infrastructure such as road, irrigation works, electric city, reticulated equipment and housing.

Human capital: this types of constituted by the quantity and quality of labor availability. At household level there for, it is determined by the household size, but also by education, skill, and health of household members.

Social capital: this includes any asset such as right of claims that are derived from memberships of a group. This includes the ability to call on friends or kin for help in times of need, support from trade or professional association and political claims on chief or politicians to proved assistance. Livelihood assets enhance capability when it can cope with and recover from stressing and shocks both now and in the future, while not undermining the natural resources base (Balgis Osman Elasha, 2005).

Livelihood assessment indicates way life or conditions an individual, a household, or communities have under specific situation. And also to analyze the coping and adaptive strategies followed by individual and communities as a reply to external and stress such as drought, civil conflict and policy failure (Balgis Osman Elasha, 2005).

2.13. Conceptual framework of adaptation

The following section provides some definitions and further discussion of the key elements of the conceptual clarity represented adaptation process.

Klein et al. (1999) suggested that the process of adaptation represents a continuous and Iterative cycle involving four main steps: (1) information development and awareness raising, (2) planning and design, (3) implementation and (4) monitoring as well as evaluation. A single focus on implementation and its costs is too limited. Such a focus ignores that successful

implementation depends on the availability of various types of resources to assist the other three steps (i.e., the capacity to adapt). There is a cost to raising adaptive capacity and creating an enabling environment but this is what is required for adaptation to have any benefits at all. To assume that the full benefits of an option can be reaped only at its implementation cost is therefore misleading.

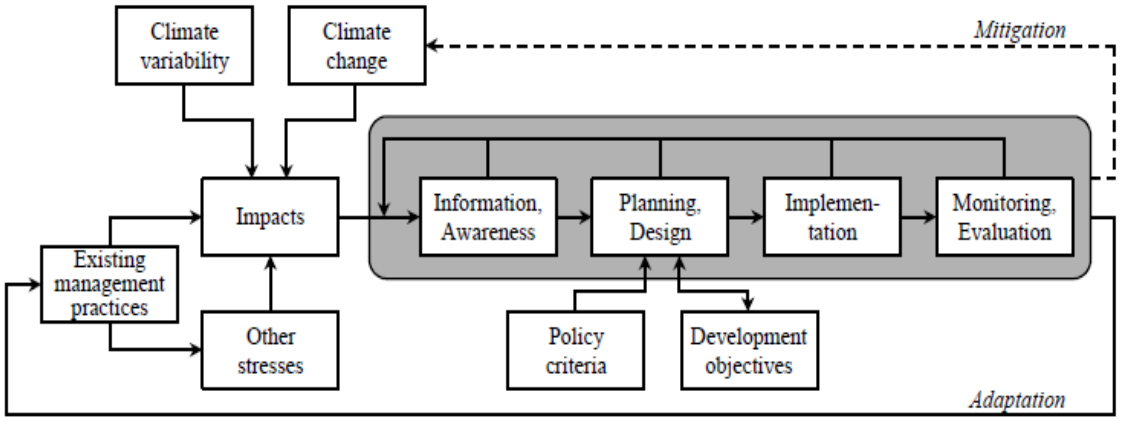

Figure.1. Conceptual framework of process planed adaptation
Source: (Klein et al. 1999)

The above planed adaptation indicates, adaptation strategies as a continuous and iterative cycle, involving several steps: first information collection and awareness rising after that planning and design through policy criteria and development objectives, next implementation and evaluation.

CHAPTERTHREE

3. STUDY AREA DESCRIPTION AND METHODOLOGY

3.1. Study area description

3.1.1. Location of study area

Seglamen kebele is located in laelay machew district, which is found in the Central Zone of Tigray regional administration. Laelay Machew is located in central zone of Tigray region; it lies between 14° 07' 00" and 14° 09' 20" latitude and between 38° 38' 00" and 38° 49' 09" longitude. The Seglamen Kebele is situated 12 km to the South western direction from Aksum town which lies between 14° 06' 16" N to 14° 04' 35" N latitude and 38° 37' 30" E to 38° 40' 45" E longitude.

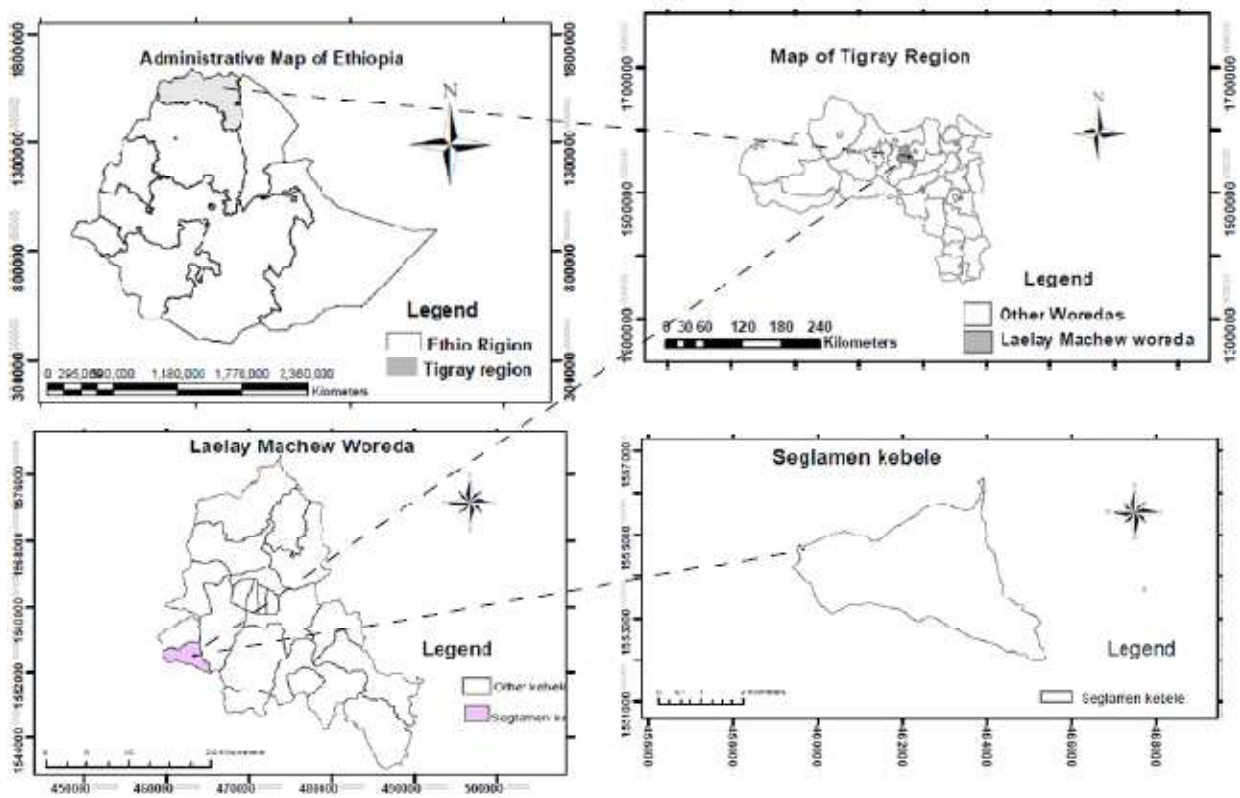

Figure2: Map of study area

The woreda district is bounded in the north by Merebleke Woreda, east Getter-Adwa Woreda, and werilekeworeda, west by ThahitayMachew woreda and southern by Naidier-Adetworeda, total area of Laelay Machew Woreda is 53833ha. The relative relieve of the woreda Laelay Machew is characterized by undulating on both the north and east west border of the woreda, but undulating hills and in pacing mountain altering with plain characterize the centeral area the elevation range from1500-2500m.a.s.l. phyisiographicaly woreda laelay machew is divided in to three broud division; 1) the northren low land 2) the centeral plateau and flat land 3) south east escarpment.The woreda has higher elevation than the neighboring woredas (LealayMachewWoreda Agricultural office, 2016).Topographically; the Woreda lays in midland with annual average temperature 15-26°c with annual average rain fall 550-770mm. The agro ecological zone of the Woreda is Weina-dega (Midland) and kola, 85.21% and 14.79% respectively with the dominant soil types of the area locally known as verti soil (Walka) 38.4% and 61.6% of the soil type is dominated by (Sandston) includes Regosoil, Combisoil, and Areno soil percent of 24.76%, 21.29%, and 15.55% respectively. These altitudinal agro ecological and soil types are generally accepted as having land use forms suitable for crop cultivation of barley, wheat, teff, maize and sorghum, as well as horticulture production of vegetables and fruits in the vast riverside valleys of the fertile low lands (Laelay MachewWereda Agricultural office, 2016).

The total population of the woreda is 79,296 of which 39,165 (49.4%) male and 40,131(50.6%) female. While the total household heads of woreda are 18,022of which 13,155(73%) male and 4,867 (27%) female.

Seglamen kebele is surrounded by other four Kebeles the north direction Debrebrhan kebele, south Shihtambuk, west bête-alas, and in the east direction by Medego. The total area of the Kebele is 899 ha from which about 279 ha of the area is cultivated land the rest 620 ha is

uncultivated land. The soil types of the Seglamen kebele composed dominant soil types are locally known as Bae'kel", "walka", "qeyhmeret"50%, 30% and 20% respectively (KAO, 2016). Total populations in the 'Kebele' are 3092 of which 1527 male, 1565 female. But the total house hold head living in the Kebele are 460 male 305 and female 155.

3.1.2. Climate

The Seglamen Kebele is wina-dega climatic zone. From the prevailing weather condition, rain fall occurs during June to August. September is a transition rain between rainy and dry season and its represents the autumn. The period between March to Jun is warmer. The annual rain fall from 2004 to 2014 of the study area varies from 549.4mm to 941.5mm. February is the driest month as it is contributes average rain fall 2.4mm and July is the wettest month with average rain fall 233.96mm. It is observed that the summer months Jun to August on average contributes more than 89.94% of the total rain fall, April to Jun the hottest months with average minimum and maximum temperature 12.4°c to 29.6°c, respectively. The coldest is December where the average minimum and maximum temperature are 8.63°c and 26.8°c, LaelayMachew Agricultural office (LWAO, 2016).

3.1.3. Physiographic situation

The relative relief of the study area is characterized by undulating topography on both villages of the Kebele. The elevation ranges from 1550-2480m.a.s.l. Physiographical the study area is divided in to four broad divisions, A) Mountain (445 ha or 49.5%) B) Hill (escarpment), 20 ha or (2.22%) C) Plain (50 ha or 5.56%) D) Valley bottom (150 ha or 16.69%), from Kebeles agricultural office (KAO, 2016).

3.1.4. Natural vegetation

The Seglamen Kebele claims to have relative some biggest forests reserves in the Maychew (south east of the study area), Ferasit (west part of the area) and Tienty (North West of the study area). The total area under forest in the kebele Seglamen is 35.4 ha, which is 3.9% of the total area of the Kebele (KAO, 2016). The study area is covered by different forests and scattered trees of Euclearacemosa (*kulio*) especially in the south eastern part of study area or Maychew, Schimperi,SennasingueanaLack(*Hambohambo*),Dodoneaviscose(*Tahisos*),andMeytanusarbustfol lia (*Atat*), and scattered cover of Carissa Endulis(*Agam*), Rumexnervosus (*Hakot*), and Euphorbia trucalli (*Kinchib),*Eucalyptus camaldulemsis, and Acacia etbaicaschlueinf (*Seraw*). Generally the study area is covered by different natural vegetation, some are deciduous their leave in the winter season and increase the temperature of area like ''Accacialehay, Acacia etbaicaSchlueinf (*Seraw)* etc and the other some yearly green their leave then dominate to the temperature and use as animal fodder.

3.1.5. Land use and land cover (2010 and2015)

The land types of the study area include cultivated, pasture land, homestead land, forest land and miscellaneous land. The overall land use type is listed out in the following table1.

Table 1: Land use lands cover type of the study area

		Woreda				Kebele			
		2010		2015		2010		2015	
No	Land use type	Area in(hectare)	In %	Area in hectare	In %	Area in (hectare)	In %	Area in hectare	In %
1	Cultivated land	14,642.5	27.2	14,912	28	279.5	31.1	295.6	32.9
2	Pasture land	4,496	8.35	4,390.5	8.2	50.1	5.6	41.1	4.6
3	Homestead	12,408	23	12,724.5	23.6	265.9	29.6	278.9	31
4	Miscellaneous land	8,435.5	15.7	8,406	15.6	258.1	28.7	248	27.6
5	Forest land	13,851	25.7	13,400	24.9	45.4	5.1	35.4	3.9
Total area		53,833 ha	100	53,833ha	100	899ha	100	899ha	100

Source: Agricultural development office Woreda and SeglamenKebele (2016)

The cultivating land: The change cultivating land of the Woreda covers 27.2% to 28% contain largest number from the other land use types and Seglamen Kebele covers from 279.5 ha that covers 31.1% to 295.6 ha or 32.9% of the area in 2010 and 2015respectively. This cultivating land of the kebele found in all parts of the study area. The cultivating land has fragmented by different rigid topography and rivers. In this cultivating land there are homesteads and among separation of one cultivate from the other and in comparing in both year the trend of cultivated land is increased by making deforestation to cover the increasing population pressure of the local area.

Pasture land: The pasture land is found in different parts of the study area it is communal pasture land and in addition for individual in the cultivated land periphery in both woreda and kebele level. And total area of it is 8.35% in the year 2010 and decreased to 8.2% in 2015, in kebele level 50.1 ha (i.e. 5.6%), 4.6% in 2010 and 2015 respectively this pasture land fourth smallest in the Kebele and fives in woreda level mostly used for the grazing especially during the rainy season. Generally the pasture land is in decreasing trend because of the local people use the land for home land and the decreased trend of communal pasture land increased an individual pasture land in the cultivated land periphery.

Forest land: forest land is found in between the cultivating land or agro-forestry and homestead or socio-forestry and especially in a steep slope area of the study area. The forest land is the fifth smaller of the Kebele followed by pasture 45.4ha (which is 5.1% and 3.9% in 2010 and 2015 respectively of the study area) and second level 25.7% in 2010 and decrease to 24.9% in 2015 followed by cultivated land of the Woreda. This forest land 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 (local name *Saspania)* this types of trees used for two purpose as forest and their leave used as fodder of cattle and forest used the community for household construction. The trend of forest land is decreased from 2010 to2015 by 1.2% in kebele level and by 0.8% in woreda level, because the community use for cultivation land by the form of mountain rehabilitation for the age of >18 years old of adult.

Home stead: Most of the homesteads are found on and around the cultivated area while these homesteads are since the cultivated land in the area is very small the home stead is closest to gather and are found almost in all part of the study area except in some uncomfortable land. The total area of the homesteads covers 23% in 2010 increased to 23.6% in 2015 of the Woreda. And in the kebele increased from 29.6% to 31% in 2010 and 2015 respectively Which is the second largest in the area followed by cultivated land covered 279.5 ha (which is 31.1% of the local area). Generally since the population pressure is increased from 77,251 to79, 296 in the woreda and 2,956to 3,092 kebele level, the home stead land is increased.

Miscellaneous land: Miscellaneous land is consists of rivers, roads, torrents, gully and rocky area. Miscellaneous land is a land which is not productive and can't change easily to productive land. The total area of the miscellaneous land covers 15.7% in 2010 and decreased to 15.6% in 2015 of Woreda area. In the kebele decreased from 28.7% of the local area to 27.6% in 2010 and

2015 respectively which is the third largest portion of the study area, followed by home stead land.Miscellaneous land is un productive land covered by rock, river and road etc. but the trend of miscellaneous land is decreased through changing to productive land like gully cutting and gully rehabilitation system to cultivated and pasture land of the area.

Generally the land use land cover of the study area is increase in cultivated and settlement land but decrease in pasture, forest and miscellaneous land by the cause of increasing population pressure.

3.1.6. Farming system

The study area has mixed (crop and livestock) farming system with emphasis on subsistence crop production. Rain fall is the most detrimental yield factor and influences largely the crop pattern. As it is largely determined by rain fall pattern cropping calendar is not fixed. During “spring” the rain are very rare. Therefore, farmers use the rain fall for land preparation. The major crops grow in the area by ranking and their production per hectare is teff (22quintal per hectare), bean (30 quintal per hectare), barley (30 quintal per hectare), wheat (40 quintal per hectare), maize (18 quintal per hectare), figermillet (25 quintal per hectare) and sorghum (40 quintal per hectare). The sowing period of the area is from June to July while the harvesting period from September to November.

Livestock play an important role in economy of the area. The most important problem of livestock production in the area is shortage of feed. The different types and number of livestock in the study area are cattle (2700 local and 92 *begait)* sheep and goat (2000), donkey (280) and camel (20) Agricultural development office, Seglamen kebele (ADOSK, 2016), and the most affected by the impacts of climate change are cattle and goats in the area.

3.1.7. Social institution and service in the study area

Education; as the elderly people said during the FGD there is one old elementary school (1-8). This elementary school waits for long year with the grade 1-6. In that the local community sends their children to other Kebele, Dura elementary school (1-8) it is very long journey and difficult student to study and student affected by impact of climate change, like high frost in the October-January since they wake up early at the morning and high temperature at noon especially in the month of April-Jun, then after completed in this and the student migrate to the Aksum town from grade 9-12. But new the Seglamen elementary school is included grade 7 and 8 then student of the local area learn from grade 1-8 in their home or with the nearest school. And also know the local community asked to open additional school grade 9 and 10 since the community have supporter any NGO and have enough students come to the school from different Kebeles. In the study area most students are dropout from school especially female students because of one and the largest problem is the traditional thinking of the society regarding female students to learn far away from their parents (by renting house) is not accepted by some people of the society and the other problem of students school dropout is lack of money to rent house in the town so these are the main reasons of students drop out from class in the study area. In sequence the most of female student school dropout leads to the female vulnerability to the impacts of climate change because, they have large home responsibilities or their parents use as adaptation mechanisms like fetching water, fire wood collect, field work etc, in addition they leads to under age marriage, increasing population pressure, then increasing their vulnerability because they have no their own land, this implies to divorced and female household head without any capital asset is difficult.

Health Care: according to KII held with kebele administrator, in this area have health institution so, the local people protected from some suffering various disease such as malaria, pneumonia, diarrhea and so on by giving awareness on their health protection and make the local professional person to use toilet, to avoid swap area etc so, by this and other effort the malaria problem is great change in the area. Beside, many children are protected from the vulnerability of to health problem related to malnutrition in the area by giving service monthly on the date of 21 always and they support any food for the underweight Kg children. This health care gives service not only for people but also for the local animal. So the local health care decreased the vulnerability to the impact of climate change disease.

Transportation: as it has been watched during field observation, there is a single road in the study area that leads from Aksum town to Adet town passing through the Seglamen Kebele. This road has not always give service to the study area (Seglamen kebele). In this area have problem of transport service; the community gets transport by going to the other Kebele or some times by paying the price of Adet town. The distance of their journey is 12 Km but they pay for the 42 Km distance. As the inter wives with people stated that, in the area problem of transport service leads to the problem market accessibility especially for the elder and poor community. Market accessibility is increasing farmer's adaptation mechanisms since they exchange their local and introduced adaptation mechanisms.

3.2 .Research method and procedures

The researcher was used cross sectional survey research design it assesses the overall activities at one shot. Whereby both qualitative and quantitative data were analyzed from a sample of population under study woreda which composed of 15 district kebeles and 1town, those district

kebele are rural area and they differentiated by population pressure, land form, land use land cover etc. But the study confined in one district kebele.

3.2.1. Sampling Techniques

The study is involving different sampling techniques. In order to select the study area and respondents the researcher was used purposive sampling method. In selecting the study area out of the 15 district the researcher purposively selected one kebele including two villages through climate change impacts like shortage of land associated with population pressure, surrounded by mountain then higher erosion and land degradation is worst impact in the area. Stratified sampling also used to categorize households to make comparative analyses among different groups in the community. First, categorical division is based on their wealth while the second extended category is within wealth category; there is also a need to address the gender balance in order to understand how both groups are contribute to and benefit from the management practices. After accomplishing the strata and having to the sampling frame, simple random sampling was implemented in each stratum to accomplish the whole process.

The researcher was conscious to make the sample size of the study to be as representative as possible in accordance with the time and budget allocated. The rationale for deciding this sample size is based on factors like the homogeneity of population, cost of the survey, shortage of time, number of factors to be analyzed and the precision level required. The household number of the study area is 460, of which 305 male, 105 female. Therefore, researcher is decided to use a simplified formula (cited in Betelhem, 2014) to determine the required sample size at 95% confidence level, degree of variability=0.5 and level of precision= 9% (0.09), $n = \frac{N}{1 + N(e)^2}$

Where n is the sample size, N is the population size (total household heads size), and e is the level of precision. The above formula requires a minimum of 97 sampled households. This study covers 100 households with proportionally to their total number of household.

In that time short discussion was made with 3 development agents and 1kebele leader to identify the indicators of wealth category in the study area. Based on the discussion, the local development agent takes basic indicator or criteria like number of livestock, amount of crop production, size of farm land. According to community criteria for a better off, if he or she would have 1 hectare and above land size, 2 and above oxen, 4 and above sheep and goats, 2 and above donkey and camel, especially camel is indicates to a better off person. Likewise, for a person to be medium she/he should be own 0.5-75 hectare of land size, one oxen, donkey and camel 3-4 sheep's and goats. Moreover, a person is considered as poor if own less than 0.5hactar land, no oxen, donkey and camel but own, less than 3 goats and sheep. Generally access to resource providing to livestock input and land is under positively correlated to resilience to climate change.

Table 2: Sampling distribution

Kebele	Village	Population size	Household size	Sample size						
				Better off		Medium		poor		Total
				M	F	M	F	M	F	
Seglamen	A/kolakul	1539	223	13	2	14	3	6	12	50
	A/serawat	1553	237	17	1	13	3	8	8	50
	Total	3092	460	30	3	27	6	14	20	100

Source: Kebele agricultural office (2016)

3.2. 2.Data Sources

Based on the designed objective, the necessary data is collected from various sources such as Woreda administration, Kebele administration along with its people and some other type of data relevant to the problem from primary and secondary data source.

The household is the basic unit for the analysis in order to conduct this study. Different types of data collection instrument are arranged in order to assess local perception, coping and livelihood adaptation strategy of the community to climate change and variability in the study area, includes focus group discussion (FGD), key informant interview (KII), field observation (FO) and (HHS).

Primary data are collected from the sample household by applying a household survey, interviewing key information, facilitating FGD, direct field observation and photographs that are illustrated various climate change induced impacts; local coping and livelihood adaptation strategy are taken from direct observations. The primary data are collected on socio demographic feature such as age, sex, marital status and educational level of the sample household through household survey; the coping and livelihood adaptation strategy to resist shock of climate variability in the study area.

3.2.3. Primary data collection instrument

Household survey

The general reliable data on local perception, cause, impact and livelihood adaptation strategy to climate change and variability were administered at household level through both close and open ended questions. As shown in annex-1 and2, the survey focuses on understanding of the household profile, needs and priorities, perception of climate change, bases of livelihoods and adaption strategies.

Focus Group Discussion

To describe the previous and the present situation of the study area, to know the present perceptions and the future intention of the community view randomly select 6 FGD for three days session were hold in all the sample population comprising the elderly people men and women, rich people men and women, medium people men and women, poor men and women, model farmers and adult. Some checklist was design to facilitate the discussions with the differentiated community member's show in annex-3.

Observation

The researcher conducts observation to computable skepticism and maximizes the reliability of the data which are acquired through questioner, FGD, and KII. Thus some their observable household situation, impacts of the climate variability, local coping and adaptation mechanism, livelihood challenges and the land use was observed and captured by photographs.

Key Informant Interviews (KII)

Also, sampling randomly key informant interview with resourceful 24 farmers and 5 development agent persons were conducted for 8 days. The key informant interview is included experienced people and community elders, including men and women. Woreda expert and Kebele official are interviewed in order to gain enhance, explanation about the local perception, impact, causes of vulnerability, adaptation mechanisms, determinants of adaptation mechanisms and problem of needs and priorities.

3.2.4. Secondary data collection source

Published and unpublished books from library and internet, documents at kebele, woreda level and metrological data were reviewed.

Figure 3: Individual and group discussion in the field

Source: Researcher interview and group discussion (FGD, 2016)

3.2.5. Methods of Data Analysis and Presentation

A combination of qualitative and quantitative approaches employed in this study to analysis the data which is gathered by different instruments. Qualitative data which are generated through different instrument are organized analysis, and interpreted using appropriate word. There for the situation of the study area is likely explain and summarize local people's perception, their coping and livelihood adaptation strategies to climate change besides some other socio- economic and cultural issues that may possibly intensify climate change risks in the area. And quantitative data generate from the sampled household through semi-structured- questioners were analyzed and processed using statistical package for social –science (SPSS). Descriptive statistics such as mean, frequency and percentage are used in explain and describe in the final result of the study. Beside the processed result of the study is illustrated by various chart, graph, and table and figures properly.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

This chapter presents the results of both quantitative and qualitative analysis of data in line with the specific objectives of the study. The chapter consists of the background information's of respondents which are related to the implementation of adaptation mechanisms such as; demographic, socio-economic characteristics of households, livelihood activities and climate change adaptation mechanism, impacts, vulnerabilities, perception and others analysis which helps to assess the adaptation mechanisms of community for climate change and variability are the main parts of this chapter.

4.1. Characterization of the sample household

4.1.1. Sex distribution of the sample household respondents

Sex is one of the categorization variables which have a parameter important in livelihood adaptation strategy particularly in farming community. This agrees with the argument that male headed households are more likely to get information about new technologies and take risky business than female headed households (Asfaw et al. 2004). Similarly, Deressa et al. (2009), Legesse et al. (2013) and Mulatu (2013) concluded that being male-headed increases significantly the ability and choice of households' climate change coping strategies. Usually under the agrarian economy rural Ethiopia, women household heads are classified under poor wealth rank which also implies vulnerability to the impact of climate change.

Thus, the sex distribution of the sample respondents would be discussed with respect to male headed and female headed household in two village of Seglamen kebele.

According to the information indicated in figure, 4 below, 33 (66%) male and 17 (34%) female headed of the sample household respondent were for A/kolakul And 38 (76%) male and 12(24%) female headed of the respondent were for A/serawat. The number of female headed household respondents was not the same with male simply because of the sample selecting techniques employed to select the sample household respondents and based on the large number of male headed 305 (66.3%) and small number of female 155 (33.7%) total 460household headed of the kebele.

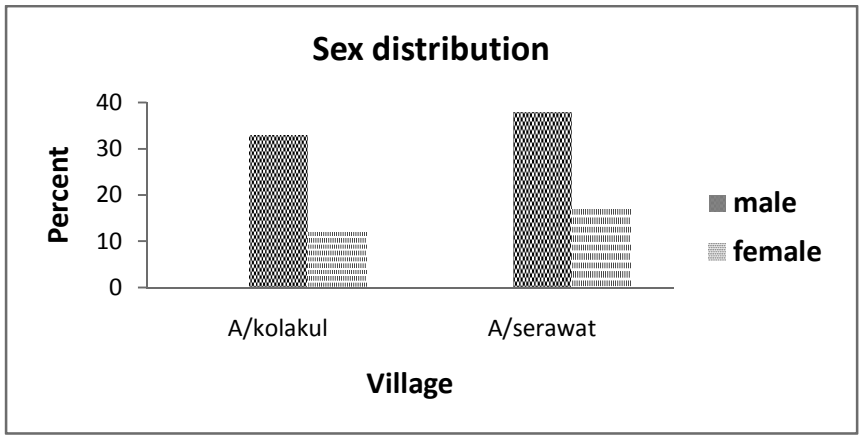

Figure 4: Sex distribution of the sample household in their respective village

Source: Computed field survey data 2016

4.1.2. Demographic characteristics

Demographic structure is another variable which plays significance role in a determining the households livelihood adaptation capacity to cope with and adapt to the climate variability and factor that affects the availability of economically active for different activity. Demographic structure is an important consideration as the elderly and youths considered as less implementers of climate change adaptation practices. Moreover, since this study is about climate change and it requires household heads to remember the climate change for the past 20 years, it would be very difficult for household heads under age 30 to remember what happened during their childhood.

Based on the survey result, majority of the sample household is under the age of adult (34-64) counted 74 % of the total sampled household. The number of household under the age of 18-33 was computed 5%, age with >65 were 21%Out of the two villages. Therefore, the large number and better off of the sampled households are under the adult or active age group. It is known that these groups are most productive forces that can play a decisive in generating and appropriate also suitable adaptation strategies to the climate change for their locality. Moreover, the number of elderly people accounts for only 21% they have their own contribution towards sharing their indigenous knowledge, skill, and experience from the ancient time to know with comparing the condition on how to cope and adapt to the shock and stress of the climate change in the study area.

Similarly table,3refers; most of the better off and male family size was in > 7 and the smallest in 0-3, but in case of the poor and female large family size in between 0-3 the smallest in >7 family size.

Generally, a small family size which is less alternate level of economic activity, but with a big family size are better off, having an opportunity as a socio economic profit, including social respect and socio-economic statues, economic power, social security and livelihood diversification. Beside the household size indicates the level of adapting capacity in a community, which determines the capability of household to implement adapting strategies. The smaller the family size, greater are the chances of people being affected.

Table 3: Distribution of demographic characteristics

Wealth rank	Family size	Age						Total
		18-33		34-64		>65		
		Male	female	Male	Female	male	Female	
Better off	0-3	0	0	4	0	1	0	5
	4-6	0	0	7	1	3	1	11
	>7	0	0	12	1	3	0	16
medium	0-3	2	0	3	3	2	0	10
	4-6	1	0	10	3	5	0	19
	>7	0	0	1	0	3	0	4
poor	0-3	2	0	7	14	0	0	23
	4-6	0	0	3	4	2	1	10
	>7	0	0	0	0	0	0	0
Total		5	0	47	27	19	2	100

Source: Computed field survey data (2016)

4.1.3. Martial statues of the sample household

As shown in table, 4 below, out of the total sample household respondents in A/kolakul 66 % of them were married, 16% divorced and 18% widowed. In A/serawat 76% of the respondent were married, 12% divorced and 12% widowed. In the study area based on marital, most of married household are under better off but divorced and widowed are the poor. Many female household head affected by climate change because of female household over loaded work most of them renting their land farming for the sharing of productions and selling pasture land, therefore decreased their income of the female sample household respondents.

Table 4: Martial statues of sample household

Marital status	Village						Total	
	A/kolakul			A/serawat				
	Better off	Medium	Poor	Better off	Medium	Poor	No	%
Married	14	13	6	17	14	7	71	71
Divorced	0	2	6	1	1	5	15	15
Widowed	1	2	6	0	1	4	14	14
Total	15	17	18	18	16	16	100	100

Source: Computed field survey data 2016

4.1.4. Educational status of sample household

Scholars believes that education is important to determine readiness to adapt new ideas, enables people to realize the diversification or specialization of livelihood activities and technology, within the frame work of adaptation strategies on the impact of climate change. Thus in turn it would improve the quality of life of the household at large and it enables to produce human resource such as skilled man power and also helps to generate aid for transforming society's economy. Indeed, education on level of households was assumed to increase participation of households in implementation of climate change adaptation mechanisms. The higher educated household heads were increased their ability to find information, better understanding and application of new technologies as well as better ability to cope with climatic risks. Furthermore, education is likely to enhance farmer's ability to receive, interpret and comprehend information relevant to making innovative decisions in their farms (Ndambiri et al., 2013).

From the survey result shows in figure, 5 below, 72% of the respondent in A/kolakul and 58% of in A/serawat were illiterate, 10% in A/kolakul and 14% in A/serawat were in between 5-8 grade level, 14% and 26% grade level 1-4 respondent in A/kolakul and A/serawat respectively. The rest 2% in A/serawat and 4% in A/kolakul read and write. The survey result indicates that more

than 65% of the respondents were illiterate. This is assumed to affect the adaptation of new technologies and in turn reduce the capability to cope with climate change impact.

In the study area there are many activities of farming system and introduced adaptation system or technology like using water pond (*horeye*), biogas, solar and chemical fertilizer etc. These all most all introduced activities first practiced by the literate person of that kebele especially grade 5-8 educated people. So, as explain before education is very important in all site of activities. When the researcher observed field study in comparing two villages, the sample households of A/serawat were mostly use the above practiced than A/kolakul. Although, the illiterate may have an adverse effect on the local community in seeking appropriate and feasible solution from their experience and traditional system to cope with and adapt to the changing climate change induced shocks so they have their own indigenous knowledge and experiences.

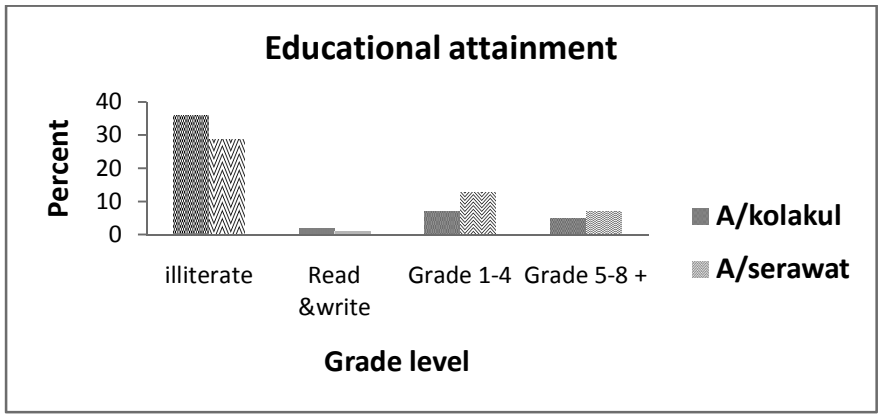

Figure 5: Educational attainments of respondents

Sources: Computed field survey data 2016

4.1.5. Income generating livelihood activities of the sample household

In rural Ethiopia, agriculture may be viewed as land use system, an economic form of production and a way of life for many people who drive their main livelihood income or subsistence from crop farming and livestock herding largely dependent on feeds grown naturally. However with

increasing challenge of natural hazards and human induced climate risks, more and more farmers are trying to combine their earlier mode of production with on-farm and off-farm or nonagricultural livelihood source small scale such as rural trading, seasonal out migration, collection and sell of natural resources. Therefore the diversification of livelihood activities as adaptation mechanism would be the preliminary step of cop with and adapt to the shocks and stress in the study area. Diversification has been reported as one of the main strategies for reducing the vulnerability of a household to the impacts of climate change (see Ellis, 1998; Barrett et al., 2001).

Likewise, the local people engaged themselves in various livelihood activities to sustain their livelihood income and maximize their indigenous knowledge and experience on adaptation mechanisms against ever increasing problem of the climate change in the study area.

As the survey result indicated that, there are encouraging signs those rural households are trying to avoid the risk of over dependence on only one source of income. Crop cultivation, which itself is very sensitive to climate change. All of sample household respondent relied on crop cultivation which is the most dominant primary livelihood activities followed by mixed farming and the respondent was engaged preserving hides and skins. As well as in some extent the sample household respondent was land renting and crop production and other off farming like house construction and hair style. In the study area very small contribution of livelihood diversification were remittance from relative family or their children wage laborer, sale of fire wood and charcoal by collecting from different individual in the kebele most sellers of fire wood and charcoal was camel owners, trading livestock they come from Adet and Edagaberhe to Aksum town and also the other traditional healer and craft. One may understand from the survey result is that most of the respondents were engaged in two or more livelihood activities to

diversify their source of income on one hand and develop their adaptation mechanism to the changing climate and variability related shocks on the other hand this is more practiced by the male than female households (See table, 5below).

Table 5: Livelihood bases of the sample household

Livelihood bases	Village				Total
	A/kolakul		A/serawat		
	Male	Female	Male	Female	
Crop production	33	17	38	12	100
Sal of fire wood & charcoal	1	0	4	0	5
Trading livestock	0	0	2	0	2
Craft	1	0	0	0	1
Traditional healer	0	0	1	2	1
Remittance	6	5	2	3	16
Land renting	0	15	0	15	30
Hides & skins	28	0	26	0	54
Mixed farming	28	4	40	3	75
Others	2	3	4	1	10
Total	99	44	117	36	296

Source: Computed field survey data (2016)

4.1.6. Landownership

Land holding refers to the terms under which land and natural resources are held by individual's households or social groups. Land particularly is the most valuable resource and asset in the woreda of study area or Seglamen kebele. However, farm lands in many areas are fragmented and too small to cover the farming household, annual consumption, expenditure patterns and food insecurity. By this case most household become vulnerable to the impacts of climate change

and less capacity to adapt. Since the majority of farmers are own very small size, the income pattern of household owning them are highly vulnerable to the vagarious of weather and economic shocks.

The survey result shows that, 85% of the better off male and 9% better off female land own 1.05-2.00ha. Most of the female or poor (59%) households and most of the medium male (70%) of them own land from 0.5-1ha. Based on the survey result the researcher generalized that, no one sample household of better off own <0.5ha and only 2% of them own land 0.5-1 ha but all most all the medium and particularly poor community own land 0.5-1ha so, this types of land size difference leads to the vulnerability of climate change to the poor and female household in the study area (See table, 6 below).

Table 6: Wealth rank and Sex based land owner of sample household

Land owned per HH (ha)	No of respondent	Wealth rank						Total	
		Better off		Medium		Poor			
		Male	Female	Male	Female	Male	Female	Male	Female
<0.5	No	0	0	0	0	3	0	3	0
	%	0	0	0	0	9	0	3	0
0.5-1	No	1	0	23	6	11	20	35	26
	%	3	0	70	18	32	59	35	26
1.05-1.5	No	28	3	2	0	0	0	30	3
	%	85	9	6	0	0	0	30	3
1.51-2.00	No	1	0	2	0	0	0	3	0
	%	3	0	6	0	0	0	3	0
Use rain fall only	No	28	2	25	6	14	20	77	28
	%	85	6	76	18	41	59	77	28
Use rain fall and irrigation	No	2	1	2	0	0	0	4	1
	%	3	3	6	0	0	0	4	1

Source; Computed field survey data (2016)

Irrigation: As survey result shows, majority of farming household i.e. about 95% of the two villages are rely depend on rainfall agricultural practice only, irrigation helps adaptation to climate change in relation to small participants 5% of all households.

Figure 6: A farmer showing fruits produced in his irrigation land

"AtoLeake Gelase is a farmer in Seglamen kebele and the owner of small irrigational practice as shows in figure, 7 below, which were justified that there is high problem of water problem not only for irrigation but also for human and animal drinking especially the village of A/kolakul. In the area shortage of water and economically problem were constrained households from using motor pumping. Shortage of land due to population pressure, topography of land, water scarcity and poor resource base are the major factors affect irrigation practice in the study area and land available for irrigation is very small. For this reason most of the households were used to cultivate vegetables like; Pepper, potato, garlic, cabbage etc. They used for home consumption and sold to local market. He said that as figure, 7 below shows small irrigational practices, in this the amount of the water is very small, uncomfortable topographic land and not use motor pumping, in sequence he use by fetching water from the river and changed the production type from maize and orange to cabbage and pepper."

Figure 7: Small scale irrigation in Seglamen kebele

Source: photograph captured from field observation (2016)

4.1.7. Livestock holding

For small farmers in Seglamen kebele livestock not only provide livelihood diversifications and manure but also a measure of social status and economic security since they can be sold to raise cash at time of most need. As the researcher observations of the study area, Cattle are generally the preferred species because they are the main sources of economically alternative and also provide fuel in the form of dung cakes. In Seglamen kebele cattle and goats are most important household asset and 52.1 ha communal area are free grazing covered by acacia lehi, local name (*Lehay*), acaciaetbaicaschlveif (*seraw*), faidherbiaalbida(*Momona*)andacaciaabysinca (*Chea*) in the kebele. And the half part of the kebele communal grazing land covered by euphorbiacanderlabrum local name *Kolankul*), Maytenusarbutifolia (*Atat*),clematissimensisfres (*Hareg*) and Rhoicissus tridentate (*Alke*). (From WNRO, 2016). In the winter and spring cattle are given crop residues of teff, barley, wheat and other crop residues as supplementary feed. According to interview stated that, the community not only affected by climate change but also by population pressure, in the area has increased the area under cultivation has expanded, and most of the land previously used as communal grazing is now taken up by crops and settlements of the population and mountain rehabilitation for young peoples, so by this case livestock of the area very decreased from time to time.

As the survey result shows in table, 7 below, 21% of the sample household respondent was they have not their own livestock they engaged in crop cultivation with in a small land farm. So were very sensitive to vulnerable to climate change because they have no alternative of livestock during the problem of crop cultivation, sharing their crop, no ox and no organic manure.

And survey result indicates that average livestock possess farmer in the middle income category of poor, medium and better off. In view of the fact that wealth ranking was mainly due to the owner ship of livestock, based on kebele agricultural office (KAO, 2016), it was expected to find that the better off group own the most animal in each village. And found that 11.26% of the better off, 5.94 % of the medium and the rest 1.72% of poor farmers own livestock. Data from the survey also revealed that except same most of from the poor are non ox, most of medium owns one ox and except very small owns one ox, large number of better off owns 2 and above oxen. According interviews they revealed that during drought many farmers in the local kebele have to sell especially cattle animal by many reasons such as to meet their daily need, since cattle are very sensitive to impacts climate change, beside they said that those who own a single ox make arrangement with kin relations, friends, or coo villagers in the same situation, for taking turn to use the pair (*Bieray Gitimiya*). Farmers without oxen can rent or borrow them for divided the crop production or for grazing land, although they have to wait until the owners have finished ploughing. In addition some non-oxen farmers rent pair of oxen from a better off 200-250 birr per day, the better off soled their oxen when they finished their own ploughing, so after passing seeding time the poor farmer could not get a good production or income. As the researcher observation during the field in the study area some better off people use camel to ploughing , if their oxen not well for example during drought time since, cattle are more vulnerable to patterns of climate change than camel many cattle died and illness, then farmers use as alternative way.

Table 7: Livestock owner and wealth rank of in the study area

wealth rank	Percent of Livestock type						
	Oxen	Cows	Goats	Sheep	Donkeys	Camels	Total
Better off	2.40	1.41	5.33	0.79	1.24	0.09	11.26
Medium	2.03	0.34	1.79	1.30	0.42	0.06	5.94
Poor	0.34	0.19	0.29	0	0.09	0	1.72

Source: Computed field survey data (2016)

4.1.8. Livestock trend before and after 2004

As information collected from adult during FGD, people gained benefits from keeping their livestock as livelihood asset such as livestock product (milk, meat and others), to buy consumption goods including food crops by selling them, to asses transportation like donkey and camel , social status as well. In the area future sustainability and viability of livestock rearing is indeed under question due to the climate change and reducing of grazing land. Moreover in the area they have two types of cattle's, local cattle and introduced or *begait* cattle came from the west of Tigray high temperature (kola) but they came to cold patterns (woyna-dega) of the area so, they cannot rapidly adapt the two types of condition then vulnerable to the climate risks. And also not only that problem but also have a problem of forage for those cattle because in the area have shortage of pasture land. According to information obtained from elderly people during FGD the number of cattle and goats has gradually been decreased from time to time because they are more vulnerable to climate change, especially during the months of March, April and May for cattle in late coming of rain fall and the month of September for goat. In addition in the area have a shortage of water for animal drinking and rapidly warm the area since its natural vegetation deciduous means that failing their leave, like Acaciaetbaica (S*eraw*) except Euclearacemosasubsp (*kulio*) so there is no shaded. Besides the some increasing number of donkey showed that the people have already started showing a tendency to engage themselves in

some other means of living by diversification their activity for instance the spreading of crop cultivation, exchange of crop production example maize with sorghum and bean with teff, to transport periodic market crop, the last and the best one in that area was donkey use for fetch water, since they have water problem they go to long distance from their home has become evident now in the area. Generally based on the trends of livestock cattle and goat are more vulnerable so, decreased their number followed by sheep and camel.

As illustrated in the field survey data in table, 8 below the dominant livestock of the area orderly is goat, cattle, sheep, donkey and camel, but when we compare from the total percentage of before and after 2004 among them the average (mean) number of ox, cow and goats of the sample household possessed before and after 2004, was reduced by 1.5 %, 2.2 % and 6.26 % respectively. As the interview information collected, the trends of cattle are greatly reduced by the impacts of climate changing and variability the shortage of food because of shorter time of rain fall in addition to narrow pasture land and dry up of watershed from February to around Jun so, cattle are more sensitive or vulnerable to different problems in that area. Also sheep and camels are reduced by 0.63 % and 0.22 % respectively of them. In case of donkey the trend was increased, but the other was slightly decreased. In general the average of total livestock animal recorded before 2004 and after 2004 was 42.71 and 32.29 respectively. So, it also implies vulnerability increase as livestock have many advantages to adapt climate change. Consequently, this is another point that initiated the local people straggle to cope with and adapt to the impacts of the changing climate and variability in the area.

Table 8: Livestock trends before and after 2004

Village	Year before and after 2004	Livestock (%)						Total
		Oxen	Cow	Goat	Sheep	Donkey	Camel	
A/kolakul	Before2004	4.24	3.1	13.41	1.63	1.26	0.22	23.86
	After 2004	3.2	2.4	9.01	1.57	1.15	0.16	17.49
A/serawat	Before 2004	4.37	3.7	6.44	2.7	1.38	0.26	18.87
	After 2004	3.9	2.2	4.58	2.13	1.89	0.1	14.8
Total	Before 2004	8.61	6.8	19.85	4.33	2.64	0.48	42.71
	After 2004	7.1	4.6	13.59	3.7	3.04	0.26	32.29

Source: Computed field survey data (2016)

4.1.9. Access to credit for the sample household in the study area

Regarding the researcher information acquired from the kebele there are many organization that attempted to facilitate access to credit for the local people of study area. Enhance farm production through introduction of access to credit, such as application of improved seed, fertilizers and other technologies. Access to credit reduces vulnerability by providing the poor with financial resources and opportunities for income-generating activities. Credit available is expected to ease possible capital constraints there by encouraging the adoption of high yielding technologies which further increases the productivity of land and labor, similar with the idea of Tesso et al. (2012) also noted that increase in credit access significantly enhanced the farmers' choice of climate change adaptation strategies.

According to the interviewees, household's access to credit is distributed in different forms and institutions, in turn increased the household's livelihood diversification. From the survey result, 45 of the households have access to credit. Comparability, percentages of households access to credit is highest use by better off followed by medium then the last is poor farmers of the

respondents have an access to credit. Likewise, the percentage of male headed households is more user than female headed households which is 82% male and 18% female households have an access to credit. This indicates that male and better off headed households has high access to credit than female and poor headed households.

The poor, middle and better-off households were provided loans, from governmental and NGO by the form of *begait*, goat, Chicken and beehive. Accordingly, sources of credit were both formal and informal institutions like: microfinance, NGO and very small number informal lender like: Idir, Ikub, relatives and from better-off farmers. In the study area, credit can provide also in terms of agricultural inputs such as improved seeds, the major improved seeds distributed in the study area were teff and wheat, chemical fertilizers until 2006 but now by buying the fertilizer and also based on water harvesting technologies like motor pumping.

On the other side 55 of the respondent has no formal credit accessibility. Large number of household is by the case of fear to the high interest payment, since the interest is increase from year to year. And the other reason is lack of interest accessing to credit, the small number of sample household are follow the traditional thinking of fear of credit in terms of social context. Regarding the credit of local people was the absence of lender and lending institution was not the reason respondents. Therefore, it indicated that the contribution of lender and lending institution might have an adverse effect on livelihood adaptation practice which would help to overcome the climate change and related impact among the poor local people in and around Seglamen kebele (See table, 9).

Table 9: Distribution of access to credit to the sample household respondents

1 access to institutional credit	2 Main reason for not access to credit	A/kolakul		A/serawat		Total	
	Lack of interest access to credit	No	%	No	%	No	%
		10	18	10	18	20	36
	Fear of high interest payment	11	20	13	24	24	44
	Fear of credit based on social context	5	9	6	11	11	20
Total		26	47	29	53	55	100

3, access to credit	Sex	Wealth rank						Total	
		Better off		Middle		Poor			
		No	%	No	%	No	%	No	%
	Male	22	49	12	27	3	7	37	82
	Female	2	4	3	7	3	7	8	18

Source: computed field survey data (2016)

4.2. Areal satellite metrological analysis

4.2.1. Temperature analysis

Temperature is one of the main climatic element claimed increasing trend by numerous studies. As it is stated in chapter two, Increases in seasonal mean temperatures have been observed across Ethiopia over past 50 years, the majority of the temperature rise was observed during the second half of the 1990s (EEA, 2008).

Mean annual maximum temperature of the study area varies between 26^0C and 29.4^0 C. The lowest mean annual maximum temperature record is in 1996 and highest record is in 2003. The trend of Mean annual maximum temperature of the study area was observed from 1996 to 2015

with interval five years. For example, Mean annual maximum temperature in between 1996 to 2000 was 26.8°c and from 2001 to 2005 28.6°c. There is a considerable increase in trend of mean annual maximum temperature over last two decades (1996-2015) in the study area. The average annual maximum temperature over the country has been increasing by about 0.10°C every ten years (ENMSA, 2001). In this the metrological recorded and the study area farmer's perception comes to the same idea, increasing trend of temperature (See figure, 8).

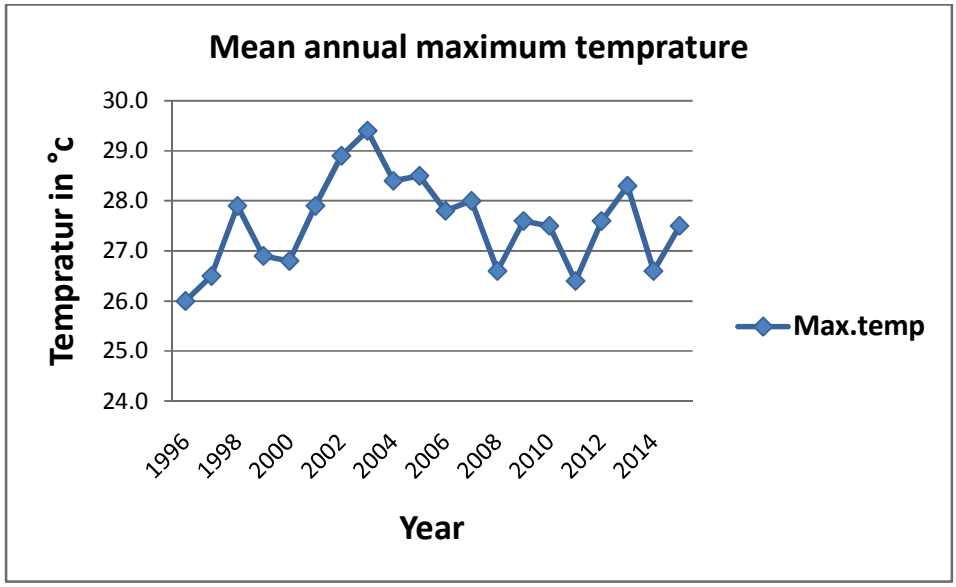

Figure 8: Trend in annual Maximum Temperature of the study area from 1996-2015

Source: NMA data, 2016

The average annual minimum temperature of the study area is 11^0C. Mean annual minimum temperature varies between 9.7^0C and 12 ^{0}C during the last two decades. The lowest mean annual minimum temperature record in 2010 and highest record is in 2015. There is a considerable decreasing trend from 1996 to 2009 and increasing in trend of mean annual minimum temperature from 2010 to 2015 over the five years by the interval of five years of the last two decades (1996-2015) in the study area. This indicates largely increasing change in mean

annual minimum temperature. Some studies have indicated that warming has occurred across much of Ethiopia, particularly since the 1970s, at a variable rate (Conway et al., 2004; IPCC, 2007b). The average annual minimum temperature over the country has been increasing by about 0.25°C every ten years (ENMSA, 2001). It is similar with the metrological data that the annual minimum temperature of study area was in increased trend (See figure 9).

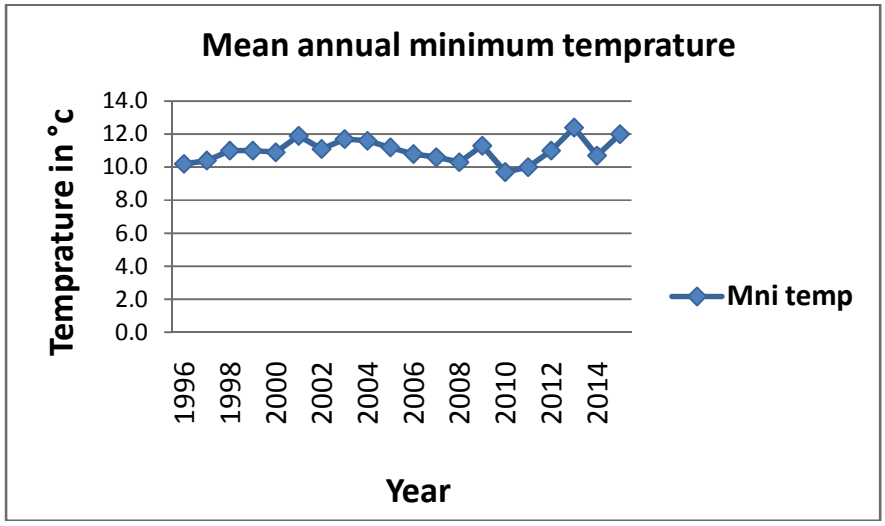

Figure 9: Trend in annual Minimum Temperature of the study area from 1996-2015

Source: NMA data, 2016

The researcher also look at the maximum and minimum mean monthly temperature of study area and resulted, mean monthly maximum temperature varies between 25.5^0C and 29.9^0 C. The lowest mean monthly maximum temperature record is in August and September; the highest record is in May. There is a considerable decrease in trend of mean monthly maximum temperature over last two decades (1996-2015) in the study area. This indicated that the metrological data and the local perception are similar on the maximum temperature month in May in the study area (See figure, 10 below).

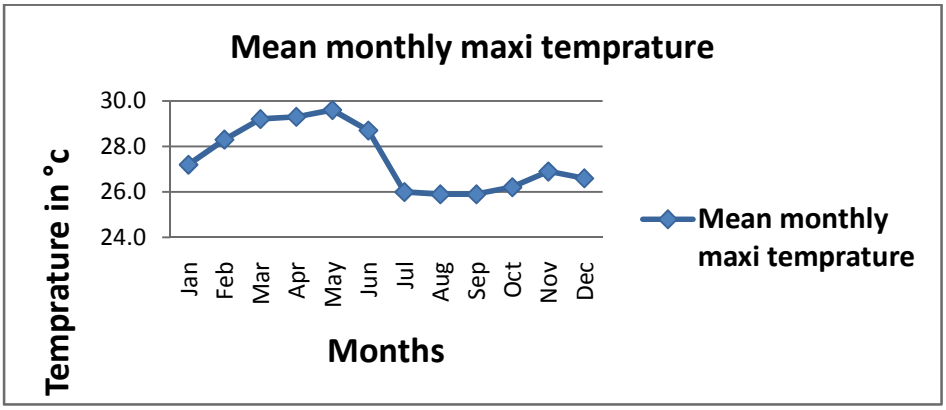

Figure 10: Trend in Monthly Minimum Temperature of study area from 1996-2015

Source: NMA data, 2016

The mean monthly minimum temperature for the study area 1996-2015 is 11^0C which varies between 8.5^0C and 13.1^0C. While the highest minimum temperatures observed in August (13.1^oC), but the month with the lowest minimum temperatures is December and January which is 8.5^oC. There is insignificant decrease in trend of mean monthly minimum temperature over last two decades (1996-2015) in the study area (See figure 11 below).

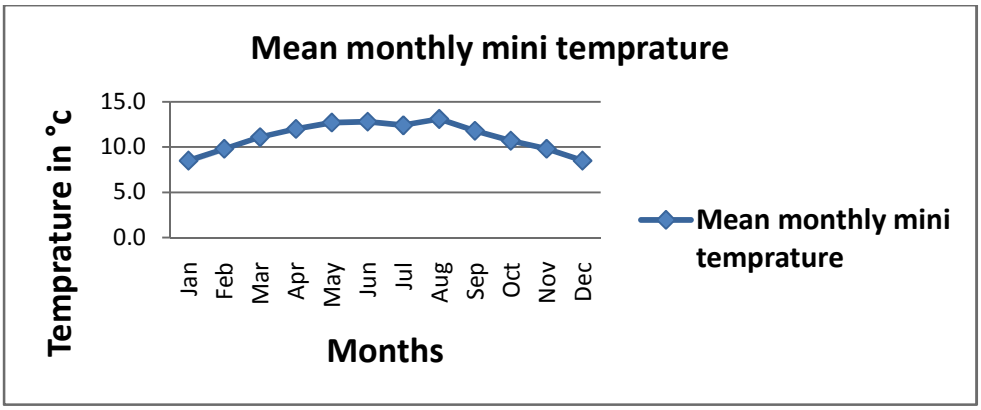

Figure 11: Trend in Monthly Minimum Temperature of study area from 1996-2015

Source: NMA data, 2016

In addition the researcher needs to make sure the data, researcher obligated to look at the average temperature of study area and resulted, average temperature varies between 18.1^0C and

20.6^{0}C. The lowest average temperature record is in 1996 and highest record is in 2003. There is insignificant increasing in trend of average temperature over last two decades (1996-2015) in the study area. In this metrological data and perception of sample household comes to the same idea increasing trend of temperature (See figure, 12 below).

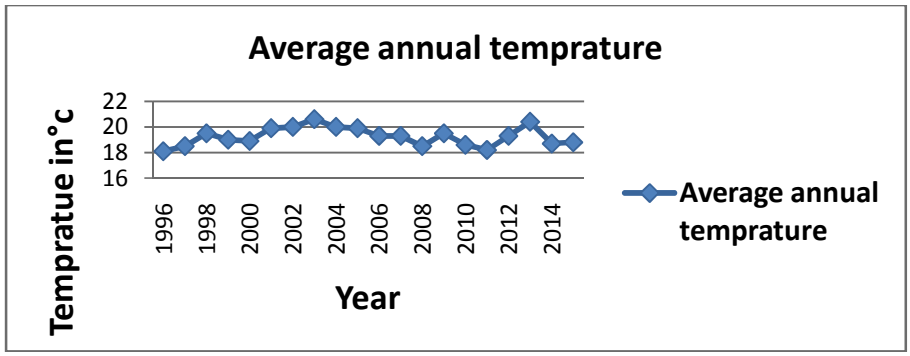

Figure 12: Trend of average annual Temperature of the study area from 1996-2015

Source: NMA data, 2016

4.2.2. Rain fall analysis

4.2.2.1. Annual rainfall trend and variability

For the period of 1996-2015 annual rainfall for study area ranges from 359.7 mm to 1037.0 mm with climatologically average of 14576.8 mm. The moist year was 1998 and the driest year was 2002.

There is decrease in trend of annual rainfall over last two decades (1996-2015) in the study area. Likewise; Hadgu G. (2013) find that rain fall in Tigray region is highly variable with non-significant trend in both annual and seasonal totals. It is the same with the local perception and metrological data decreasing trend of rain fall (See figure, 13 below).

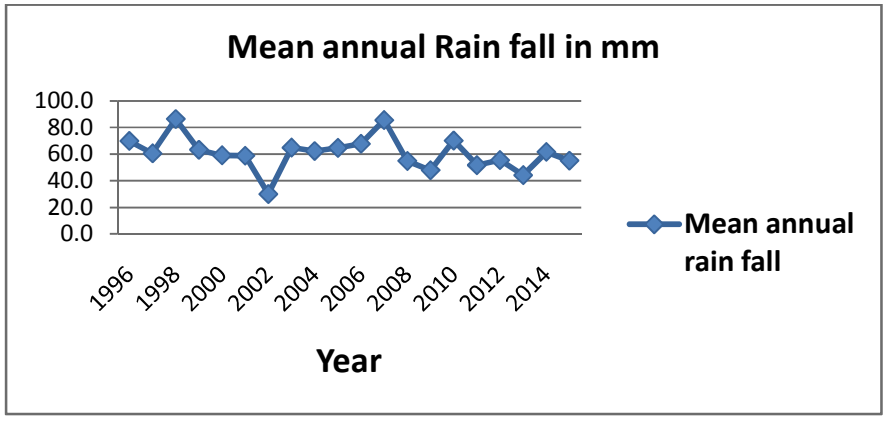

Figure 13: Annual rainfall trend and variability of the study area, 1996-2015

Source: NMA data, 2016

4.2.2.2 Seasonal rainfall trends and variability

With reference to seasonal trend the *kiremt* rainfall (June to August) the total high rainfall amount with slightly decreasing trend and *belg* (September to November) which is harvesting season shows some times very small rain and where as *bega* (December to February) shows a dry season and frost at the morning also spring (March to May) rare and light rain fall and the month of May is very hot. Generally all changes in seasonal trends are statistically significant (See figure, 14below).

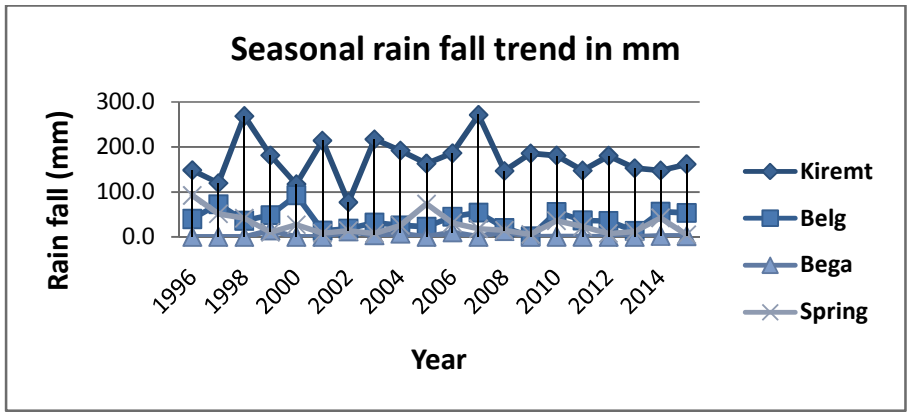

Figure 14: Seasonal rainfall

Source: NMA data, 2016

4.3. Community problem of needs and priorities

Based on the question of community problem of needs and priority, according to FGD, there are many problems of needs and priorities, but the first and predominant community problem is drought, degrading cultivated and pasture land, soil erosion and deforestation are direct and indirect climate change related problems. Similarly the other governmental, local administration and economic problems are followed by the problem of climate change and they increase the vulnerability to the impacts of climate change.

Social; like create social conflict through decreasing resource as well as migration and other is economical; e.g. small number of crop type, yield and decreasing animal fodder. In case of the governmental problem is exposure the local people to the impacts of climate change for example by increasing the price of agricultural in put (chemical fertilizer), most of the local people use very small fertilizers and some other not use.

In addition in the area some people affected by decreasing of their cultivated land due to road construction, because the government could not give any payment through money or compensation of cultivated land. Also in the local administrative problem like on mountain rehabilitation, traditional safety net, distribution of gabion for the individual person, in giving training in agricultural practice (irrigational practice). On mountain rehabilitation, the local people have no equal chance, because without hearing all people the information of mountain rehabilitation (lack of information distribution of local DA) and lack of good governance, therefore some people take for 2 or 3 children in one household and the other no one.

Beside the mountain rehabilitation rules and regulation as well as the local community practices have a large gap. on the rules and regulations the government needs to use the local people by

taking *begait* and beehive from the government credit to pay gradually with interest, then divided the mountain in a group people (from 7-8 person to gather) by local DA. The group member of the *begait* uses the grass only and they to protect the forest or large tree, in case of the group members of beehive to use the place to put the modern honey in that place and they protect forest and grass to get the beehive their food from the flower of grass and forest.

But the farmer of the study area uses the grasses and makes it deforestation both *begait* and beehive group. As the researcher observed during field observation, in the study area there is no any modern honey put in the mountain the people simply lead to high deforestation and increasing impacts of climate change, like increasing temperature and land degradation. In addition to the other impacts of climate variability related problem is erosion since, the area more surrounded by mountain vulnerable to the impacts of water erosion, so this gabion most of time use for the communal land degradation, but sometimes give for individual based on their vulnerability seen by the local DA and measure, if the valley width is greater than 26 meter square, distribute the gabion to the individual. But instead of these criteria, the local people take the gabion without any problem then use to other needs like to make shelter of goat, fences and other purposes, but not access to the erosion vulnerable persons that can to adapt the problem by this mechanism in the area.

According to the table, 10 below, most of the sample household answered that climate change is Community needs and priority in the local area followed by economical problem. Additionally the some respondents replied that absence of good governance. In general from this interview, FGD and survey result the researcher generalized that, problem of needs and priorities of the people is more depended on climate change related and in relation to this absence of good

governance such as lack of assessment to the vulnerable people etc, leads to increasing climate change impact of the community (See table, 10).

Table 10: Community problem of needs and priorities

Problem of needs and priority	Village				Total	
	A/kolakul		A/serawat			
	No	%	No	%	No	%
Absence of good governance	10	20	12	24	22	22
Economical	12	24	11	22	23	23
climate change	28	56	27	54	57	57
Total	50	100	50	100	100	100

Source: Computed from field survey data (2016)

4.4. Local perception on climate change and variability

The perception of farmers on climate change and variability refers that, rainfall amount and pattern has changed for the worst especially in the recent years. Before 20 years the month April to August was coldest, January to March hottest and September to December frost but now the coldest and frost months in changed trend to hot. Also the other now disappear, farmer uses as erratic and small amount rain fall indicator is fog, before the recent years the month of July dominated by fog from the early morning until 3 or 4 hours. Rainfall decreasing in amount, its pattern, and distribution has become variable or erratic, more unpredictable with increasing temperature are main community observed.

As clearly indicated in table 11 below, 68% and 74% of the household respondent in A/kolakul and A/serawat village of Seglamen kebele respectively answered that, erratic rain fall with the amount to some extent decreasing trend and increasing in temperature was the most common climatic characteristics of the area. On the other side double 24% for the two village of sample household respondent in A/kolakul and A/serawat replied uniformity temperature and rain fall

(constant temperature and rain fall). The remaining 8% and 2% in A/kolakul and A/serawat of the sample household respondent responded that complete absence of rain fall and decrease in temperature was observed in the area.

Generally out of the total respondent all most of them responded that, erratic rain fall with the amount slightly decreasing trend and increasing temperature. There for it is commonly erratic variation of rain fall with slightly decreasing trend that resulted in a sharp drop in precipitation and higher temperature conditions leads to challenge in the most vulnerable and poor community in the area.

Table 11: Perception on Climate change

Local Perception on patterns of climate variability	No of respondents	Village		Total
		A/kolakul	A/serawat	
Erratic rain fall with the amount slightly decrease trend and increasing temperature	No	34	37	71
	%	68	74	71
Complete absence of rain fail and decreasing in temperature	No	4	1	5
	%	8	2	5
Uniformity temperature and rain fall (constant temperature and rain fall)	No	12	12	24
	%	24	24	24
Total	No	50	50	100
	%	100	100	100

Source; Computed from household survey (2016)

4.4.1. Local perceptions of climate change trend on different regimes

Regarding the observable change in the amount of rain fall and temperature within the three decades or during Haileselase, Derge and EPRDF in the study area the information acquired from elderly people and women during KII, the amount of rain fall is slightly decreasing, while the temperature is increasing in the area. They also added that the onset of rain fall and cessation

of rain fall shifted. In addition the duration, amount, and intensity of rain fall were slightly changed.

The FGD respondents said that there was difference in rain fall, temperature and frost in different regimes. Regarding to rain fall, the amount is much reduced from Hailselase to EPRDF but the intensity is high in short time, so this high intensity with short time is increased land degraded rather than water percolation to the ground. During Haileslase, the amount of rain fall was very high especially Jun to July was rained daily with high amount and long duration. But during EPRDF, rain fall is rained rarely, low amount, high intensity with short duration. In addition they said that if the rain is high amount and long duration it is high frost, so in this the frost is low since low rain fall, low amount with short duration. Additionally trend of temperature is increased from the Haileslase regime to the EPRDF; because of rain fall late coming and early cessation. Thus, the study area is characterized by decline in the amount of rain fall and frost with increasing in temperature as indicated in the table below.

Table 12: Perception of climate change trend on different regimes

Regime	Trends of climate change						
	Rain fall					Temperature	Frost
	Amount	Duration	Intensity	Onset months	Cessation		
Haileselase(1930-1974)	High	Long	Low	April	End of September	Low	High
Derg(1974-1991)	High	Long	Medium	May	From the half of September	Medium	Medium
EPRDF(1991-2007)	Low	Short	High	End of Jun	End August	High	Low

Source: Result of FGD (2016)

4.4.2. Perception on crop dynamic period

According to FGD with elders (men and women) and KII with adult, Shortage of rain fall (moisture stress) is major constraint of agricultural production of the woreda particularly in the study area. In the last decades, the big rain usually started in April; farmers used to cultivate sorghum and maize, and harvested it in October to November, which lasts large months. Reliability of rain fall increasingly become low year after year, and the onset of rain fall had been in the middle of March and April before 20 years ago and it gradually been shifted to, at the end of May and most of time middle of Jun in that time crop production has been affected significantly. So, in late coming and early cessation of rain fall, farmers still exercise cultivation of crop which harvested in short time and drought resistant ones, e.g. barley, wheat, bean, American maize and red teff local name (*zagurey*) because white teff stay for long time (maximum 4 months) than red teff, (maximum 3 months) harvested.

Figure, 15 shows that, Sorghum and barley crops are seeding and harvesting in different times. In case of sorghum when the big rain started in April at whom farmers used to cultivate sorghum and maize which last large months (7-8 months). As well as barley is very quickly harvesting from all types of crop of the study area (2 -3 months), so by this case most of the people of study area use barley especially in the western part of the two villages. Sometimes the short growing crops can vulnerable in late coming and late cessation of rain fall, in this time the farmers harvested the short time crop and sow an other types of intercropping legumes and barley (*Saesea)*.

Figure 15: Long time growing maize (left) and Short time growing barley (right)

Source: field survey data (2016)

As the survey result shows, 72% and 70% of the respondent in A/kolakul and A/serawat respectively responded that the patterns of seasonal variation of rain fall in the area was late coming and early cessation, means that short period of raining time. As the information collected from interview they said that in the late coming and early cessation of rain fall, the western part of kebele is more affected by drought since, the land is quickly dry and contains low moisture than the eastern part of study area contains vertisols (*walka*) dominated by *teff* crops.

In Addition 25% of the total respondent said that the patterns of seasonal variation of rain fall or the timing of rain fall was late coming and late cessation. According to the KII, the late coming and late cessations were cause distraction during the harvesting time especially affected to the short growing crops like barley, wheat, bean and red teff so, the farmer said that (**ካብያ ማይ ቀውዓ አንበጣ ቀውዓ**) means that autumn locust is preferable than autumn rain since, the autumn rain is highly impacted crop production than autumn locust because locust eats leaves of crops and in the autumn most of the leaves of crops are dry whereas autumn rain harms the overall production. Generally, the local communities perceived climate change in the study area due to

erratic rain fall, late coming early cessation also sometimes late coming and late cessation (See table, 13).

Table 13: Perception on patterns of seasonal variation of rainfall

Perception on patterns Of seasonal variation of rain fall	Village				Total	
	A/kolakul		A/serawat			
	No	%	No	%	No	%
Normal	1	2	3	6	4	4
Late coming and early cessation	36	72	35	70	71	71
Late coming and late cessation	13	26	12	24	25	25
Total	50	100	50	100	100	100

Source: Computed from survey data (2016)

4.4.3. Perception on Causes and indicators of climate change

Regarding the people's perception on causes of climate change, some reasons were guessed by the local people while others suggested by most of the metrologies in the world. Commonly it is known that the causes of climate change are both natural and human actions. However, the local people could not give much emphasis for natural process which is playing the leading adverse role in changing climate change in the area. According to the information gets from KII of the elder people of women and men, said that the causes of climate change is through the process of human action e.g. by deforestation and by dig out of large stone from the side of mountain for the purpose of house construction so this process is more enable to erosion. Likewise, either natural or human or both natural and human process were given as cause for climate change in the area by the local household respondents.

Besides, they proved that from Haileselasie up to Derg regime the area was covered by large trees and forests with use to live different wild animal like hyena and fox. But now these types of forests and wild animals are lost by different human functions, because people make high

deforestation for house construction local name (*hidmo*) constructing by digging the ground and the roof is through wood most of the society use to store crop production. For such kind construction one person cut 50-60 large trees to construct one house and after the large trees lose the system of housing construction changed to tin. And the other was dig out of large stone which makes the area susceptible to erosion.

According to field survey, 40% of the respondent in A/kolakul and 68% of the respondents in A/serawat perceived that human action or process like deforestation as a cause for climate change in the study area due to settlement and over cultivation. Likewise, 18% of the total respondent revealed that the natural process was another causes of climate change but the rest perceived curse/wrath of God as the cause of climate change.

In general large number of sample household perceived deforestation as main cause of climate change.

Table 14: Perception on causes of climate change

Causes of climate change	No of respondents	Village		Total
		A/kolakul	A/serawat	
Curse/wrath of God	No	10	4	14
	%	20	8	14
Human action	No	20	34	54
	%	40	68	54
Natural process	No	8	6	14
	%	16	12	14
Both human and natural	No	12	6	18
	%	24	12	18
Total	No	50	50	100
	%	100	100	100

Source: Computed from survey data (2016)

Based on the indicators, sample respondents have identified the major indicators of climate change as follows; according to KII from the elder people of the sample household answered that the area have great problem of ground and surface water. The hand pump water in the area stays

for less than six months due to low ground water. Before 10 years the local community uses water from nearby rivers for home consumption, animal drinking and other agricultural production. While now's a day the rivers and lakes in the area totally dry up in the winter season due to rain fall irregularity. According to FGD, loss/decrease of crops has considered as indicator of climate change. Increase in uncertainty of the climate especially temperature and the uneven rainfall distribution have resulted in decline of crop production, livestock and their products (e.g. honey, meat, milk).

As survey data, respondent replied that the main indicators are dry up of ground and surface water, loosing of crop variety for example loosing of long growing crops due to shortage of rain fall and declining animal numbers as a result of shortage of food and disease. In addition rain fall comes lately with small amount and high intensity then flood frequency etc, was existed in the area. 26% of the respondents were revealed that the observing changes in physical structure like land degradation and increasing land slop of study area.

Therefore, most of the respondent responded that the most indicators of local climate change is the dry up of water resources, next rain fall comes lately also the people replied increasing depth of water availability (ground and surface water) See figure,16.

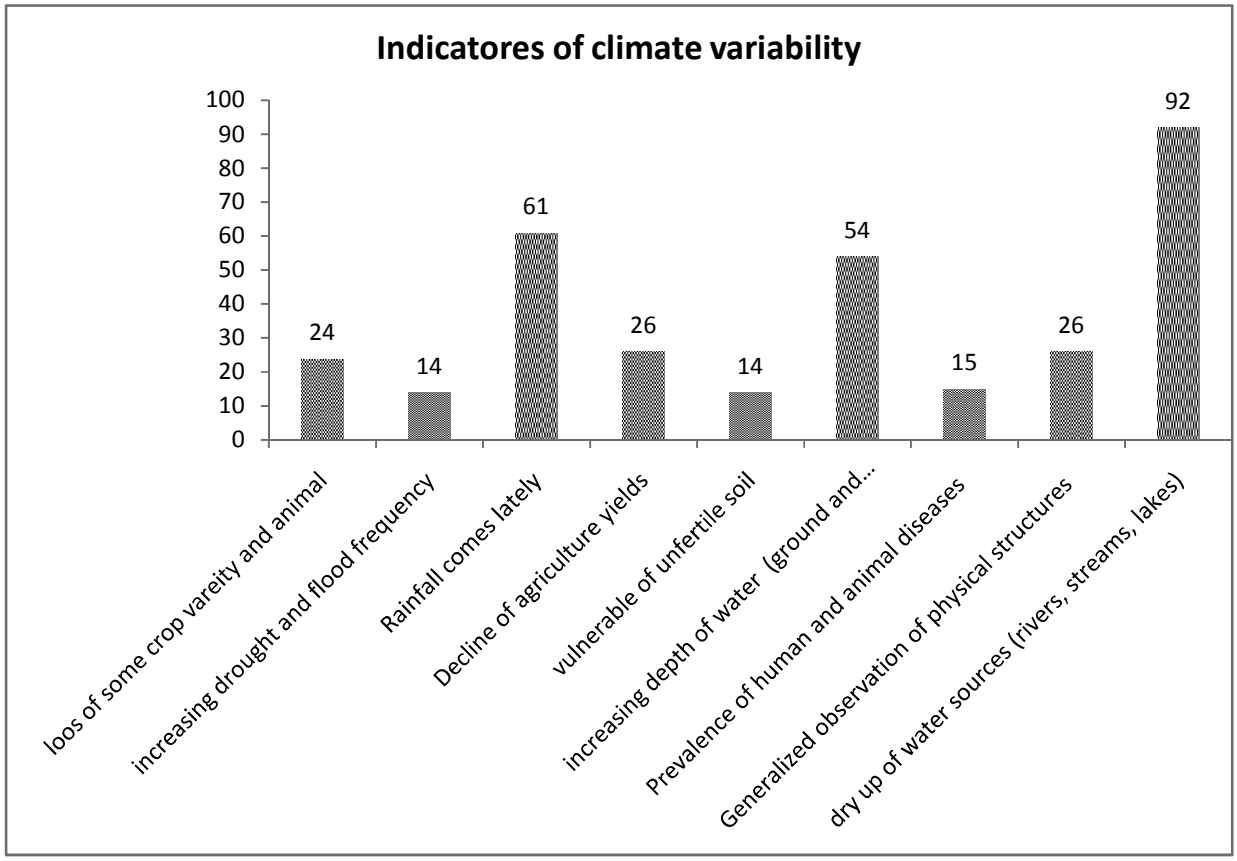

Figure 16: Local indicators of climate change

Source: compute from survey data (2016)

4.5. Impact of climate change induced hazards on local peoples

Climate change is regarded as the most negative effect of the significant advances in economic development and well-being in the last century (Stern 2006). The impact of climate change on the organization of human societies has been the subject of assumption by classical economists, political theorists, and policy analysts.

According to KII and FGD with the sample household respondents said that climate change has large negative impacts on social, economic and environmental aspect of the community, based on the declining amount, short duration and high intensity of rain fall and increasing in temperature. In sequence very small positive impact of climate change is in decreasing frost and

cold, because crop damage due to forest and cold is no more a serious problem. The economical, social and environmental impacts are listed below.

Economical impact

An irregularity in precipitation is utmost important disaster which cause food insecurity in the kebele as a result of drought induced crop failure. The climate anomalies over the past years have significantly impacted the economy of study area by affecting the households' income from agricultural products. The impact of climate change and food insecurity is depending on the capacity of land size differentiations of the community.

The researcher nullified the hypothesis that, there is a difference in the distribution of land size among the different wealth groups using one way ANOVA (see table,15).

Table, 15: ANOVA of land size distribution among households with different wealth status.

ANOVA					
wealth rank					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	57.855	4	14.464	104.611	.000
Within Groups	13.135	95	.138		
Total	70.990	99			

Source: Own computation from household survey, 2016

The difference of mean between wealth status and land size is statistically significant. This indicates an overall significant mean difference in land size by wealth status. Therefore, needs to look the pair wise (Post Hoc) mean difference between wealth status (better off, medium and poor) contrasting to land size, so the first idea of (I) wealth rank indicate, better off land size is greater by 0.51563 from medium and 0.93382 from the poor and the second is medium smallest their land by -0.51563 from better off and greater 0.41820 from poor, the last the poor smallest by-0.93382 from better off and -0.41820 from medium. A significant difference were obtained

between all wealth groups, between better off and poor, better-off and medium, poor and medium (p= 0.000) See table,16 below. Generally this significance difference indicates that the poor community owns small land size than others so, their impact is high.

Table, 16: LSD, Post Hoc analysis land size as dependent variable and wealth status as independent variable.

LSD, Post Hoc analysis land size as dependent variable and wealth status as independent variable.

(I)wealth rank	(J)wealth rank	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
better off	Medium	.51563*	.04223	.000	.4318	.5994
	Poor	.93382*	.04159	.000	.8513	1.0164
Medium	better off	-.51563*	.04223	.000	-.5994	-.4318
	Poor	.41820*	.04192	.000	.3350	.5014
Poor	better off	-.93382*	.04159	.000	-1.0164	-.8513
	Medium	-.41820*	.04192	.000	-.5014	-.3350

The mean difference is significant at the 0.05 level.
LSD =Fisher's Least Significant Difference, MD(I-J)=Mean Difference of (I) and (J) wealth status

Source: Own computation from household survey, 2016

According to the survey result, respondent replied that climate change impacted grain yield, followed by increasing of weeds and Spreading of crop diseases with pest like karate for teff as well as insect maize and sorghum. The rest answered that, declining of fodder and short harvesting time are parts of climate change impacts.

Table 17: Impacts on crop production

The impacts on crop production	No of respondents	Village		Total
		A/kolakul	A/serawat	
Decrease in grain yield	No	16	28	44
	%	32	56	44
Declining of fodder	No	5	9	13
	%	10	18	13
Spreading of crop diseases and pest	No	8	7	15
	%	16	14	15
Increasing of weeds	No	17	4	21
	%	34	8	21
Short harvesting time of crop production(delay ploughing)	No	5	4	9
	%	10	8	9
Total	No	51	52	103

Source: Computed from field survey data (2016)

Social impacts

The respondent said that based on social impacts; rural outmigration due to frequent drought occurrence, disrupted normal way of living and has also resulted in family disintegration. Moreover, the demand for child labors increased when the households were short of continuation. During group discussions, they revealed that some people are migrating to nearest towns to sell their labor. Particularly young people are migrating to Humera for seasonal employment so, the young people affected by the malaria disease of western Tigray (Humera). In addition, as the researcher observed during field observation, the people in the area uses water for drinking from hand pump water and conflict among the people due to lack of sufficient hand pump water accessibility to all society is common and the people spent more than 3 hours in water fetching. In the area the problem is not only lack of water accessibility but also unwise use of water also increases their vulnerability.

As KII revealed, when the volume of the local river (*Mihitsealabu*) reduced during dry season, the community led to conflict on using the shallow well water source and in the summer season

the local community create conflict with other kebele (*Medego*) eastern of the study area through over grazing land as well as with the forester within the Seglamen kebele. Also the other conflict source of the study area is due to erosion between the upper and the lower streams particularly in the western part of the study area.

Environmental impact

They stated that the major environmental impacts of climate change are land degradation, increasing land slop and lose soil fertility due to increasing cultivated land and over grazing. In addition degradation of natural vegetation or losing of tree species hence the air condition has become hotter, erratic with small amount of rain fall. And disappearance of special grasses like Sindedo (*Girmty*), Edini which are used for handicraft purposes by women's, besides animal fodder grass (*Mugiya*). Those types of grass growth if the rain onset early April-May so, now disappeared totally due to the case of climate change. Figure 17, below shows that the environmental impacts of climate change or pasture land degradation.

Figure17: Land degradation

Source: photograph from field observation (2016)

Severity of climate change induced impact

Severity refers to harshness of climate change impact. According to KII, due to unwise utilization of natural resource for construction materials, fuel wood, grazing land, primitive and continuous farming, the area were exposed to severe soil erosion, soil nutrient depletion, moisture stress, deforestation and over grazing. Climatic hazards like flood, drought, and rainfall and temperature variability were very severe impact in the study area. Flood hazards were sever in the study area due to that conflict among the upper and lower stream settlers were very common. The harshness of climate change induced drought effects were extreme severity, especially in the year 1976-1978 drought was affected the local community by out migration and died large number of people also animals. In the 1976 and1978 time of drought and 1977 existence of locust causes overall crop failure. In addition they stated that, the severity of climate change impacts before and after 20 years are relatively different. Before 20 years, the communities were high severity flood due to the long duration of rain, flood enter in to their home especially to their production store home constructed by digging the ground (*Hidmo*) then much production of the community was altered but not now's a day for the reason that introduction of different adaptation mechanisms.

The survey result indicates that, 46% of the respondents blamed that the effect of climate change on their livelihood is medium and 32% of the respondent replied the high severity effect of climate change while the remaining 22% of them responded that climate change affected the livelihood of their family less severely. So from this generalized that, although the severity of climate change was differentiated from person to person and year to year but most of the respondents replied that now the impacts of climate change are medium in comparing before 20 years.

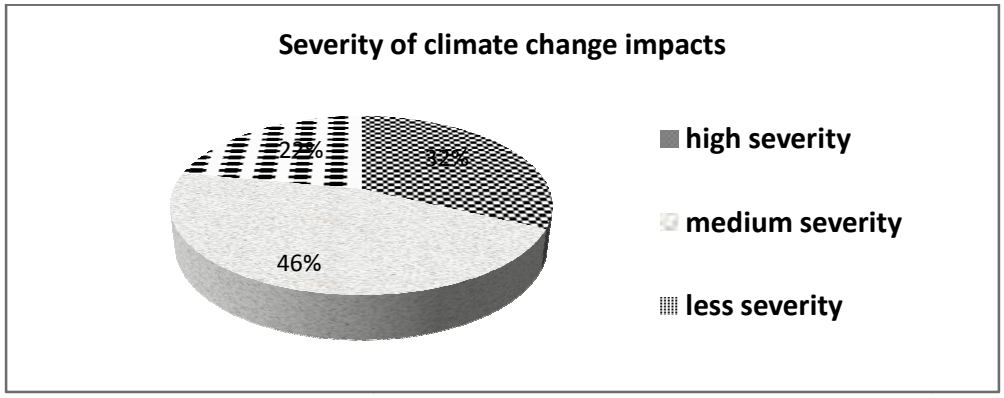

Figure 18: Severity of climate change induced

Source: Computed from field survey data (2016)

4.6 Causes of vulnerability

4.6.1. Vulnerability of local livelihood to climate change

Vulnerability is depends on pre-existing condition of physical and social space. Pre-existing conditions include; the geographical location; nature of dwelling; access to physical infrastructure, information and communication systems; patterns of social capital; and the ability of different groups or individuals to secure alternative livelihoods and ensure the flow of resources – financial, social and political – to maintain livelihood security (Twigg,2001).

Climate change vulnerability on agriculture includes decreased pasture availability and water, decreased capacity of livestock to resist disease and productivity in terms of milk and meat also death of livestock. Generally, drought causes crop failure, leading to food insecurity, increased conflict over scarce resources, migration of people for search of labor work and increased school dropout.

Table 18: Main livelihood resources in the study area

Natural	Physical	Financial	Human	Social
Pasture Water sources Farmland Forest	School Road Clinic Irrigation	Livestock Livestock products Charcoal and firewood Savings and credit Remittances Seasonal/daily labor	Traditional health care Management skills House construction Traditional shoe making skills Craft skills	Savings and credit groups Women income generating groups Women association groups

Source: Kebele Agricultural office (2016)

Vulnerability on natural resources

Communities are observed significant vulnerability of drought and extreme heat events on natural resources such as pasture, water sources, farmland and forest. Farm land is the most important natural resource in their locality. In KII respondent mentioned the declining availability, productivity and quality of pastures and farmland lead to enormous human displacement, death and crop damage.

Vulnerability on physical resources

A small number of physical resources are impacted by drought, flood and wind. As the communities mentioned that the utility of traditional wells and ponds decreases due to reduced water levels. Distraction of irrigational structured, by flood and out of use due to shortage of water. Irrigation facilities are essential for rain-fed agriculture dependent households. It is assumed that households with irrigation facilities will be less vulnerable to changing rainfall patterns in the study area. In addition flood diversion of road and wind challenges for the school also other construction is shows a physical vulnerability of climate change in the study area.

Vulnerability on financial resources

As a KII, the main financial resources upon which study area communities depend include livestock and livestock products, crops/grains, savings and credit. As mentioned above, drought leads to decreased pasture and water availability, which in turn leads to livestock decreased and death, reduced livestock productivity (in terms of milk and meat), reduced livestock disease resistance, more livestock being sold on the market, and lower livestock prices, there by leading to weaker terms of trade and decreased household incomes. As stated by many community groups, income generated through livestock sales is no longer sufficient, compounding poverty and food insecurity. Among livestock species in, cattle and sheep are especially vulnerable. Goats and camels are more drought-tolerant and less affected by pasture degradation and bush destruction. Drought also vulnerable to savings and credit groups/cooperatives, since incomes from livestock, livestock products, crops, and activities and charcoal are highly reduced.

Vulnerability on human resources

Drought is also vulnerable to human resources that are significant to people's livelihoods, with education, health, human labor and various abilities/capabilities. Increased migration resulting from droughts and conflicts leads to increased school dropouts. In addition, the decrease in food, in times of drought affects human health, reduces human disease resistance, human labor productivity, and human capability to take on different activities such as learning in schools, craft and business management.

Vulnerability on social resources

Social associations, such as youth associations and women's income generating groups are also vulnerable to drought impacts. Increased migration and longer durations spent searching for water, livestock feed and food leaves little time for social activities.

4.6.2. Vulnerability and concern shocks

Increasing temperature, combined with dependency on rain fed agriculture (the declining of the rain fall and the frequency of the drought), as well as deforestation and land degradation of the soils, have resulted in decline of agricultural production according to Temesgen et al. (2008).

Besides, the sample household mentioned some of the observed shock in the study area with different vulnerability between the two villages. As FGD and survey, temperature, flood and strong wind are highly vulnerable to the A/serawat village because the place is quickly warm and the vegetation's shade their leaves in the winter season, flood is affected since surrounded by mountain and sensitive crops to the wind storm.

Concerning very cold, human disease, cattle epidemic and frost hazards are vulnerable to the village A/kolakul since 50% of the soil type vertisols, there is high cold and mud in the summer season due to that the local communities are vulnerable to malaria disease. The remaining respondents responded that almost all the climatic shocks listed above are observed in the area.

Generally, the majority of the respondents replied extreme temperature, flood, drought, crop failure, cattle epidemics strong wind were the most commonly observed climatic change induced shocks in the study area (See table, 19).

Table 19: Climate change related hazards

Hazards	Respondents	Village		Total
		A/kolakul	A/serawat	
Extreme temperature, flood, strong wind and drought	No	15	22	37
	%	30	44	37
Extreme temperature, human disease, frost, flood , reducing crop production and cattle epidemics	No	12	13	25
	%	24	26	25
Very cold, human disease, cattle epidemic, frost and flood	No	15	5	20
	%	30	10	20
All of the above can be answer	No	11	7	18
	%	22	14	18
Total,	No	50	50	100
	%	100	100	100

Source: Computed from survey data (2016)

4.6.3. Vulnerable segment of community to climate change

Even though, climate change has been the same for all people, the vulnerability on livelihood of different wealth categories and social groups is not the same (IPCC, 2007).

Women, men, children and elder perform different tasks and have different roles, based on the researcher collected the information by KII from women and elder people. According to the FGD with elder women and men, they said that all groups of the community are not equally affected by climate change/variability. Vulnerability is depending on the wealth rank, age and sex of the community. As most survey and FGDs respondents stated, children and women are more affected by climate change impacts. Women have several household responsibilities; they are taking care of children and livestock, fetching water, collecting firewood and cooking food as a result they are vulnerable to climate change impact. Besides, crop failure as a result of irregular rainfall may result in the selective starvation of girls due to their poor capacity to adapt different factors such as lack of community support (low status) and limited access and control of natural

resources they become more vulnerable than men. And men can able to migrate to nearby towns to escape from the drought patterns of the area and search for better future.

Figure 19: Women Vulnerability to climate change

Source: photograph from field observation (2016)

Children's are also greatly vulnerable to the impacts of climate change, drought has disrupted children from attending their school through different types of disease, since the children could not get sufficient food supply vulnerable to different disease easily and lack of educational materials lead Students drop out from their schools and additionally respondents replied that students are vulnerable to climate induced impacts, because they are used as adaptation mechanisms to the impact of climate change by sending them to work areas to support their individual family during severe drought event.

According to the interviews, poor people are more vulnerable to climate change than medium and better off households. The poor community stated that, climate change more vulnerable to the poor community, because they owned small land size covered by one types of crop, in addition with erratic types of rain fall the non-ox poor community cannot seed at normal seeding time rather stay until the better off or their renter finished then their crop exposure to drought.

And some of the poor communities crop production is not enough subsistence yearly and the other poor community uses to consumption only without selling to the other needs of society.

In better off, owns a large land size, large family size and large number of livestock amount. So, if the farmer has large cultivated land collect much amount of crop production and varieties like teff, maize, bean, wheat etc, in one year. And they use different fertilizer (organic and chemical fertilizer), introduced technology like line seeding, and improved seed. In addition they have large labor force so weeding on time rather than use pesticides. If the farmer have large family size, and with age of > 15 years old of male, in any problem move to near country and places to work then not only for themselves but also give support for their parents. In case of female cannot move from their house. And also the better off farmer uses as alternative of selling animal and crop production to the other needs but not in case of poor community so, the poor community are more vulnerable to the climate variability.

Based on the questioner survey ranking vulnerable groups are women found that in both village categorized in the first rank followed by children, 55% followed by children 25% respectively with 17% are elder of the total respondent the last is the adult vulnerability is 3% of the respondent.

Generally regarding on the above different responses, women are first and more vulnerable to climate change because they own small land size, over loading internal and external responsibility etc. And with regard to the wealth rank, the poor community is vulnerable to climate changes (See table, 20).

Table 20: Vulnerability segment to climate change in the community

Vulnerability to climate change	Village				Total	
	A/kolakul		A/serawat			
	No	%	No	%	No	%
Women	29	58	26	52	55	55
Children	14	28	11	22	25	25
Elder	4	8	13	26	17	17
Adult	3	6	0	0	3	3
Total	50	100	50	100	100	100

Source; Computed from field survey data (2016)

4.7. Climate change adaptation strategies

One of the intended objectives of this study was to identify some of coping and adaptation methods practiced by farmers, in response to impacts of climate change and variability. The sample households had adapted to cope up the impacts of climate change and variability. The most widely adapted strategies were that have little cost to the household and relatively easy. Thus, in order to minimize the problem related to climate change, the local community was familiar to producing and practicing some adaptation strategies in the area since long years ago. Likewise, the most common household adaptation practices in the area were discussed being categorized under, Planting early maturing crops appears to be the major adaptation mechanism of communities, preservation of food and seed storage, diversifying livestock composition, Sale old/ weak animal before drought occurs, migration and Soil and water conservation. Generally, this study included local (indigenous) and introduced (governmental and nongovernmental) adaptation mechanisms.

4.7.1. Traditional early –warning system

An early warning has to be well-timed so as to be effective. Timely warnings assist to make rapid for successful and exact responses and need to be resolved for effective adaptation. According FGD with elderly people there were variability of rain fall from time to time, year to year and month to month. In the local area rain sometimes onset from April, but now most of the time onset from the half of Jun and depending on erratic onset of rain the local farmer seeds different types of crop.

And the elderly people said that, the local people predict the future occurrence of rain fall and conditions of production, first through the condition of vegetation. Based on vegetation if the Wanza (*Awuhi*) types of tree is very well in the winter season the farmer predicts that time of teff, if Echinopishispidus or local name (*Dandier*) very well it is time of sorghum and medium rain fall and onset April, if Acaciaetbaciaschlueinf (*Seraw*) is very well they predict time of drought and very small rain onset on the end of Jun, if the tree of Crotonmachostachys local name (*Tambuk)* is very well the time of barley rain onset on the beginning of Jun and if the tree of Carrisaedulisvahl locally (*Agam*) very well to figermillet or they say a time of figermillet. Therefore the communities already prepare seed types based vegetation prediction.

The second way that farmers predict rain condition is based on the period's name like Matias, Liquas, Yohannes and Markos. If the period is Matias, it is known for low rain fall, high temperature, drought and famine. In the period of Liquase medium rains fall, temperature and production. If the period is Yohannes and Markos they think as a time for high rain fall, high amount of production and very comfortable health's. In sequence the community uses different adaptation practices like, storing food crop by buying cheaply from the nearby vicinity, selling livestock to food crop.

Besides, elderly KII stated that, the local people predict rain situation by using wind direction, if the wind flow to north direction during spring season it is known for early rain, on the other hand if the wind flow to south direction there is no rain. In the autumn season wind flow to south so the rains in this time cessation, due to that it is known as autumn wind, regarding this prediction they prepare short growing crop. Based on the daily prediction the society uses condition of the sun, means that if the sun is very high in the morning without cloud cover, the farmer in the area predict that there is high rain fall, but if there is no cloud cover, they predict that there is no rain rather the sun is very high. Therefore farmers do their work early at the morning and arrange the position of flood way. These types of adaptation practice still now farmers use those traditional early warnings especially wind direction and the condition of sun to predict rain fall.

4.7.2. Agronomical adaptation strategies

As the researcher observed during field observation, over the entire area of Seglamen kebele, the predominant crops in the area are barley, teff, wheat, maize, figermillet, bean and sometimes sorghum. Crop production has been the most and basic economic activity for the local community and the respondent's use different local adaptation practices.

Different local adaptation measures are undertaken by farmers in response to changing climatic variation in the study area. As elderly people revealed during FGD, the types of adaptation practices of crop production such as short growing season crops (barley, wheat and bean), crop rotations which means changing the type of crop from one year to the next year, for example from bean to barley, from barley to sorghum, from figermillet to teff and storing food crop by buying cheaply from the nearby vicinity and Practice fallowing, are the major and common adaptation practices of the community.

Fallowing, is local type of adaptation practice, there are two types of fallow: natural and improved. Natural fallow consists of allowing land that is usually cultivated to remain uncultivated and instead using it for grazing or left to natural vegetation to restore soil fertility. Improved fallow consists of planting trees, mainly legume tree species, in order to enrich the soil within a shorter time period, compared with natural fallow (Bekele-Tesemma 2007). Similar to this the respondents said, white fallowing and legume fallowing. White fallowing: in this the land Wait for one and above years without cultivation. And legumes fallow is the land sow in the half of the summer season by grain legumes. Half part of A/kolakul village or Wallaku is almost dominated by one type of crop (teff) because the land is comfortable for this crop and most people used fallowing in that area and due to that it is not more vulnerable to drought.

"*Ato Berhe Yohannes is farmer of Seglamen kebele, which stated that, when we compare the current fallowing system with previous years, Currently, fallowing system is reducing because of two reasons, first, due to small land size of farm land, second due to the introduction of chemical fertilizer in the area. Chemical fertilizer introduced in the kebele in 1965 in Haileslasie regime, with the price of 15 birr per quintal, from that time the community needs to cultivate their land yearly using chemical fertilizer rather than fallowing for some years. They said that* **(ካብያ ንዓመታ ደርሆ ንሎሚ እንቓቆሑ***), since the people owns very small land plot in the area."*

The fallow land always saw teff without using or sometimes using very small chemical fertilizer (See figure, 20 below).

Figure20: Grain legumes (left) and Teff dominated area (right)

Source: photograph from field observation (2016)

Mixed cropping: Mixed cropping is complex cropping systems in which two or more crop species are planted within sufficient spatial proximity to result in competition or complementation. Mixed cropping is growing of two or more crops simultaneously on the same piece of land (field), there is crop intensification in both time and space dimensions thereby enhancing yields which is practiced in the western parts of the study area, but not in the eastern part, wallaku half of the village A/kolakul, and mewakil small part of the village A/serawat. The western part of the study area is warm quickly than the eastern part and vulnerable to the impacts of climate change (See figure, 21 below).

Figure 21: Mixed cropping

Source: photograph from field observation (2016)

Inter cropping: are the other local crop adaptation practices and most uses in the western part of the study area. This is type of farming practice means that growing of one dominant crop and the other types of crop sow rarely (in one cultivated land more than one seeds). This is important to compensate one to the other types of crop and to get many types of crop in the same time or one year from the same land area (See figure, 22below).

Figure22: Inter cropping, Teff & Abyssinia (left); Sunflower, maize & been (middle); wheat and Abyssinia (right)

Source: photograph from field observation (2016)

According to the survey result indicates the respondent's uses different local adaptation practices, most of the local listed adaptation practice are dominated in the study area. And those adaptation mechanisms practiced based on their wealth status and their settlement village.

Regard less of their amount the three wealth group respondents equal practice (100%) on cultivation of food crop as alternative means in their respective village, because crop cultivation is first livelihood in the area followed by rearing animal. All better off respondents are used Organic fertilizer (manure) and followed by 88% and 21% of medium and poor households respectively. In addition 39%, 12% and 9% of the better off, medium and poor respondents respectively informed that they were storing food crop by buying cheaply from the nearby vicinity attempt to reducing the impacts of climate change. As the KII with adultery stated that

the person who owns donkey especially camel simply exchange and store crops from the town Edagaberhe and Adet e.g. barley to maize and bean to teff. Other adaptation practice which is not used more by the respondent and create great difference among the wealth group are fallowing practice and mixed cropping. With regarding to the fallowing 52% of respondent practiced by better off, 6% from medium and no one is from the poor can practiced, because as explained before fallowing needs large land size. 94% of better off respondent, 76% from medium and 18% of poor are practiced mixed farming adaptation practice, this is as information from the poor community, to practice the mixed cropping is depends on the large land size and different types of seed by this case most poor community not practiced.

The rest crop rotation and inter cropping are small differentiation among the wealth group. Fallowing system is most dominated in the eastern part study area they use pluses types of crop, as well as crop rotation, inter cropping, mixed cropping and short cropping season are the other most dominant adaptation strategies in the western part of the study area. Generally from the survey result and KII the information indicates that agronomic adaptation practices are different with labor force availability, land size, wealth and land of the village type (See table, 21 below).

Table 21: Crop production adaptation system

Crop production related adaptation to climate change	No of respondent	Wealth rank			Total
		Better off	Medium	Poor	
Practicing cultivation of crop as alternative means	No	33	33	34	100
	%	100	100	100	100
Storing food crop by buying from the nearby vicinity	No	13	4	3	20
	%	39	12	9	20
Practice short growing season crops	No	30	31	26	87
	%	91	94	75	87
Practices crop rotations	No	31	31	26	88
	%	94	94	75	88
Practice fallowing	No	17	2	0	19
	%	52	6	0	19
Organic Fertilizer(manure)	No	33	29	7	69
	%	100	88	21	69
Mixed cropping	No	31	25	6	62
	%	94	76	18	62
Inter cropping	No	30	28	17	75
	%	91	85	52	75
Total of multiple response	No	218	187	146	551

Source: Computed from field survey data (2016)

To full fill the gaps of local adaptation, the NGO and Regional government institution intervene; respond to adapt the impacts of climate change condition in that particular locality. From the FGD, all of the participants blamed that they have large assistance by different institution of governmental and nongovernmental organizations through various methods contributed to the local community. Adaptation strategies designed and promoted by the government then accepted and implemented by the community are like introduced soil and water conservation systems, a forestation activity, Percolation ponds are constructed to reduce run off and raise ground water level, providing improved seed, chemical fertilizer and Introduction of early maturing crop varieties is another government strategy. Crop production introduced adaptation activities are such as chemical fertilizer, improved seed and line seeding etc.

Line seeding: As the researcher observed during the field, the line seeding types of adaptation mechanisms was use very small number of communities. As the adult people responded during FGD, line seeding is one of the introduced adaptation mechanisms and very important practice, but as that of significance it includes drawbacks. In the practice of line seeding it needs high man power in the seeding time and also creates very weeds since it have large gape of space entire crops of the land. So, by this case line seeding is used by small number of farmers (See figure, 23 below).

Figure23: Bean (left) and Teff (right) line seeding

Source: photograph from field observation (2016)

According to the KII, another common adaptation practice in the area is chemical fertilizer. Still now, the amount of the chemical fertility decide all people to credit by the local DA not by capacity or willing of farmer them self, by this case land size and fertilizer is not much and with poor community the local DA associated with the safety net program they obligate to buy by the payment other ways leave out from this aid.

The survey result indicates; regardless of amount all households use chemical fertilizer. And the other adaptation practice that has not use more by the respondent and creates great difference among the wealth group are line seeding and improved seed. With regard to line seeding 52% of respondent practiced by better off, and 3% from medium and no one is from the poor can practiced, because as explained before line seeding needs large family size in the seeding and

weeding time, but in case of improved seed (wheat and teff) the case is price expansiveness so, mostly used by the better off and sometimes by the poor community. In general the introduced adaptation practices creates greats difference among the wealth rank, especially on improving seed and line seeding almost none practiced by the poor community (See table,22. below)

Table 22: Introduced crop adaptation practice

Introduced crop adaptation practice	Wealth rank						Total	
	Better off		Medium		Poor			
	No	%	No	%	No	%	No	%
Line seeding	17	52	1	3	0	0	18	18
Improved seed	21	64	9	27	2	6	36	36
Chemical fertilizer	33	100	33	100	34	100	100	100

Source: Computed from field survey data (2016)

4.7.3. Biological adaptation strategies

As the interviewed local D.A, most of the people understand the function of forests, since they received formal and informal trainings and use different information technology like radio. The community uses different adaptation practices such as re-forestation, socio forestry and agro forestry etc.

Moreover, the government and non-governmental agents started exotic tree planting in the individual and communal land of study area. In the study area the society is affected by shortage of grazing land then the community use exotic tree planting like *Saspaniya* to feed their animals through the cut and carrying system (See figure 24 below).

Figure 24: Exotic fodder trees

Source: researcher captured from field observation (2016)

4.7.4. Soil and water conservation

As the data from the farmers, the main physical conservation measures implemented in the study area were like tracing and stone bench. Beside there are some sources of water which are used to the local communities in the study area including river, spring (*mizezgi, migoanda, miklkal and mialak*) which are important for home consumption and livestock uses.

According to KII with elder peoples they said that even though the amount of water has gradually been decreasing due to the erratic nature of rain fall in the area, households are harvested the different water source like shallow well.

In addition the local people were trying to employ some adaptation mechanisms physical soil and water conservations such as water harvesting during rainy season to crop production like changing flooding way inter to the cultivated land, digging local trench (See figure, 25 below).

Figure25: Local physical adaptation systems

Sources; photograph from field observation, (2016)

Inside of introduced adaptation strategies, as the researcher seen during field observation, there were some practiced of soil and water conservation were implemented such as, deep trench, terraces, hill side terrace, half moon, gabion, gully cutting and stone bund (See figure 26 below).

Figure26: Introduced soil and water conservation method

Source: photograph from field observation, (2016)

In addition some source of introduced water harvesting structure related in the study area including check dam, vasca, spring development, shallow well, river diversion and percolation diet (*Horeye*). Some of the above mentioned sources of water were built by the local community individually and communally. In addition as precisely observed during field observation the households in the area uses water for drinking from hand pump water but it creates conflict among the people because of lack of the hand pump water accessibility to all society and the people spent more than 3 hours in water fetching. In that area not only lack of water accessibility but also they have wisely using problem of the community.

Table 23: Water harvesting structures

No	Type of structure	No of structures
1	Check dam	30
2	Shallow well	5
3	River diversion	2
4	Motor pumping	7
5	Spring development	2
6	Vasca(Tanker)	1
7	Water pond	127

Source: Water resource development office, Seglamen kebele (2016)

According to KII with elder peoples they said that more over the amount of water has gradually been decreasing due to the erratic nature of rain fall. They revealed that the river of this area is dry up from the February so, the local livestock uses to drink from different communal human harvesting water source like shallow well in the area so that the local people were trying to employ some adaptation mechanisms such as digging of shallow well, using of percolation diet (*horeye), river diversion, check dam* and other harvesting rain water (See figure, 27 below).

Figure27: Introduced water conservation structure

Sources: photograph from field observation, (2016)

As depicted in survey result 70%, 15% and 0% of the respondent from better off, medium and poor respectively use water pond in the study area. According to the KII with poor people stated that, the poor community not use adaptation mechanisms of water pond (*horeye),* since they have not capacity, skill and comfortable land, as a result more practiced by the better off. 18% of the

better off community, 3% medium and 0%poor responded to the adaptation system of motor pumping. And 58%, 33% and 24%of the respondent revealed that water conservation during rainy season. In general from the above listed water related adaptation practice done to meet the water demand of humans, livestock and crops. Large number of the respondent uses Water pond harvesting system followed by, water conservation during rainy season, the last and use by small number of respondent is motor pumping. So regarding the response of survey and KII this generalized that, water related adaptation is more practiced by better off community than poor in general and female in particular (See table, 24 below).

Table 24: Water conservation structure adaptation strategies

Water conservation structure	Wealth rank				Total in %
	No of respondent	Better off	Medium	Poor	
Water pond (*horeye)*	No	23	5	0	28
	%	70	15	0	28
Motor pumping	No	6	1	0	7
	%	18	3	0	7
Water conservation during rainy season	No	19	11	8	38
	%	58	33	24	38
Total	No	48	17	8	73

Sources: Computed from field survey data (2016)

In addition to the crop and water adaptation strategies, the government great contribute to the local livelihood diversification from one activity of crop to raring livestock, beekeeping, chicken etc in the form of credit, safety net program etc. Productive Safety Net Program is also one of government induced adaptation strategies. The main objective is to fill food gap of the constantly food insecure farmers by assist crop (wheat) so that the farmers may not to sell their remaining assets. And through giving early warning on climate change and impacts by the local DA, on giving or providing credit by the form of chicken, *begait* and also mountain rehabilitation.

Based on the nongovernmental institution the (GLIMER) organization contributed many practices to the society, such as construct school in the area, distributing gabion regarding the impacts of land degradation of the area and to livelihood diversification contributed *begait* for women to pay the money by the form of Ikube etc. Figure, 28 below shows the livelihood diversification of governmental accessibility of chicken and modern honey system in addition NGO contribution of gabion to the local people in their kebele.

Figure28: Introduced livelihood diversification adaptation systems

Source; photograph from field observation (2016)

As the survey result indicates that, most of the respondent in the kebele responded that the governmental institution is contributing adaptation practice such as giving early warning by using metrological information and provide agricultural input, followed by 22% of the respondent stated that safety net program is governmental adaptation practice. Beside 20% of the respondent answered that, governmental and nongovernmental institutions contribute their adaptation practice by providing kind credit. In general based on the FGD and survey result, summarized that the governmental and nongovernmental adaptation system large effort to the local community like livelihood diversity and providing kind credit etc, and some practice of nongovernmental organization adaptation mechanisms of climate change (See table, 25 below).

Table 25: Introduced livelihood diversification system

Governmental and nongovernmental interventions	No of respondent	Village		Total
		A/kolakul	A/serawat	
Through giving early warning and provide agricultural input	No	30	28	58
	%	60	56	58
Safety net program	No	13	9	22
	%	26	18	22
Providing credit	No	7	13	20
	%	14	26	20
Total	No	50	50	100
	%	100	100	100

Source: Computed from survey data (2016)

4.7.5. Local livestock adaptation strategies

As observed during observation over the entire area of Seglamen kebele the local communities have had predominantly cattle, goat, sheep, camel and donkey. Livestock production has not been the most indispensible and not the basic economic for the local community but they use as adaptive mechanisms next to crop production since whose life style has entirely been based on crop production.

As the survey result indicates in table, 26 below, the livestock related adaptation mechanisms of the respondent have different range by their wealth rank and gender. Most of the respondent 85% male and 3% female of the respondent better off, 79% male only of them from the medium and 29%male with 3%female from poor responded that decreasing the number of livestock is one of the livestock adaptation practice. As interview with better off, stated that now the number of livestock is very small from the previous because of erratic with very short period of rainy time and increasing temperature, the community exposure to the problem of animal fodder. Before 20 years ago the local people uses grass as livestock fodder not only for the summer season but also for the winter season, by drying and storing local name (*Durka*) in addition to the production

crop residues and in that time they feed the whole day on the communal grazing land, but now the livestock fodder is most depend on production residues in all season and they feed especially in the morning and evening.

In addition 52% and 6% of better off male and female respectively, 24% medium of male, 29% poor of male respondent answered that, Sale old/ weak animal before drought occurs. In addition 9% of male and 53% female of the total and poor respondent replied that none of the above was practiced since they have not their own livestock. As information from interview of poor community, the poor community is more vulnerable to the climate change because they have no alternative adaptation mechanisms livestock, like selling the livestock to purchase food, renting out animal.

This implies that the local community of the study area has already been confined to the most commonly known livelihood adaptation practice with respect to the livestock production so as to minimize the adverse effect of climate change in this particular vicinity. And it reflected that livestock adaptation more practiced by male and better off less practiced poor and female.

Table 26: Livestock related household adaptation practice

Livestock related house hold adaptation practices	No of respondent	Wealth rank						Total
		Better off		Medium		Poor		
		Male	Female	Male	Female	Male	Female	
Increasing the number of livestock	No	0	1	1	0	0	0	2
	%	0	3	3	0	0	0	2
Decreasing the number of livestock	No	28	1	26	0	10	1	66
	%	85	3	79	0	29	3	66
Selling the livestock to purchase food	No	3	0	2	0	0	1	6
	%	9	0	6	0	0	3	6
Rent out animal (horse, donkeys, camels and oxen)	No	0	0	1	0	0	0	1
	%	0	0	3	0	0	0	1
Cattle entrustment (giving out)	No	4	0	2	0	6	0	12
	%	12	0	6	0	18	0	12
Sale old/ weak animal before drought occurs	No	17	2	8	0	10	0	37
	%	52	6	24	0	29	0	37
None of the above was practiced	No	0	0	0	0	3	18	21
	%	0	0	0	0	9	53	21
Total	No	52	4	40	0	29	20	145

Source: Computed from field survey data (2016)

In related to livestock fodder, movement provides an opportunity for their resource availability and job searching. Movement was determined by the availability and distribution of resources mainly pasture, water and job opportunity. As the information revealed by KII with women they said that, in the summer season the community moves daily movement to search pasture around to the other kebele (*Medego*) with the demarcation of river since in the summer season the livestock fodder is depend on communal grazing land, but in the winter season the livestock

fodder is crop residues like teff, barley, maize and wheat so, the communities move to the water availability areas sometimes go to the other kebele (*shihtambuk)southern study area*. In addition more information from KII better off, answered that in the summer season most of the livestock owner or better off community were move to search grazing land than the other, but some of them have their own grazing, their home is nearest to the local mountain and the movement of poor community is most of time in the summer and winter season for seasonal labor especially Humera and the some people to the Aksum town. But in the summer season women work in their local area with the better off community as daily labor especially in the weeding time. Figure, 29 below shows that, local daily movement of livestock to the local communal grazing.

Figure29: Communal grazing areas

Sources: photograph from field observation, (2016)

In the study area there is conflict due to pasture land, water and flood. According to FGD held with the local elder people, conflict was primarily resolved through discussions or negotiation among clan leaders and elder peoples it is local practices. First a group of people was formed as conflict resolving committee from their local sub village and they arrange their own time, most of time they use Sunday weekly and on the date 21 monthly. But if the conflict remained

irreconcilable, they proceed to the other options. In general, although conflict is inevitable due to the mobility nature of farmers to get the accessibility of water, grazing land and through the geographic nature of the area leads to erosion problem, the conflict resolution mechanisms in the area has given more opportunities rather than uses through administrative personnel or introduced types of adaptation system.

As it is shown in table, 27 below, out of the total household respondents, large number of them responded that the conflict resolving mechanism could be held through negotiation among council of elder people. Whereas the remaining of the respondent responded that conflict is resolved through negotiation among clan leader and rest answered none of the above mechanisms we use.

Table 27: Local conflict adaptation mechanisms in the study area

Conflict adaptation mechanisms	Village				Total	
	A/kolakul		A/serawat			
	No	%	No	%	No	%
Through negotiation among council of elder people	32	44	29	58	51	51
Through negotiation among clan (trip) leader and forester	13	28	14	28	27	27
None of the above mechanisms we use	5	10	7	14	12	12
Total	50	100	50	100	100	100

Source: Computed from field survey data (2016)

4.7.6. Other adaptation practice

This adaptation mechanisms practiced in to two ways, individual and communal systems (communal activities most of time uses in introduced types of adaptation practice). Regarding their individual, as interviewed with better off farmers stated that, like sending children to relative (in other place), changing of livestock to small animals goat and sheep and camel use as alternative to plough. Interview with medium farmer, by using pair of oxen with coordinate

ploughing already before the seeding time then during rainy time seeding by using different other animal's local name (*wahilal*) for Teff only uses for two things one for the erratic rain fall and two for problem of oxen.

As survey result indicated, the other means of adaptation mechanism more used by the better off community Sending children to relative (in other place) 70% of them, 33% and 29.4% of them medium and poor respectively Sending children to relative (in other place). As the information collected by KII, stated that the better off community more practiced the Sending children to relative adaptation mechanisms, because of large family size. And the poor and some part medium peoples are migration to search seasonal labor. And the poor community more used to using traditional safety net system 71% with no anyone in case of better off and medium similarly renting out pasture land (only if private) 41% the poor, 3% medium community. The female and poor households revealed that the productive safety net was the main source of their income and if the productive safety net were phase-out they are vulnerable. Accordingly, the poor and female households were used the income from safety net only for consumption (See table, 28 below).

Table 28: Other means of household adaptation practice in the study area

Other means of household adaptation practice in the study area	No of respondent	Wealth rank			Total
		Better off	Medium	Poor	
Renting out pasture land	No	0	1	14	15
	%	0	3	41	15
Selling fire wood and charcoal	No	2	1	0	3
	%	6	3	0	3
Sending children to relative	No	23	11	10	44
	%	70	33	29	44
Using traditional safety net system	No	0	0	24	24
	%	0	0	71	24
Total	No	25	14	48	87

Source: Computed from field survey data (2016)

Other means of adaptation strategy includes innovation. As the local developmental agency revealed that they have more efforts to reduce the impacts of climate change in the area by different systems, although in this area have not farmer training center (FTC), but they try to create social early warning of climate change and its impact, based on air pollution the local community to use biogas and solar system, based on water related disease to avoid home nearest swamp and drinking water by using chlorine etc.

As figure, 30 shows biogas, the researcher observes from the field observation in the biogas system, by digging hole in the nearest the toilet and daily collecting of animal dugs then mixing all in the hole after that the energy uses for light and food preparation. In addition to the researcher observation *‘’AtoAfwerkiFissaha, is a model farmer and administrator of the kebele, said that, this biogas is uses for the energy source of food preparation and light energy, as a result reducing of air pollution and deforestation.’’*

Figure30: Biogas use as source of energy

Source: photograph from field observation data (2016)

‘’As the only in the kebele user biogas person Ato Afewerki Fissaha said that biogas use not only for energy but also use for other function of fertilizer system. In comparing the chemical fertilizer and this biogas result fertilizer, the dung biogas fertilizer is very well using for continuous year but chemical fertilizer is for one times only. As below figure seen maize is the only used by manure fertilizer’’.

Figure31: Other function of biogas

Source: photograph from field observation data (2016)

4.7.7. Barriers to climate change adaptation

The community pointed many factors which hinder farmers' ability to adapt to climate change. According information gained from the adult women and men respondents during FGD in the study area, as these local communities were highly marginalized in many aspects such as social, economical, culturally and geographically, the local coping and adaptation practice have remained challenging for them to overcome the impacts of the climate change in their respective village. They stated that, in the area have high problem of transport service, if any person wants to go to the market or Aksum town, he/she go to half journey to the other Kebele known as Dura and sometimes get in their kebele but the price paid is not balanced with the distance of the area. And according to the information getting from the adult respondent during KII, they revealed that the local community has had major challenges on reducing the impacts of climate change by lack of natural resource and lack of knowhow to the activities of new technology. For example the government supports to livelihood diversification by giving credit in the form of *begait* but the local community could not get any important rather the community lead to crises since many cattle's are died, because of cold and shortage of fodder.

In addition to this in the area the other challenges to adapt the effects of climate variability, lack of knowledge like using modern honey system like that of *begait* the government give by

the form of credit to use the society to adapt different climate change impact but not the society uses, practically the community take the modern honey and put it without using in their home since the community have not know how about modern honey using system, not only the community but also have not knowledgeable local development agency in the area. So the community have large problem of these and others make fall simply the society to the impacts of climate change.

As a survey result, majority of the respondent replied that, Socio economic condition and Shortage of land followed by Shortage of labor force and lack of information. And the lowest such as lack of market access and lack of agricultural inputs are constraints of coping and adaptation to the impacts of climate change. In general, this implies that local coping and adaptation practice to the climate change induced shocks have seriously been challenged in the area by the major constraints mentioned below (See table, 29).

Table, 29: Barriers that hinder adaptation mechanisms in the study area.

Barriers of adaptation mechanisms	Village				Total	
	A/kolakul		A/serawat			
	No	%	No	%	No	%
Socio economic condition	21	42	22	44	43	43
Lack of information	8	16	7	14	15	15
Lack of knowledge	7	14	4	8	11	11
Lack of agricultural inputs	1	2	0	0	1	1
Shortage of land	18	36	18	36	36	36
Shortage of labor force	16	32	13	26	29	29
Lack of market access or poor transport service	9	18	2	4	11	11

Source: Computed from field survey data (2016)

CHAPTER -5

CONCLUSION AND RECOMMONDATION

5.1 Conclusion

The focus of this research is assessing local livelihood adaptation strategies to climate change and variability. Based on the questionnaire survey, focus group discussions and field observations the following major conclusions are made possible:

- **Community problem of needs and priorities:** Generally the problem of needs and priorities of the differentiated community vary on wealth rank and settlement village. However, the most predominate problems among the farmers are drought, decline of cultivated and grazing land and soil erosion which are directly or indirectly related to climate change. Similarly the other problems were related to the increasing price of agricultural inputs and lack of compensation for the loss of agricultural land due to infrastructural development. In other words it is related to the policy issues.
- **Perceptions on climate change:** By and large the community perception is skewed to the decreasing trend of rainfall amount and increasing temperature across the different regimes since 1960th. This has been compounded by high intensity of rainfall which accelerates run-off and soil erosion. Usually the erratic rain is accompanied by crop failure, declining of grazing and livestock diseases. This perception has some similarities with the local metrological evidence.

  In addition the farmers have wider range of understanding to the causes of climate change related to natural and human factors. Most of them underline to the deforestation and population pressure, while others some have underline with natural.

- **Impact of climate change:** No doubt framers have complex, diverse problems and challenges also to isolate the impact of climate change as it is integrated with other non climatic phenomena's. The impact includes infestation of human, plant and livestock diseases, decline of plant biodiversity, land degradation and decline of land productivity. Similarly the decline of land productivity attributed to food insecurity and dependency on safety net program. Some are forced to migrate to urban areas, while students are dropout from schools during drought. However, the positive impact of climate as indicated by the target farmers is the decline of frost with the increasing of temperature. Hence crop damage due to forest is no more a serious problem in the community.
- **Vulnerability to climate change:** Within the study area the most vulnerable natural livelihood resources or land use land cover are the cultivated and pasture land areas. Moreover, the poor wealth rank groups in general and women heads in particular are vulnerable mainly due to limited access to resources including land, livestock and agricultural inputs.
- **Adaptation to climate change:** Generally both indigenous (local) and introduced agricultural practices are attributing to resilience on the negative impact of climate change. The indigenous farming practice includes traditional early warning systems using different indicators, physical soil conservation measures and agronomic practices. There is also a shift from cattle to small animals including sheep and goats to adapt drought and pasture shortage. Similarly the government extension service has many packages including agronomic measures (improved seed, use of fertilizer, line seeding and weed/pest control), improvement of livestock breed with local including begait fodder and beekeeping. Similarly the natural resource management under the watershed

approach attributes to rehabilitation of forest and degraded lands and development of small-scale irrigation. The safety net program targeting the poor with cash and grain has also attributed to the protection of asset loss and conservation of communal resources.

5.2. Recommendation

Based on the objectives and conclusions the following major recommendations were made possible:

- **Mainstreaming climate change:** The livelihood bases of the rural economy are highly influenced by climate change. Hence any development intervention in the rural setting needs to mainstream climate change and develop strategy for diversification.
- **Targeting the poor:** Usually the most vulnerable community in the rural settings is the poor in general and the women in particular. Accordingly the extension services need to address the needs and priorities of the poor which attributes to the resilience of climate change and assuring food security.
- **Supporting indigenous practices:** The farmers have deep rooted practices in good land husbandry on agronomic and physical soil conservation measures. Hence this practices need to be strengthened and integrated with modern technologies.
- **Integrating early warning systems:** The traditional early warning system need to be investigated and combined with modern metrological measurements for reliable outcomes.
- **Expansion of extension services:** Already the government extension services on agronomic, livestock and natural resource management have attributed to the adaption of climate change. However, this needs to be intensified and expand for assuring food security and resource management. Similarly under the water harvesting approach both the indigenous and modern technology need to be integrated.

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Questionnaire

Addis Ababa University

School of graduate studies

Department of Geography and Environmental Studies

My name is Brkti Asayehegn, a graduate student of Addis Ababa University. I am conducting a research for the partial fulfillment of master of art (MA) degree in geography and environmental studies. The aim of this questionnaire is to gather data on farmers' perception of and their adaptation efforts to climate change/variability for educational research going to conduct in rural Kebeles of Seglamen Administration. I kindly request respondents to fill this questionnaire honestly and carefully.

Annex-one

1. Demographic and socio economic characteristics of households

1.1 Gender of the household head: 1. Male 2. Female

1.2. Age of the HHH: _____

1.3. Family size of the HH: _____

1.4. Levels of education/ cod/;

1 illiterate
2 read and write
3 grade 1-4
4 grade 5-8
5 grade 9-10
6 grade 11-12
7 above grade 12

1.5. Marital status of household

Q1/ what is your marital status?

1. Single
2. married
3. divorced
4. separated
5. widowed
6.polygamouse
7.bereaved(widower or widow)

1.6. Income generating livelihood activity of house hold members

Q 2/ which income generating livelihood activity do house hold members perform to earn their living?

S.NO	LIVELIHOOD ACTIVITY	yes	No
1	Crop production		
2	Sales of fire wood , wood product and charcoal		
3	Wage laborer		
4	Trading livestock		
5	Craft		
6	Traditional healer		
7	Pension		
8	Remittance		
9	Oxen renting		
10	Land renting		
11	Cattle fattening		
12	Milk and yoghurt selling		
13	Hides and skins		
14	Livestock forage / animal food/selling		
15	Mixed farming		
16	Crop production and off farm activity		
17	Other activity		

Q3/. Do you have your own farm land? 1 yes 2. No

Q4. / If the answer for question number 3 is 'yes' how many hectare ___ and what your land use land cover is? 1. For pasture 2. Crop production only 3. Use for both 4. If other specify

Q 5/ Based on question number '4' what types of farm land do you have?

1. Thick 2. Medium 3. thin

Q 6/Type of agriculture practiced 1. Rain fed only 2. Irrigation only 3. Both

Q7/ If you used irrigation estimate the size of cultivated land _____ hectare.

Q 8/ How long you have been farming? _____

Q9/ What are your dominant crop production and livestock? List in the table below.

Village	A/kolakul	A/serawat
Crop types		
Livestock		

Q10/ Please estimate the total crops produced and sold last year

No	Type of crop		Quantity produced in quintal	Quantity sold in quintal	Single Price	Total
1	Grain	Maize				
		Barley				
		Wheat				
		Teff				
		Bean				
		Figer Millet				
		Sorghum				
2	Vegetable					
3	Fruits					

1.7 Situation of livestock possession in the study area

Q 11/ have you currently owned livestock? 1 yes 2 No

Q 12/ If your answer to question number 11 is' yes,' how many livestock? List in the table below.

S.NO	Livestock type	Number of livestock (before three years)	Number of livestock (at present)
1	Cattle		
2	Camel		
3	Donkey		
4	Goat		
5	Sheep		
6	Other specify		

Q13/ was there any livestock loss or death observed due to climate variability induced effect for the last three successive years? 1 yes 2 No

Q 14/ what are the most prevailing problem of livestock production in your locality?

1 Degrading of pasture (drought) 2 Livestock disease (epidemic)

3 Absence of animal health treatment 4 shortage of water 5 increase in temperature

6 --------, --------, ------, ------can be possible answer 7 If others specify

1.8 house hold asset possession (access to credit: financial)

Q 15/ do you have access to credit? 1 yes 2 No

Q16/ if your answer to question number 15 is 'yes' from which source did you get the credit for the last three consecutive years?

Please, fill the amount of money obtained in each year and then purpose of the money obtained in the table shown below.

No	Source of credit	Purpose of the money obtained
1	Family or relative	
2	Money lenders	
3	Traditional institution	
4	Government organization	
5	NGOs	
6	Remittance	
7	Other specify	

Q17/ if your answer to question Number'16' is No what major reasons

1 lack of interest in accessing credit 2 fear of high interest payment

3 fear of credit in terms of social context 4 Absence of lenders and lending institution

5 if others specify

1.9. Please estimate your total annual off / non farm income

No	Type of income sources	Sex	Monthly income	Annual income
1	Remittance			
2	Charcoal selling			
3	Daily labor			
4	Small shop			
5	Poutry			
	Total			

Annex- two

2.2 The community problem of needs and priority

Q 18 has your Community problem of needs and priority?

1. Yes 2. No

Q 19/ If your answer for question number '18' is "yes" what types of problem?

1. Absence of good governance 2. Economical 3. climate variability related 4 if others specify , For your answer, how, clarify _____

Q 20/ have you ever faced problem related conflict due to mobility in and around your locality?

1. Yes 2. No

Q 21/ if the answer for question number '20' is yes what would presumably be the source of conflict in this particular area?

1. Water 2. Grazing land 3. Investment intervention 4. Erosion 5. ___, ___, and ____can be possible answers 6. if others specify__

Q22/how do you possibly resolve such conflicts in your locality?

1. Through negotiation among council of elder based on customary law 2. Through negotiation among clan leader 3. Through administrative personnel 4. ___,___and ___can be possible answers 5. if others specify____

2.3. Community perception on climate variability

Q 23/ what is your general perception on the characteristics of water cycle of the area in terms of its temperature and precipitation condition?

1. Erratic rain fall with slightly decreasing trend and increasing in temperature

2. Complete absence of rain fall and decreasing in temperature

3 uniformity in temperature and rain fall 4 if other specify

Q24/ is there any observable change in the amount of rain fall, temperature and frost during these three regimes (Haileslasia, Derg, and FDRE)? 1 yes 2 No

Q25/ If your answer to question number '24' is yes how do you characterize the magnitude of change in rain fall, temperature and frost?

1 very high temperature, low rain, and frost 2. Very low temperature, high rain and frost, 3. Medium temperature, rain fall and frost 4very high temperature rain and frost 5 very low temperatures, rain and frost 6 if other specify

Q26/ what are the patterns of seasonal variation of rain fall in your locality?

1. Normal, 2. Late coming and early cessation, 3. Late coming and late cessation, 4. If others specify

Q 27/ If your answer to question number' 26 'is' late coming and early cessation of rain fall, what would often happen in your locality?

1. Decrease crop production 2. Decrease in pasture land 3. Drought 4. Mobility due to scarcity of natural resource 5. Increase livestock loss 6. Distortion of production during harvesting time

7___, ___, ___, can be possible answers

8. If others specify

Q 28/. Which local indicators do you use to evaluate the change of local climate in the area?

Local indicators	
1Loss of some crop variety and animal	
2 Increased drought and flood frequency	
3 Rainfall comes lately	
4 Decline of agriculture yields	
5 vulnerability of unfertile soil productivity/fertility	
6 increasing depth of water (ground and surface water)	
7 Prevalence of human and animal diseases those are not familiar to the area	
8 Generalized observation of physical structures	
9 dry up of water sources (rivers, streams, lakes)	
Other (specify)	

2.4 Impact of climate change induced hazards on local peoples

Q 29/ what impacts the temperature and rainfall trends have brought on agricultural production?

1. Decrease in crop yield production 2. Decreased forage availability

3. Increased incident of crop pest and weeds 4. Change in seeding period

5. Changing harvesting time 6. Other (specify)

Q30/ What are the major hazards affecting the livelihood in your locality? Please rank them based on their severity.

Rank1_____, rank 2_____and Rank3_____

A. flood B. extreme heat C. livestock diseases D. Human diseases E. drought F. pests and herb infestations G. bush encroachment H. other (specify)

Q 31/ did the climate variability affect your livestock and crop cultivation for the last three decades?

1 yes 2 No

Q 32/ if your answer to question number '31' is yes to what extent severity has climate variability affected you and your family?

1. Extremely, 2. Highly, 3. Moderately, 4. If others specify

Q 33/ how would the NGO's regional government institutions, and private sector intervene and respond to reduce the impacts of climate variability condition in that particular local level?

1. Through giving early warning on climate variability and impacts and providing agricultural input 2. Safety net program 3. by providing credit
   4. No one attempted to see these problems in our locality so far 5. ___,___,___, can be possible answers 6. If others specify----------

2.3 The cause of vulnerable community by climate change

Q 34/ what do you think is the main cause for the climate variability?

1 .Cures/wrath of god, 2. Human action, 3. Natural process, 4. Both natural and human process

5 still do not know 6. If others specify

Q 35/ Have you ever encountered any climate related catastrophic phenomenon in your life time?

1. Yes 2. No

Q36/ if your answer to question number '35' is yes which climate related shock have you observed so far?

1. Extreme temperature, flood and drought 2. extreme temperature , flood , reducing crop production and cattle epidemics
   3. Very cold, flood, strong wind and cattle epidemic 4. ___,___,and__ can be possible answers 5. If others, specify

Q37/ have your local livelihood been more vulnerable to climate variability?

1. Yes 2. no

Q38/ if your answer to question number '27' is' yes 'how the climate variability has been affecting your livelihood?

1. Intensify degradation of resource
2. Increasing steep slope of land 3. Reducing crop production 4. The case of flood increasing conflict 5. if others specify

.Q 39/ who do you think are the most vulnerable social groups by the climate variability?

` 1. Women 2.Children 3. Elder 4.Adult 5. Others (specify)

Q 40/ Based on question number '39' what are the reasons for these social groups being most vulnerability? 1. Limited access and control of natural resources, 2. Lack of skills and knowledge, 3. Poverty 4. Lack of community support 5. Lack of supports from GOs and NGOs 6. Others (specify)

2.5 Adaptation strategy employed in response to any climate change and determinants of farmers' choice of adaptation measures

Q 41/ have you ever used the livelihood strategies to cope with shocks or stresses of climate variability in your locality?

1. Yes 2. No

Pleas fill your answer in the space provided below

S.NO	House hold adaptation practices	Yes	No	rank
I	Livestock related practices;			
1	Stock(increasing the number of livestock			
2	Destock(decreasing the number of livestock)			
3	Selling the livestock to purchase food			
4	Rent out animal (horse, donkeys, camels and oxen)			
5	Cattle entrustment			
6	Cattle fattening for market and consumption			
7	Sale old/ weak animal before drought occurs			

8	Store butters for market (to sell in dry season)			
9	If others specify			
II	Agronomic related			
1	Practicing cultivation of crop as alternative means			
2	Storing food crop by buying from the nearby vicinity			
3	Practices new variety and short growing season crops			
4	Practices crop rotations			
5	Practice fallowing			
6	Chemical fertilizer			
7	On line seeding			
8	Improved seed			
9	Organic fertilizer			
10	Mixed cropping			
11	Inter cropping			
12	If others specify			
III	Soil and Water conservation			
1	Water pond(*horeye)*			
2	Motor pumping			
4	Digging of the land among the crop			
IV	Mobility related practices			
1	Moving to nearby towns to search for manual labor			
2	Moving with livestock in search of pasture and water			
3	Evacuating due to conflict on resource degradation			
4	If others specify			
VI	Other means of adaptation practices			
1	Renting out pasture land (only if private)			
2	Selling other tangible assets such as accessory materials , house hold equipment guns etc			
3	Selling fire wood and charcoal			
4	Caring inter tribal trade items like cattle , coffee			
5	Sending children to relative (in other place)			
6	Using traditional safety net system			
7	If other specify			

Q 42/ for your adaptation practice of the above listed identify briefly, to why and how used. ----------

Q 43/. What are the reasons for determinants of the above adaptation measures? (1) lack of money, (2) lack of information, (3) shortage of labor, (4) lack of knowledge, (5) Lack of credit, (6) Lack of agricultural inputs, (7) lack of water, (8) Lack of Extension service, (9) insecure property right, (10) lack of market access or poor transport link, (11) land scarcity and other (specify) write the numbers on the space provided. Multiple answers is possible

Q 44/ what are the major constraint that hinders your local adaptation mechanisms (strategies) to climate variability? 1. Poverty 2. Poor infrastructures 3. Lack of access to service 4. Resource scarcity 5. If other specify

Annex- thee

2.1 GAIDING CHEKLIST FOR GROUP DISCUSION (FGD)

First; I would like to thank you for respecting our call for and coming here on time. Thank you, all of you again. Today, we are here to discuss the issues concerning local coping and adaptation strategies to climate variability with in your community. More over to share your perception on climate variability, impacts, causes to vulnerability of the community, adaptation mechanisms and determinants to adaptation strategies on climate variability in the local area of community. On this there is no right or wrong answer; both positive and negative answers will be welcomed. Please feel free and be confident enough to agree and disagree on various ideas and issues related to climate variability.

1 Name of participants_____ 2 Age _____

3 Sex _____ 4 Educational back ground_____

5 Livelihood activities

A/ the community problem of needs and priority

1. Have you ever problem of needs and priority in your local area?
2. If the answer is 'yes' from what source and how?

B/community perception on climate variability

1. Have you heard of "climate variability in your locality? What is mean"? From which sources?

2. Have you observed changing rain fall and temperature patterns? What kind of patterns have you observed so far about the onset and recession of rain fall in the particular area?

3. What does the magnitude / intensity of rain fall and temperature situation in your locality looks like?

4. When do both dry and wet season begin and end in your locality?

5. People's perception climate variability based on the rain fall, temperature and frost on the three regimes.

Regime	Rain fall											Temperature			Frost		
	Months		Amount			Intensity			Duration			Amount			Amount		
	Onset	Cessation	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L
Hailesellasei (1930-1974)																	
Derg (1974-1991)																	
EPRDF (1991-2007)																	

5. Do you presume that climate variability has been affecting your pastoral livelihood and crop production at household and community level? How?

C The impacts of climate variability

1. Have you had past experience in identifying, the effect of climate variability and extreme weather events ? If so, would you explain the impacts of climate variability that you observed on the environment at large and your local livelihood in particular?

2. Have you ever faced problem such as flooding, drought, problem of water, problem of crop production and animal loss in your locality?

3. How climate variability impose impact on agriculture production?

4. What are the Hazards affecting the community and their coping strategies?

Hazards	Most months	Years affected	Impacts	Coping strategies
1.				
2.				
3.				
4.				

D Causes of vulnerability to climate variability

1. In your assumption, what would be the causes of the vulnerability to climate variability in this area?

2. Which social groups are more vulnerable to climate variability? 1. Women 2. Men Why?

3. Who are the most vulnerable groups to climate variability impact?

1. The poor, 2. The medium, 3. The rich

4. What are the parameters (criteria) used to classify local community in to the above social categories?

1. Livestock size 2. Land holding size 3. Owner ship of 4. Crop production 5. Size of the house hold (number of children) 6 ___, ___and___ _can be possible answer

5. To what extent the above mentioned asset parameters are employed precisely to classify house hold in to three categories as the poor, medium and rich?

Please complete the following table with an appropriate amount in number.

No	Asset used as a parameter	Amount records in each statues			
		Poor	medium	Better off	remark
1	Livestock size				
1.1	Ox				
1.2	Cow				
1.3	Goats				
1.4	Sheep				
1.5	Camel				
1.6	Donkey				
1.7	Horses				
2	Land holding size (in hectare)				
3	Little alternative crop production (in quintal)				
4	Family size(number of children)				
5	Other specify				

5. From the two village which one is more vulnerable by climate variability? Why?

E / Coping and adaptation practices, and constraints to adaptation

1 What adjustments the community made to those long term and short term change in rainfall and temperature? List them

2. What barriers do you have to adapt climate change?

Assessment of institutional facilities for the farmers

1. Do you have access to credit, food aid, extension, agricultural inputs and technologies and water for irrigation?

2. Do you receive early warning information on short term variations and/or long term climate variability from any sources? From which

3. Where do people sell their agricultural products (crops and livestock's)? And how far is it from your village?

4. How did the GOs and NGO's respond to reduce the impact of climate change / variability in your locality?

5. Finally what should be done in order to minimize the impact and increase the adaptive capacity of the community? Through GOs, NGOs and by local communities.

Annex-four

INTER VIEW CHECKLIST FOR KEY IN FORMATION (KII)

Name_____ Age_____ Sex_____

Education _____ Kebele: _____

1. Do you have the problem of needs and priorities of the society in your local area?

2 if your answer for question number is 'yes' what types of problem?

1 governmental 2 social 3 economical 4 climate variability

3 What is your perception on the general trend of temperature and rain fall pattern; the magnitude /intensity, frequency and its distribution of rain fall; the duration of rain fall (onset and cessation) and period in which rain start and end falling?

4. What do you tell about the cause for vulnerable to climate variability? To what extent the households are vulnerable to climate variability effect and extreme weather event?

5. What are the major impacts of the climate variability?

6. Are there alternative livelihood system / practices as adaptation strategy to cope with climate change in general climate variability in particular?

7. What is the feature of your adaptation strategy which is entirely based on endogenous knowledge of the local community?

8. What are the major constraints of cope and adaptation to climate variability?

Annex- five

Report to clarity the main document written about temperature and rain fall

1. Maximum temperature data

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1996	28.1	28.7	29.7	25.2	26.1	25.3	24.5	24.4	24.4	21.9	28.0	25.7
1997	25.8	26.6	28.0	27.8	27.8	27.0	22.5	26.1	25.2	27.4	27.0	NA
1998	27.3	29.5	29.6	30.5	31.1	31.1	26.5	23.9	26.3	26.2	25.7	26.7
1999	25.6	26.7	28.5	29.9	30.2	30.0	23.4	25.4	25.0	26.0	25.4	26.6
2000	26.1	28.0	29.4	27.6	29.0	28.9	25.5	24.0	24.3	25.9	26.5	26.9
2001	27.5	28.2	29.2	30.3	30.9	28.2	26.9	25.5	26.1	27.2	27.3	27.3
2002	28.0	30.5	30.8	30.8	32.3	30.0	27.1	24.7	26.9	28.0	29.0	28.1
2003	29.1	30.7	32.5	32.5	30.5	29.5	27.0	27.8	28.3	28.6	28.0	28.4
2004	28.8	28.7	22.9	30.9	31.9	29.7	27.9	28.2	27.2	28.2	28.2	28.3
2005	NA	28.5	29.1	29.0	30.1	28.8	27.5	28.2	28.7	28.7	27.9	28.2
2006	28.4	28.8	29.6	29.6	29.0	28.8	28.0	24.4	25.6	28.2	27.8	27.7
2007	28.0	28.1	29.1	29.1	29.8	28.7	26.8	28.0	27.0	27.4	27.4	27.0
2008	26.9	27.7	28.5	28.2	28.4	28.1	25.8	24.8	24.2	25.4	25.5	25.4
2009	27.4	27.7	30.6	27.9	30.2	29.1	25.6	24.6	26.1	25.9	27.2	28.3
2010	27.6	28.4	29.2	29.2	29.4	28.4	28.9	26.7	26.0	26.0	25.3	24.9
2011	26.1	26.3	29.1	29.6	29.9	29.5	26.6	25.2	25.2	24.0	23.1	21.9
2012	23.9	28.9	29.6	30.5	31.6	28.1	24.3	28.6	24.9	26.5	28.5	25.8
2013	26.9	28.6	31.3	31.8	32.0	29.8	26.7	21.9	28.9	27.8	27.0	27.1
2014	27.8	28.1	30.2	29.0	24.8	28.2	23.1	29.0	24.9	NA	25.9	26.5
2015	26.8	NA	27.1	26.7	26.9	27.0	25.1	25.9	22.0	22.9	27.1	23.9

2. Minimum temperature data

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1996	8.7	10.0	12.1	13.3	13.5	13.5	12.8	13.5	12.4	8.2	10.1	8.1
1997	8.2	8.1	11.0	9.4	11.9	10.6	12.9	13.8	11.7	9.3	9.8	8.3
1998	8.6	10.1	7.7	11.2	12.2	12.9	13.8	14.0	13.8	11.4	10.3	7.0
1999	8.1	8.7	9.5	12.9	13.7	13.8	12.8	13.8	13.1	12.6	7.3	7.3
2000	8.7	9.5	10.6	11.3	9.8	13.1	12.6	12.9	12.9	11.7	10.6	7.6
2001	8.2	9.4	11.8	13.2	13.5	13.2	13.6	14.2	13.1	12.3	11.4	8.8
2002	9.1	10.8	12.4	12.9	12.9	14.4	13.4	13.7	12.2	12.0	11.9	10.4
2003	7.4	10.8	12.0	11.1	11.8	13.3	12.9	14.5	14.3	12.2	10.4	9.1
2004	9.7	9.9	11.8	13.5	13.7	12.5	12.0	13.1	12.4	11.8	10.0	9.1
2005	7.4	10.6	11.9	13.3	12.4	12.4	12.7	12.9	11.7	NA	9.9	8.9
2006	NA	10.9	10.8	11.6	11.6	11.7	10.7	13.2	11.7	10.1	9.3	8.7
2007	9.3	10.3	11.0	11.0	11.9	13.4	11.5	12.7	11.5	8.8	8.9	6.3
2008	9.5	9.0	9.4	11.5	12.7	11.4	12.0	12.5	10.7	9.6	7.2	7.5
2009	6.9	10.0	12.1	12.3	13.5	14.7	12.5	12.8	11.1	NA	10.4	8.4
2010	8.0	9.4	10.6	10.8	NA	10.8	10.7	12.5	NA	9.2	7.3	7.1
2011	8.5	8.6	9.7	11.9	13.3	13.8	11.7	12.0	10.5	7.6	7.5	4.7
2012	6.1	7.9	10.5	10.9	14.1	11.2	13.1	12.9	11.8	12.4	10.5	10.2
2013	10.6	11.1	13.3	14.1	14.7	13.7	12.1	12.2	12.8	12.0	10.5	11.3
2014	9.4	9.3	11.2	11.0	12.1	13.1	10.9	11.3	9.4	10.5	11.0	9.4
2015	9.2	12.0	13.5	13.3	13.3	13.3	12.9	12.8	9.9	10.4	11.0	12.4

3. Precipitation

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1996	0.0	0.0	73.7	56.5	146.1	56.4	168.5	219.5	30.5	15.3	72.6	0.0
1997	0.0	NA	21.8	8.9	122.2	116.0	138.0	103.7	42.8	147.1	26.9	0.0
1998	0.0	0.0	6.7	33.2	85.0	76.6	372.1	356.1	83.6	23.7	0.0	NA
1999	40.3	NA	NA	20.7	10.2	41.9	281.2	219.5	52.3	92.0	0.0	2.0
2000	0.0	NA	NA	66.5	11.4	13.6	198.5	139.1	100.4	160.5	16.8	0.0
2001	0.0	NA	1.5	6.4	15.9	74.0	212.1	355.6	25.8	14.5	0.0	NA
2002	0.0	8.8	10.0	20.4	9.2	31.1	102.3	96.5	50.6	1.3	1.8	27.7
2003	2.5	8.5	2.4	8.3	12.2	125.5	315.7	209.1	89.6	1.4	3.7	0.0
2004	18.2	3.8	34.9	41.0	0.0	132.4	269.0	173.6	16.8	24.4	34.8	0.0
2005	0.0	NA	129.7	86.0	5.1	85.4	176.6	226.0	67.2	0.0	0.0	0.0
2006	NA	0.0	NA	31.1	61.0	86.5	230.7	240.6	123.9	9.5	0.0	30.5
2007	NA	NA	7.0	10.9	35.5	112.6	428.1	272.8	154.3	NA	6.1	0.0
2008	38.5	NA	NA	85.2	41.3	102.3	161.8	174.7	49.9	NA	6.8	NA
2009	0.0	0.0	0.0	6.0	8.6	35.6	231.9	288.6	1.8	NA	0.9	0.8
2010	1.2	0.0	54.2	36.3	17.3	109.4	209.4	223.2	137.5	26.9	0.0	0.0
2011	1.2	0.0	NA	7.9	58.7	86.3	204.2	151.1	93.7	NA	11.8	NA
2012	0.0	0.0	2.7	14.6	4.3	93.9	157.0	289.5	76.7	23.9	3.2	0.0
2013	0.0	0.0	0.0	34.4	0.0	84.8	124.8	248.2	27.9	10.5	0.0	0.0
2014	0.0	0.0	59.4	12.0	54.5	78.2	145.9	217.9	118.9	26.9	20.9	5.9
2015	0.0	0.0	0.0	13.5	0.0	62.9	140.9	280.1	111.9	22.9	23.8	5.4

Note:

NA, not available