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Research Thesis on:

LOCAL PEOPLE'S PERCEPTION ON CLIMATE CHANGE, ITS IMPACT ON FOOD SECURITY AND ADAPTATION PRACTICES IN GUBA DISTRICT OF BENISHANGUL GUMUZ REGION, ETHIOPIA

For the partial fulfillment of Master of Art in Rural Development (MARD)

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DCLARATION

I hereby declare that the Dissertation entitled LOCAL PEOPLE'S PERCEPTION ON CLIMATE CHANGE, ITS IMPACT ON FOOD SECURITY AND ADAPTATION PRACTICES IN GUBA DISTRICT OF BENISHANGUL GUMUZ REGION, ETHIOPIA Submitted by me for the partial fulfillment of the M.A. in Rural Development to Indira Gandhi National Open University (IGNOU) New Delhi is my own original work and has not been submitted earlier either to IGNOU or to any other institution for the fulfillment of the requirement for any course of study. I also declare that no chapter of this manuscript in whole or in part is lifted and incorporated in this report from any earlier work done by me or others.

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DEDICATION

I dedicate this thesis manuscript to my father, Fentaw Dessie

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ACCRONYM

BSG BoARD	Benishangul Gumuz Bureau of Agriculture and Rural Development
BSG BoFED	Benishangul Gumuz Bureau of Finance and Economic Development
FSEGP	Food Security and Economic Growth Project
CBA	Community Based Approach
CC	Climate Change
CIER	Centre for Indignons Environnemental Ressources
DA	Development Agent
DADO	District Agricultural Development Office
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
FTC	Farmer Training Center
GDP	Growth Domestic Production
GHG	Green House Gas
GLCA	Global Leadership for Climate Action
HH	Household
IPCC	Intergovernmental panel on Climate Change
Km	Kilometer
LDCs	Least Developed Countries
LU/LC	Land Use/Land class
m.a.s.l	Meter above Sea Level
NADP	National Adaptation Program
NCCF	National Climate Change Forum

NGO	Non Governmental Organization
NMSA	National Metrological Service Agency
NSF	National Science Foundation
SPSS	Statistical Package for Social Science
ToT	Training of Trainer
UN	United Nation
UNEP	United Nation Environmental Program
UNFCCC	United Nation Framework Convention on Climate Change
WB	World Bank
WMO	World Metrological Organization
WWF	World Wide Fund for Nature

SUMMARY

The study was conducted in Guba district of Benishangul Gumuz Region of Ethiopia. The research design used in this study is a cross-sectional survey, employed both qualitative and quantitative approaches. The combination of stratified sampling and simple random sampling were used in the selection of study site and sample households. 60 households (45 male headed and 15 female headed) were selected randomly. It also used key informant interview and FGD.

Local people in Guba district perceived changes in temperature and rainfall. They are able to recognize that temperatures and frequencies of drought have increased, and rainfall pattern has become unpredictable and more erratic. They feel the area is becoming warmer and drier by local indicators (standards).

Analysis of historical climate data in the study area reveals that there has been increased rainfall variability. Similarly, temperature pattern clearly showed an increasing trend of warming. The change in the pattern of rainfall and temperature created moisture stress, more pressure on the available water supply, forest and range resources. Thus, it has exacerbated food shortages and making the environment more vulnerable to future changes in the climate system. As the result of unfavorable changes in the pattern of climate a number of hazards occurred in the study area that exposed the people to the risks of several types of disasters such as drought and pests and diseases.

For many years, the local people of the study area have struggled against the impact of different types of natural hazards. Local people are suffered from climate change induced impacts of food insecurity and used different coping mechanisms when critical food shortage such as reducing

number of meals, wild fruit gathering, hunting, selling of assets, migration, borrowing money from money lender, wage labor and gold panning.

In order to adapt the impact of climate change disasters the local peoples have been applying different strategies. The major local adaptation strategies include introducing new crops, change in cropping pattern, growing short maturing crops and diversified income. Local people also used traditional practices to stop rain from falling during crop harvesting and to bring rain fall when it delays in crop sowing season. The local government and NGOs helped the people by asset protection and livelihood enhancement and disaster risk reduction. The adaptation options employed are reactive ones, born out of necessity by the peoples themselves. The adaptation options they employed are not enough to reduce the impact of current climate change and variability due to various barriers. The study identified poverty, water scarcity, market problem, lack of information about the weather or long-term climate change, forage and feed scarcity, limitation of micro-finance, poor agricultural extension system, limitation of expert, poor awareness of community, HTPs, scattered settlement, lack of agricultural technologies and appropriate seed and lack of health service were major constraints of adaptation for many peoples in the study area.

CHAPTER 1. INTRODUCTION

Climate change is already happening with its multi-faceted effects on human society and the environment (IPCC, 2007). An increased concentration of the so called greenhouse gases (i.e. $C0_2$, CH_4, N_20) in the atmosphere as a result of human activities and its possible consequence of climate change has been an international issue since the 1980's (NCCF, 2009). Climate and climate change will certainly have an effect on the future sustainable development of much of our planet's resources such as those relating to biodiversity, water, forests, land and oceans as well as in relation to various sectoral activities like agriculture and biodiversity (WMO, 1992).

Countries, regions, economic sectors and social groups differ in their degree of vulnerability to climate change. This is due to partly to the fact that changes in temperature and precipitation will occur unevenly and that climate change impacts will be unevenly distribute around the globe. It is also recognized that even with in regions impacts, adaptive capacity and vulnerability will vary (IPCC, 2001). The least developed countries (LDCs) have contributed the least to the emission of greenhouse gases but they are the most vulnerable countries to the effects of climate change and have the least capacity to adapt to these changes. They will suffer from a possible increase in natural disasters such as floods and droughts due to climate change. The LDCs lack the necessary institutional, economic and financial capacity to cope with climate change impacts and to rebuild the infrastructure damaged by natural disasters (Sokona and Denton, 2001 as cited by Huq, et al., 2003). When affected by natural disasters, the LDCs are dependent on external aid, as they do not have the necessary funds available to deal with the problems themselves. Therefore, poverty accentuates the degree of vulnerability to the impact of climate change.

It has become a common knowledge that the poor are likely to hit hardest by climate change, and that capacity to respond to climate change is lowest in developing countries and among the poorest people in those countries (Olmos, 2001). People who live on arid or semi-arid lands, low-laying coastal areas, in water-limited or flood-prone areas, or on small islands are particularly vulnerable to climate change (Watson, et al., 1996: 24 cited in Olmos, 2001).climate change will affect socio-economic sectors including water resource, agriculture, forestry, fisheries and human settlements, ecological systems and human health in many parts of the world, with developing countries being the most vulnerable (IPCC, 2000a, cited in Olmos, 2001).

Africa is the most vulnerable region to climate change, because of the low adaptive capacity of the African population (Chijioke, O.B, et, al 2011). This low capacity is due to the extreme poverty situation of many Africans, frequent natural disasters such as droughts, floods, and agriculture, which are heavily dependent on rainfall. The main impacts of climate change will be on the water resource, food security and agriculture, natural resource management and biodiversity, and human health (Dievudonne, 2001 cited in Huq, et al., 2003). Recurrent droughts have long been a permanent feature of life throughout the dry lands of Africa. Over the past 30 years or 50 however, usually sever and/or prolonged droughts in these dry lands have seriously affected agriculture and wild life and caused many deaths and severe malnutrition. Currently, 36 countries in Africa are affected by recurrent drought and some degree of desertification (UNEP, 1992 cited in IPCC, 1998). Within the African region, the Horn Countries are among the most vulnerable but, least prepared countries for adverse global environmental change in the world with a very weak economy, climate-sensitive livelihoods and fragile agro-ecological conditions. As a result, poverty, catastrophic droughts, vigorous hydrological cycles,

and famines have been the hallmarks of these countries (UNEP, 2002 cited in Aklillu and Alebachew, 2009a). Despite this, high population growth coupled with low economic growth accentuated the impact of climate change. They are also most vulnerable to the impacts of projected changes because wide spread poverty limits adaptation capabilities. Increased droughts could seriously affect the availability of food in the horn of Africa during the 1980s and 1990s. Among the Horn countries Ethiopia is one of the most poor and known by high population growth, which is adversely affect by the impact of climate change.

Ethiopia, a country on the Horn of Africa which is 1.12 million Km^2 wide, is the 27^{th} largest country in the world and more than twice the size of Spain. It is one of the world's poorest and least developed countries. About 45% of the country is defined as highland, areas that are at least 1500 meters above sea level (Haakansson, 2009).

The national program on how Ethiopia can adapt to climate change NAPA (2007) states that repeated droughts, hunger and the recent floods are among the most serious problems affecting millions of Ethiopians almost every year. Drought occurs anywhere in the world but its damage is not as severe as in Africa in general and in Ethiopia in particular due to low adaptive capacity (NAPA, 2007). Rainfall variability and associated droughts have been major causes of the country's food shortage and famine because agriculture is the foundation of the national economy and constitutes the primary source of livelihood for the overwhelming majority of the population. Due to climate change impact, poverty, health, food security, ecosystems and social situation of the people are headache of the country (NCCF, 2009).

1.1. Statement of the Problem

Despite the increasing funds for disaster response, ($320 million per year) damages from natural hazards continue to rise. Local adaptation plan cannot receive the necessary attention. The mitigation plans have been reactive rather than preventive (Aklilu and Alebachew, 2009a). The country is extremely vulnerable to the least change in climate. If the rain is late, does not arrive or irregular, it immediately result in an increase in the number of people who need help because they are already living on the margins of life.

Although many poverty and food insecurity focused research in the country have been manly undertaken in the Northeastern highlands of the country, where historical famines of 1970s, 1980s and 1990s predominate (Melesse, 2007). The issue of climate change did not get a concern. The research findings give different accounts to the causes of famine such as drought, political conflict, land degradation, population pressure and ill development policies. The food status of the Benishangul Gumuz Region, as indicated by the regional disaster prevention and preparedness bureau (DPPB), becomes sever even before. All districts of the region are recognized as food insecure and drought-prone respectively (BG BoARD, 2005).

Perception about climate change, its cause, impacts and the necessary response mechanisms to cope with climate calamities are important for any population in a given community. Level of aweless determines the scope of implementation that needs to be taken to tackles the problem. Lower awareness will make intervention mechanisms to be very slow and untargeted. For instance, local peoples have a range of strategies to cope with drought. However, these traditional coping mechanisms are based on local knowledge and not supported by research. Therefore, they may not be able to counter all of the challenges imposed by climate change in the future.

Research studies have shown that climate change has potential to have several negative impacts on human welfare, natural resources and development activities in the country. However, most of these studies have been carried out at the macro level. There are very few studies dealing with the empirical status at the micro level .Unless, the impacts of climate change are expressed at the micro level and understand local people perception, it would be difficult to convince and motivate local communities to undertake adaptation actions. To fill this gap, this research has been carried out with a focus on understanding the perceptions of people, assessing local impacts of climate change and the adaptation strategies of the people in Guba district of Metekel Zone, Benishangul Gumuz Regional State.

1.2. Objectives of the Study

The main objective of this study was to assess local people's perception on climate change, local impacts of climate change and adaptation practices that contribute to development activities. The specific objectives were:

1. To understand local peoples' perception towards changes in temperature and rainfall pattern over the last couple of decades;
2. To assess the local impacts of climate change induced-hazards on peoples' food security and the environment;
3. To identify ongoing adaptation strategies employed at local level in response to perceived changes in temperature and rainfall;
4. To investigate barriers of adaptation strategies to changing climatic conditions;

1.3. Research Questions

In order to get hold the objectives, the following questions were answered.

1. What is the perception of the local people about the existence of climate change and variability?
2. What are the local impacts of climate change induced-hazards on peoples' livelihood and the environment?
3. What adaptation strategies have been adopted by different actors of the study area to cope with climate change?
4. What are the major constraints different actors of the study area faced to employ different adaptation strategies in response to changing temperature and rainfall?

1.4. Justification and Significance of the Study

Ethiopia is one of the poorest nations of the world vulnerable to the impacts of climate variability and change. The limited economic, institutional and logistic capacity to mitigate and adapt to climate change exacerbated the vulnerability of many peoples and communities to climate change induced-hazards that are occurring through global climatic change and land use transformation. The problem is more serious on communities who heavily depend on climate sensitive livelihoods. This situation retard the country's development program and creating multi-faceted challenges. The challenge limits the country's primary agenda, poverty reduction, which is the main factor that made the country more vulnerable to climate change induced impacts and environmental degradation. Though climate change stands as a major obstacle to eradicate poverty and protect the environment; its direct and indirect impacts were not well studied in the country. Facing climate change-induced hazards may not be new for the Ethiopian

pastoralists and farmers. The challenge, however, is both diversified and frequent hazards in the current climate system. Now a day the magnitude and number of hazards are beyond the control of local people. In addition, the mitigation plans have been reactive rather than preventive. The practical measure expected from Ethiopia is, however, developing adaptation strategies and enhancing adaptive capacities of different stakeholders. This shows that the need to review disaster-response mechanism. This is however, impossible without research-generated knowledge at local level and community participation.

In addition to this understanding of peoples' perception about the issue of climate change is non-negotiable aspect of development program. Therefore, capturing the perception of people in general and local people in particular for development activity and planning appropriate adaptation strategy to cope with climate change is important. However, there is lack of adequate research generated data on perception of local people about climate change and their response.

This is also true in the case of Guba district of Metekel zone. Thus, the purpose of this research is to assess the local impacts of climate change, perception of local people and their adaptation strategies employed in the study area.

CHAPTER 2: LITERATURE REVIEW

Today, climate change is increasingly recognized as a critical challenge to ecological health, human well-being and future development (IPCC, 2007). It is one of humanity's greatest challenges, affecting both current and future generations. The global community took initial steps in 1992 (United Nations Framework Convention on climate change-UNFCCC) and then again in 1997 (Kyoto Protocol) to curb global greenhouse gas emissions. However, these efforts have produced only modest gains in a handful of countries. The resulting emission reductions are nowhere near, what they should be in order to halt or slow the pace of climate change (GLCA, 2009). In addition, local community- based adaptation practice is urgent issue particularly in developing countries. However, little is known about local community perception worldwide.

In light of the above induction, the aim of this chapter is to review literature on climate change, its cause and impact on food security, adaptation and local people perception. Accordingly, the review of literature help to establishes conceptual framework for the study and highlight previous studies on climate change with their underling concepts so as to helps to identify gaps in the literature and forward research questions for the study.

2.1Global Climate Change: An Overview

Climate Change- Refers to a statistically significant variation either in the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer).climate change may be due to natural processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land-use (IPCC, 2001). **Climate Variability -**Refers to variations in the mean state and other statistics (such as standard

deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability) (Levina & Tirpak, 2006). In recent years, the term "climate chnage" has become a core issue in various developmental and political forums at the national, regional and international level. Many regional summits worldwide have dedicated discussion sessions on climate change based on the recognition, that global climate is subject to increasing change and this has become more evident in recent years (Aklilu and Alebachew, 2009a). According to the IPCC fourth assessment report, Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level. The global average temperature has risen by 0.74^{o} c and the global sea level has risen by 17cm during the 20^{th} century, primarily due to melting snow and ice from the mountains and Polar Regions (IPCC, 2007).

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

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

Based on climate models, global average temperature is projected to increase by 1.4 to 5.8^0c by the end of the present century (CIER, 2008), sea level is expected to rise 0.09 to 0.88 meter from the 1990 level by the end of this century and precipitation extremes are projected to increase more than the average in the future (WMO, 2003). The following section discuses cause and impact of climate change.

2.2 Causes and Impacts of Climate Change

Climate change is a reality; it has changed in the past, it is changing at the present, and it will change in the future (Burroughs, 2007). The change of climate can be slow and gradual, rapid and catastrophic, short-term or long term can be at local regional and global scales, it can be due to natural factors or anthropogenic factors. The overwhelming majority of climate researchers have reached the understanding-based on decades of evidence, modeling, and debate-that it is extremely likely that human activities are responsible for rising temperatures on Earth. Human behavior will continue to be a major factor in climate change (UN, 1992; NSF, 2009).

The human factors that contribute to the change are in the form of green house gas (GHG) emissions and land-use/cover changes (Aklilu and Alebachew 2009a, WB, 2008). Most important green house gases are emitted from electric power station, various industries, the

transport sector and deforestation due to human activities. These activities increase the concentration of different green house gases. Global GHG emissions due to human activities have grown since pre-industrial times, with an increase of 70% between 1970 and 2004. Global atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) have increased markedly because of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years. Global increases in CO_2 concentrations are due primarily to fossil fuel use, with land-use change providing another significant but smaller contribution. It is very likely that the observed increase in CH_4 concentration is predominantly due to agriculture and fossil fuel use. The increase in N_2O concentration is primarily due to agriculture (IPCC, 2007). Thus, the green house effect is intensified, resulting in rising temperature on earth. Over the last 100 years (1906 - 2005), the global average temperature has risen by $0.74^{O}c$ (IPCC, 2007).

Population growth and economic expansion has intensified the pressure on the global climate system through industrialization, increased use of fossil fuels, transport development and land use/cover changes (Aklilu and Alebachew, 2009a and Hardee K., 2009). Before industrialization, the concentration of Co_2 in the atmosphere was only 280 PPM. In 2005, the concentration of $C0_2$ in the atmosphere was 379 PPM and the annual rise in $C0_2$ content was higher in the period 1995-2005 than at any other time since continuous atmospheric measurements began in 1950 (Haakansson, 2009).

Anthropogenic effects on the physical and chemical properties of the atmosphere have the potential to affect the quality of life and even the very existence of certain life forms. Weather and climate-related disasters result in high death, a decline in production of food, pollution of waters and land surfaces, and the destruction of production capacity and infrastructure. The data

received from many observations indicate that regional climate changes have already affected many physical and biological processes and systems. Examples of observed changes include reduction in glacier cover, thawing permafrost, changes in altitudes of vegetation extent, reduction of populations of some species of plants and animals, expansion of desertification processes (Anon, 2002).

Agriculture is the basis for the livelihoods of millions of people in Africa. An average of 70% of the population lives by farming and 40% of all exports are earned from agricultural products (WRI, 1996 cited in IPCC, 2001). In addition, 10% to 70% of gross domestic product (GDP) in Africa is generated by agriculture (Mendelsohn, et al. 2000). However, agricultural production is affected by climate change. The estimate for Africa is that 25 % to 42% of species habitats could be lost, affecting both food and non-food crops (FAO, 2007). According to reports of the IPCC (2007), the projected yield reduction due to climate change in some poor countries could be as much as 50% by 2020. Under climate change, much agricultural land will be lost, with shorter growing seasons and lower yields. National communications report that climate change will cause a general decline in most of the subsistence crops, example sorghum in Sudan, Ethiopia, Eritrea and Zambia; maize in Ghana; Millet in Sudan; and groundnuts in Gambia (UNFCCC, 2007). Many countries in tropical and sub-tropical regions are expected to be more vulnerable to warming because additional warming will affect their marginal water balance and harm their agricultural sectors (Mendelsohn, et al. 2000). African countries were identified as having the highest vulnerability to drought. The Africa Sahel Situated at the southern fringe of the Sahara desert and stretching from the West African coast to the East African highlands is particularly prone to drought. Droughts have particularly affected the Sahel, the Horn of Africa and Southern Africa since the end of the 1960s. For instance, estimates suggest that one third of

African people live in drought-prone areas and that around 220 million people are annually exposed to drought (Elasha, 2006; WWF, 2000).

Africa contains about one-fifth of all known species of plants, mammals, and birds, as well as one-sixth of amphibians and reptiles. These species compose some of the world's most diverse and biologically important ecosystems such as savannahs, tropical forests, coral reef marine and freshwater habitats, wetlands and montane ecosystems. These globally important ecosystems provide the economic foundation that many Africa countries rely on by providing water, food, and shelter. However, because of climate change, these ecosystems and the livelihoods that depend on them are threatened (WWF, 2006; McMullen & Jabbour, 2009).climate change affects biodiversity by influencing species distribution, composition and function directly and indirectly (Aklilu and Alebachew 2009a).

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

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

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

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

2.3 Global Responses to Climate Change

Climate change is a global issue that requires an urgent international response. Governments, industries, communities and organizations across the globe are working together to develop and

implement measures to reduce greenhouse gas (GHG) emissions and avoid dangerous climate change (office of climate change, 2010). Several international conferences, seminars, symposia and workshops were held. Some of them were first world climate summit (1979) in Geneva, Conference on Industries and Climate (1980 in Vienna), Vienna convention (1985, in Austria), Montreal Protocol (Canda 1987), constitution of IPCC by UNEP and WMO in 1988, First Earth Summit (1992 Brazil), Kyoto Protocol (1997, Japan) etc (Singh, 2008).

The united Nation Framework convention on climate change (UNFCCC) is an international environmental treaty produced at United Nations Conference on Environment and Development (UNCED) held in Ride Janeiro in 1992. The objective of the treaty is to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. As a framework treaty, the convention set no mandatory limits GHG emissions for individual nations and contained no enforcement provisions; it is therefore considered non-binding. Rather, the treaty includes d provisions for updates (called "protocols") that would set mandatory emission limits. The principal update is the Kyoto protocol (Aklilu and Alebachew, 2009a). The Kyoto Protocol, adopted in December 1997, is an international agreement, which builds on the UNFCCC and sets legally binding targets for cutting GHG emissions of industrialized countries. Like the UNFCCC, the Kyoto Protocol aims to stabilize GHG emissions in the atmosphere. The major distinction between the two documents is that while the convention encouraged developed countries to stabilize GHG emissions, the protocol commits them to do so. The protocol sets out emission reduction targets for developed countries because they have been responsible for the vast majority of the world's human-induced GHG emissions (office of climate change, 2010). The protocol was entered in to force on 16 February 2005. As of November 2009, 187 states have signed the protocol. The same literature

adds that Copenhagen Accord was forged at the 15th Conference of the Parties, held in Copenhagen in December 2009, towards a new agreement beyond the Kyoto Protocol. The accord is significant because it is the first global agreement on climate change, involving the major developed and developing countries. The United States and major developing economies, such as China, Brazil and India, played a key role for the first time.

The UNFCCC and the Kyoto protocol have faced several challenges to achieve their prime objectives of reducing emissions. For instance, despite the Kyoto protocol's ambitious goals, even countries that have shown to be its leading advocates, such as Japan, Canada, and the members of the European Union had not able to meet their targeted reductions of emissions. In addition, the Australian government still refuses to ratify this agreement and along with the United States of America remain the only Annex I countries of the United Nations Convention on climate change to not ratify the Protocol (CamWalker, 2006).

Climate change is one of the all-encompassing global environmental changes likely to have deleterious effects on natural and human systems, economies and infrastructure. The risks associated with it call for a broad spectrum of policy responses and strategies at the local, regional, national and global level. The UNFCCC (United Nations Framework Convention on climate change) highlights two fundamental response strategies: mitigation and adaptation. While mitigation seeks to limit climate change by reducing the emissions of GHG and by enhancing 'sink' opportunities, adaptation aims to alleviate the adverse impacts through a wide-range of system-specific actions (Fussel and Klein, 2002).

Although mitigation and adaptation measures must be pursued to tackle the climate change problem and to create an effective and inclusive international climate change regime, mitigation

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

2.4 Climate Change and Food Security

Food security is challenging to define and means different things to different people. Defining food security is bound up in what ones considers to be human food needs based on diet. Food security also relates not only to the food being available for consumption in a certain region, but also that it is available at prices that people can afford, which is affected both by the price of the food itself but also the level of employment income and unemployment in the region under consideration (Ellis,2010). The most commonly used and accepted definition of food security developed by the united Nations Food and Agricultural Organization (FAO) is: Food security exists when all people at all times have physical or economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO,1966).

Agriculture is important for food security in two ways: it produces the food people eat; and (perhaps even more important) it provides the primary source of livelihood for 36 percent of the

world's total workforce. In the heavily populated countries of Asia and the Pacific, this share ranges from 40 to 50 percent, and in sub-Saharan Africa, two-thirds of the working population still make their living from agriculture (ILO, 2007). If agricultural production in the low-income developing countries of Asia and Africa is adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and their vulnerability to food insecurity increased.

Climate change will affect food security through its impacts on all components of global, national and local food systems (FAO, 2008). Ellis(2010) reviewed that, the FAO stress that to evaluate the potential impacts of climate change on food security it is not enough to assess the impacts on domestic production. Factors such as the impact of climate change on over all global food surpluses and the ability of the countries and individuals to purchase those surpluses must also be considered.

Climate change will likely affect food systems: directly through its impact on biophysical infrastructure associated with food processing and distribution; and indirectly through its effect on human capital, economic and sociopolitical structures (Schmidhuber and Tubiello, 2007). Food production, especially agriculture and fisheries, will be one of the key aspects of our food system affected by climate change. This is important because food production is how the food we consume is generated, but also because food production employs 36 % of the world's population (FAO, 2008). Thus, if people are no longer able to make a living producing food, their ability to have the capital to access food may also be affected there by creating an indirect effect of climate change on food security. While the potential impacts of climate change on food production may be the most immediately obvious, the food processing, distribution and

utilization aspects of our food system will also likely be directly impacted by climate change and are of equal importance (Ellis, 2010).

2.5 Local Community Perception of Climate Change

As Ban and Hawkins (2000) define perception, it is the process by which we receive information or stimuli from our environment and transform it into psychological awareness. Local community perception about their environment is critical because their perception fundamentally determine socioeconomic activities in their locality. Successfully mitigating and adapting to climate change require changes in the behavior of billions of human being, who each day make individual choices that collectively have enormous impact on the Earth's climate (Brechin, 2003: 106 cited in Adane, 2009). However, very little is known about international local community opinion regarding climate change. For example, in Ethiopia empirical studies about local community awareness of climate change is very low (Adane, 2009).

Many people promote the use of a community-based approach (CBA) to climate change adaptation, yet the literature on the topic is largely unpublished, limited, and poorly informed by theory or evidence. CBA is described as adaptation with a community focus that seeks stakeholder engagement and which recognizes that adaptation to climate change occurs within the context of other risks and is implemented through existing institutions and decision-making processes (Dumaru, 2010). The same literature adds that response to disasters recently moved from a post impact relief and reconstruction approach toward a risk management process that includes pre-disaster planning and preparatory work. It has been argued that the involvement of communities is essential for this shift to occur. Therefore, focus on community adaptation is

necessary because this is the scale where climate change will be experienced most by people, and to which they will have to adapt.

However, many programs are inconsiderate of communities. Assessing the awareness and knowledge of the beneficiaries of a given program is necessary, if such programs are to find support amongst targeted areas and be integrated into the day-to-day management of operations. An examination of the awareness and knowledge of resources, whether protected or not, provides a means of assessing the influence of such climate change programs (Infield & Namara, 2001). Despite being the primary custodians of natural resources, local communities are poorly involved in decision-making and policy formulation (David, 2009). Their exclusion from this process de-motivates them and this makes it difficult for local projects to achieve their goals. The lack of appropriate incentives for community involvement in conservation is an important issue that needs to be considered (Mogoka, et al. 2001 cited in David, 2009). In addition to this, there is little awareness of the contribution of everyday individual actions to the problem of climate change (Defar, 2002; Mori, 2005; Thompson & Rayner, 1998 cited in Whit marsh, 2009).

CHAPTER 3: METHODOLOGY

3.1 Description of the Study Area

Benishangul Gumuz regional state is located in West – North Western Ethiopia and is divided into three administrative zones: Kamashi, Metekel and Assosa. The region consists of 19 Districts and one special district (Mao Komo).

Metekel Zone is situated between 11002’ and 420 33’latitude, and 370 25’ and 380 43’ longitude with the altitude ranges from 1500m-4203 m.a.s.l located at distance of 667 km to the western side from the capital city of Ethiopia, Addis Ababa, and 370 km from Assossa, the capital city of the region.

Metekel is one of the three zones of Benishangul Gumz Regional State. The zone consists of seven districts namely, Bulen, Dangur, Dibate, Guba, Mandura, Wombera, and Pawe Special. Both extensive land use systems (based on shifting hoe cultivation and hunting and gathering in the forest) and highland oxen-based agriculture system are practiced by different communities living in the area.

Guba district is one of the six districts of Metekel zone, Benishangul Gumuz regional state. It is located between 35 ° 05’ – 36 ° 14’E and 10 ° 54’ – 11 ° 55’ N. Guba is bordered by the Abay river on the south which separates it from the Asossa Zone, Sudan on the west, Dangur on the north and east, and on the southeast by the Beles River which separates it from Wenbera. Mankush, the center of the district, found 230 Km away from Assossa.

The study area

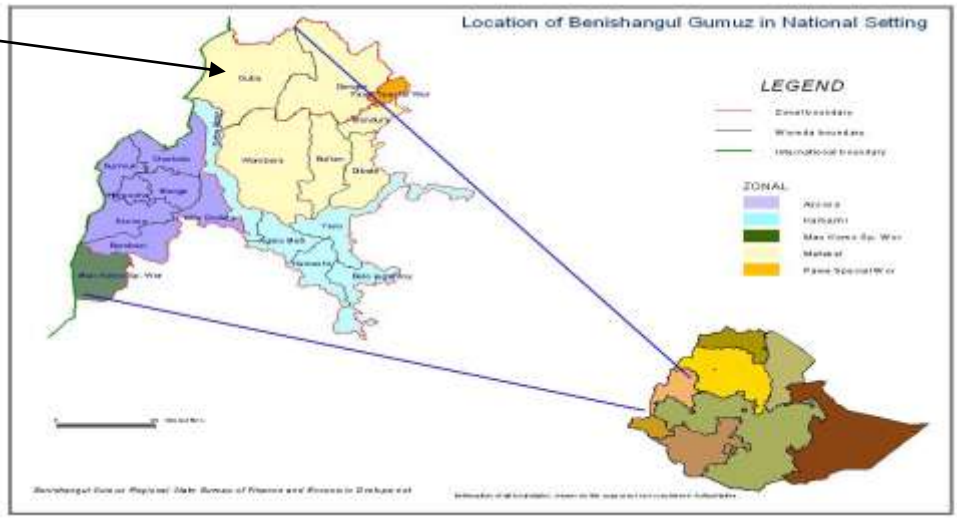

Figure 1: Map of the study area

Source: New Atlas of BG Regional State (BG BoFED, 2007)

The total population of the district is 14, 901 (from which 7,416 are female). The major ethnic groups in the district are gumuz. The district is comprised of 17 *'kebele'*s. The climate of the district is characterized by warm moist. It has a monomodal rainfall. It has average temperature of 29 ^{o}C, its altitude ranges from 500 to 900 m.a.s.l. agro-ecologically 100% *'kolla'* (moist low land) (GDADO, 2012).

The district has adequate land and natural resource to boost agricultural productivity and production. However, the community does not take farming as a full time business. Major crops produced include sorghum, sesame, maize (home garden) and haricot bean, which are mostly produced under rain fed condition. Livestock resources of the district mainly include goats, sheep, cattle, and donkey. Honey is collected from forest not from beehives.

The total area of Guba district is 405,413 ha. It is characterized by different LU/LC classes, shrub land and woodland being the major ones. Shrub land accounts 50% of the total land

coverage and is the largest class. Next to Shrub land, woodland is the second largest class accounting for 38% which makes the total percentage of the two land covers 88. The remaining 12% is covered by bamboo, cultivation, grassland, water body and natural forest (BSGFSEGP, 2011). However there is dramatic decrease of forest cover due to expansion of investment and indiscriminate slash off trees.

Though Guba district is blessed with various potentials and opportunities, it has remained one of the least developed districts in the region and it is food insecure. There are many factors contributing to this. To begin with, the district was marginalized and was not given due attention by past successive governments. Consequently, the socio-economic conditions are very poor. Crop production and productivity is very limited due to use of rudimentary labor-intensive farm tools, prevalence of crop diseases, pests and weeds, declining soil fertility, inadequate use of improved inputs, erratic and unseasonal rainfall, human diseases such as malaria, poor rural infrastructure facilities like market and road, absence of credit services and poor working culture of the indigenous communities largely due to use of labor-intensive farm tools and low awareness.

Livestock production is one of the sources of economy for the people. There are about 5985 cows, 1394 oxen, 190474 goats, 6341 sheep, 16029 donkeys and 16029 poultry. Livestock production is constrained by climate change and variability.

3.2 Research Design and Sampling Techniques

The research design used in this study is a cross-sectional survey, employed both qualitative and quantitative approaches. Site selection was one of the first steps in carrying out this research. Guba district was selected purposively. The selection has been undertaken with close discussion

and consultation with the experts of zonal food security office, zonal environmental protection, land utilization and administration office, and zonal agricultural department. Several factors were considered during the selection of Guba as a case study area. The following were the most important factors. First, the district like many other districts of Benishangul Regional State has been considered as affected by climate change and food insecure. Second, the researcher is relatively familiar with the district, and finally, from the view point of resources available (budget and time) for the research.

Study population and study unit

The study was primarily a descriptive type attempted to assessed local impacts of climate change, understanding local people perception and their responses. The people lived in Guba district were the study population. The study units for the household survey were sample households. For focus group discussion (FGD) and key informant interviews, the people selected were those individual lived in the sample *'kebele'*s who were believed to have experienced and aged people represent the opinion of the community. For expert interviews, government officials and NGO representatives were select.

Sampling design and sample size

The combination of stratified sampling and simple random sampling were used in the selection of study site and sample households. At the first stage three *'kebele'*s were randomly selected. In the study communities, households were stratified in to two: Male headed and female headed. The purpose of this stratification was to include the view of both sexes and to know the most affected segment of the community and to find out the reason(s) for this variation. For household survey, 60 households (45 male headed and 15 female headed) were selected randomly. The

sampling was done by using *'kebele'* registration lists obtained from the respective development agents.

For key informant interviews, 9 (nine) household heads were select (three household heads from each *'kebele'*). The purpose of the interview was to explore the perception of the community about climate change, its cause and their responses. Interview was made with experts: two government offices and one NGO representative in order to get relevant and reliable information.

In addition to these, at *'kebele'* level two group discussions (one from each agro-ecology) were undertaken. The people participate in the FGD were believed to represent and reflect the opinion of the community members.

Data collection

"Using both qualitative and quantitative approaches together yields more than the sum of two approaches used independently" (Devereux et al, 2003). Degefa (2005) also confirms that a mix of the two research approaches have paramount importance because either of them are not sufficient. Hence, both quantitative and qualitative research methods have been integrated for this study for both data collection and analysis. The main purpose of using quantitative technique were to get households' demographic information, to know the proportion of the most vulnerable segment of the community and to know the pattern of local climate based on temperature and rainfall records. Qualitative technique was also mainly used to investigate coping and adaptation strategies, cause and impacts of climate variability and change, as well as peoples' perception on local climate variability and change.

Data sources

The required input data of this study was generated from both primary and secondary sources. Primary data was generated from three groups of respondents and direct personal observation. The first group was selected households from the study area. The second group of data source was key informant and expert interviews comprises of people who were believed to represent and reflect the opinion of the community member. The third group was participants of FGD and direct personal observation. On the other hand, secondary data can be generated by reviewing different relevant literature. These included books, research works, journals, published and unpublished document, different activity reports of government and non-government institutions, and available rainfall and temperature records of some selected stations.

Data collection instruments

Structured household survey: Household survey was used in this study. The structured household survey was mainly used to collect quantitative data. The survey consists of four parts: demographic information, local people perception of climate change and its cause, local community understanding of the local impacts of climate change induced-hazards and local people, NGO and government responses to the impact.

The survey was conducted on the selected 60 households. It was handled by three development agents of the respective *'kebele'*s' after received appropriate training. One day training was organized and orientation was provided for these three enumerators and discussion was made with them to make the questionnaires clear. Development agents were preferred for many reasons:

- they had a list of households of each category that could be included in the survey and making sampling could be easy;
- they are more familiarized with the community there by communication and getting reliable data was easier;
- they have long time experienced of surveying;
- they have knowledge and experienced on the subject matter and can easily understood the questionnaires and;
- they all had diploma holders in agriculture;

While the enumerators handled the survey, the researcher was inspected the enumerators, and side-by-side in-depth interviews with the selected households were conducted.

Interviews: Individual in-depth interviews were used to collect qualitative data and it was conducted on a one-on-one basis between a respondent and an interviewer. It was a straightforward and less problematic way of finding things out (Robson, 1995). Interviews were made on nine households (6 men and 3 women), two government officials and one NGO representatives. The main purposes of conducting interviews were to clearly understand the perception of peoples on climate change, its cause and the responses of the community, government and NGOs. In addition, it was important to triangulate the household survey.

The interview made on government officials focused on: the impact of climate variability and change on the study area, responses of the government and level of participation and role of the community to tackle the impact. Similar interview was conducted with NGO representative of BSG FSEGP on the focus of their response to the natural and manmade hazards mainly caused by climate change.

Focus group discussion: Focus group discussion (FGD) helps to generate data on group dynamics, and allows a small group of respondents to guide by a skilled moderator, to focus on key issue of the research topic (Mwanje, 2001). The focus group discussions were held with the households of the sample *'kebele'*s and respective development agents. In each *'kebele'*, one focus group discussion was held with the community. The main purpose of focus group discussion was to understand the perception of the people about climate change impacts, its cause and their responses. The major discussion topics were local community understanding of climate change and its cause, major hazards and their impact and adaptation strategies and barriers to employ them effectively. At each FGD 12 to 15 persons were participated.

Observation: Observation is be used as supportive or supplementary technique to collect data that may complement or set in perspective data obtained by other means (Robson, 1995). During my stay in the study area, I was observed various environmental changes. The vegetation covers, topography/relief, major development interventions, peoples' perception were observed while conducted the fieldwork for this research and before this when I was there.

Document review: various documents available at district and *'kebele*s' were reviewed and used to generate secondary data. Census reports, activity progress reports, relief distribution that contain demographic characteristics, climate distribution, and economic information will be reviewed and supplemented the primary data.

Data analysis and presentation

Data obtained from various sources were analyzed using qualitative and quantitative data analysis techniques. The qualitative information gathered using direct observation, focus group discussion and interview was analyze by using qualitative techniques whereas the quantitative

data generated by questionnaire and meteorological data were analyzed by using quantitative technique with the help of Statistical Package for Social Science (SPSS).

CHAPTER 4. RESULTS AND DISCUSSIONS

This chapter discusses and presents observation results of climate variability and change, local peoples' perception of climate change, impacts of climate change on food security, coping mechanisms and adaptation practices and barriers to adaptation in the study area based on results obtained from household survey, historical rainfall and temperature records, and qualitative information generated from various groups of the community and concerned officials through FGDs and interviews. For ease of memory for interviewee people and key informants, the downfall of *'Derg'* regime (22 years ago), late ruling government, used as a reference point of departure.

4.1Profile of the Respondent Households

The survey results revealed that of the total household heads included in the survey, 25% and 75% were female-headed and male-headed households respectively. The age distribution of the respondents ranges from 25-86 years. 82% of the respondents were between 30 and 60 years. Regarding marital status, 73% of the respondents are married, while 27% of them were single. Although the average household size of the respondents is 6.5, the absolute size of the respondents ranges from 1 to 13 members.

The survey results also showed that of the total household heads included in the survey 86.7% were Gumuz and 13.3% were Amhara and Tigre. In terms of religious composition, 88.3% of the survey households are adherent of Muslim, and the Orthodox Christianity is 17.7.

As shown in Table 1, 78.3% of the household heads were illiterate with no formal education of any kind and thus are unable to read and write. Only 11.7% of the respondents stated that they

could only read and write, while 10% have completed first cycle education. All households (100%) were farmers.

Regarding household income, it was difficult to establish because the respondents could hardly tell sincerely their household earnings. However, an attempt had been made to know their income by asking the amount of crop production per year and converting it to Ethiopian birr and then to dollar based on the current market price. Accordingly, the income distribution of the respondents ranges from $ 44 – 132 (Ethiopian Birr 800-25000) with an average income of $ 421 (Birr 7800) per year. However, 62 % of the respondents earn below the average. Though there is no land ownership certification, more than half of the respondent households owned greater than five hectare of land used in shifting cultivation system.

Table 1: Characteristics of the respondents

Characteristics of the respondents		Frequency	% respondents
Sex of HHs	Female	15	45.0
	Male	45	75.0
Religion of HHs	Muslim	53	88.3
	Orthodox	7	11.7
Ethnicity of HHs	Gumuz	52	86.7
	Amhara and Tigrie	18	13.3
Marital status of HHs	Single	16	27
	Married	44	73
Place of HHs	Guba	60	100
Land holding of HHs in ha	< 2	9	15
	2 – 5	20	33.3
	5 – 10	13	21.7
	>10	18	30
Educational levels attained by HHs	Illiterate	75	62.5
	Read & Write	37	30.8
	1st cycle completed	6	5.0
	2nd cycle completed	1	.8
	High school completed	1	.8
Current occupation of HHs	Farmer	60	100
	Trader	0	0

Source: Field survey, 2012

4.2 Patterns of the Local Climate

In general, meteorological stations in Ethiopia are few in number and data for most of the stations is very scant and incomplete. There is one meteorological station at Mankush, capital town of Guba district, established in 1984. However, there is missed data for some years. Although some years incomplete, it can tell about the trend with the existing station data of the remaining years. Monthly rainfall and temperature data of 1984 to 2009 for Mankush station was obtained from National Meteorological Service Agency (NMSA). However, temperature and rainfall data for some years (from 1987 to 1997) was missing. However, it can be used the reaming years of data to see the trend.

4.2.1 Annual rainfall trends

The average annual rainfall of Guba ranges between 778 mm in the driest year to 11324 mm in the wettest year. As it is shown in Figure 2, annual rainfall has experienced inter-annual variability over the past 25 years. Analysis of linear trend of annual rainfall indicates a decreasing trend in the station.

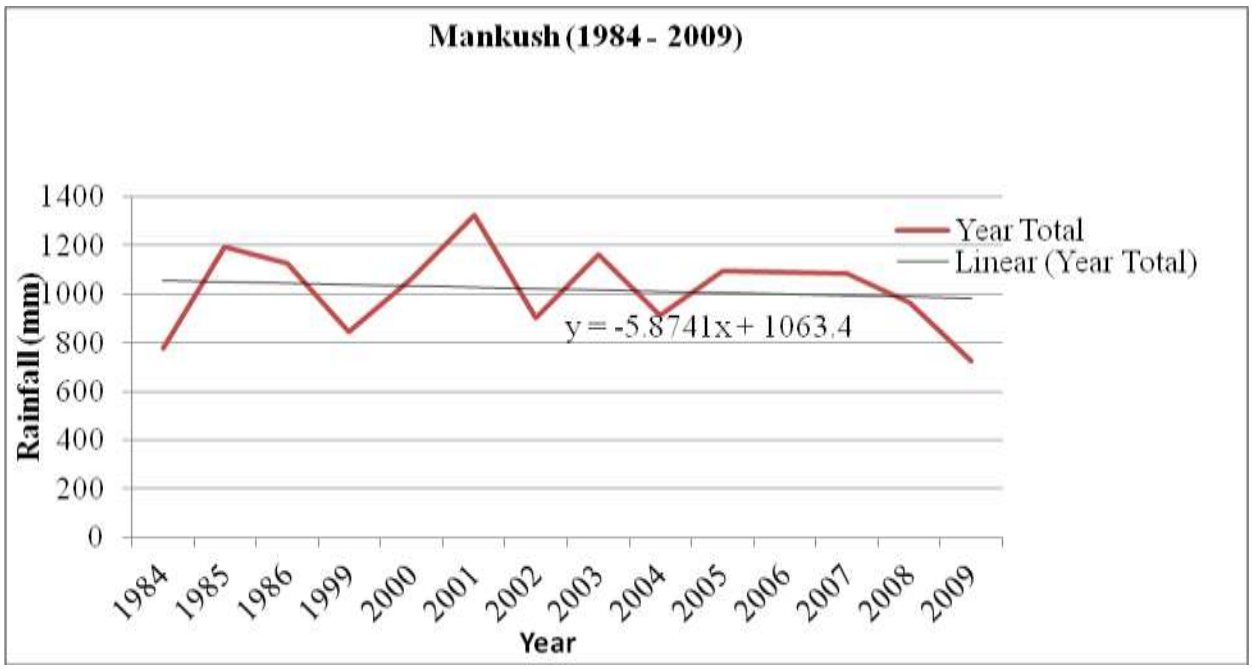

Figure 2: Inter-annual Rainfall Patterns and Trends of Change

Data source: NMSA, 2012

4.2.2 Temperature variability and trends

According to NMSA (2007), the average annual minimum temperature over the country has increased by about 0.37^{o}c, whereas, average annual maximum temperature has increased by about 0.1^{o}c every decade (NMSA, 2001). Temperature distribution in the study area was characterized by a general trend of increase and vivid inter-annual variability. As depicted in Figure 3, the average of maximum and minimum temperature has increased.

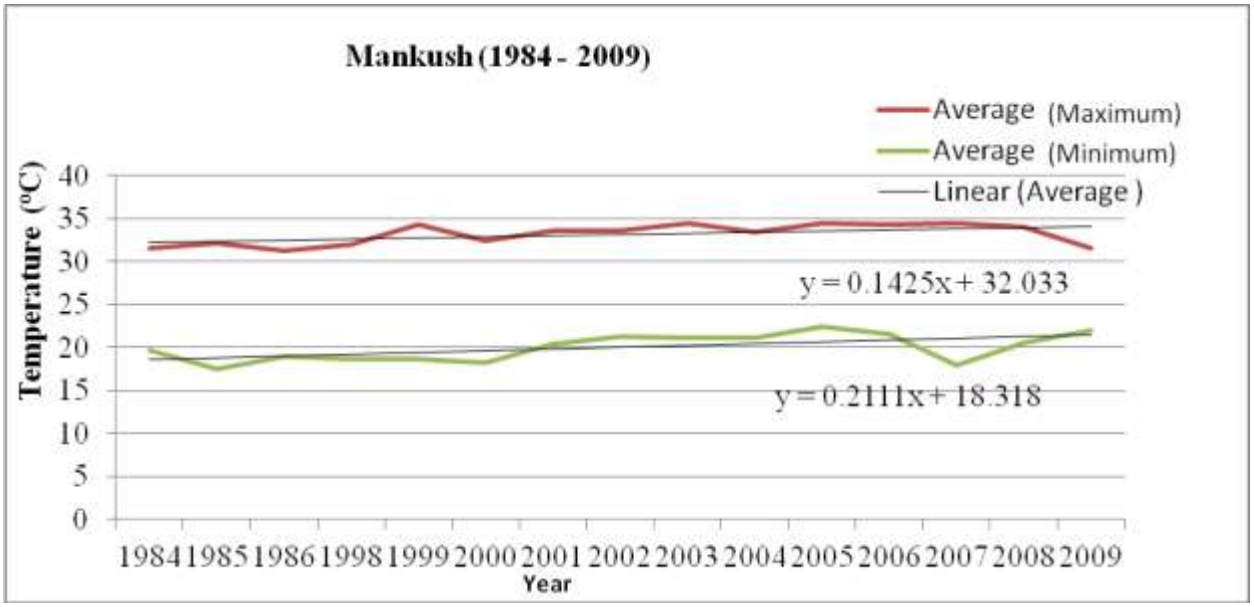

Figure 3: Patterns of annual average maximum and minimum temperature in the study area

Source: Data source: NMSA, 2012

This finding is consistent with studies of Muna (2006), in which she showed that an increasing trend of temperature by about 0.3^{o}c per decade in the Ethiopian highlands.

4.3 Local People's Perception of Climate Change

Understanding of local peoples' perception to climatic variation is crucial to designing appropriate adaptation and coping strategies to climate change and variability for many poor countries that are highly vulnerable to the impact of climate change and variability (Maddison, 2006 cited in Demeke, 2010). It is important to have an insight of local peoples' view on temperature and rainfall trends of change to dig out locally available climate change and variability adaptation options. In line with this, FGD participants, key informants and respondents were asked their understanding of climate change and source of information. Their

response shows that few people (35%) were informed about climate change. From the informed people, the major sources of climate change information were radio (80 %) and government agent (20 %)(See Table 2).

Table 2: Local communities understanding of climate change and source of information

Questions		Frequency	% of respondents
Have you heard of the word "climate change" before?	Yes	21	35
	No	39	65
Do you understand what "climate change" mean?	Yes	55	91.7
	No	5	7.3
From which source you heard about climate change?	Radio	16	76.2
	Governments	5	23.8

Source: Field survey, 2012

The assessment of climate change by people of different sex showed that the proportion of female respondents who have heard about climate change in the study area was 13.3%. The remaining 86.7% did not have any idea about climate change. About 42% of male respondents reported that they have heard about climate change (see Table 3).

Table 3: Respondents' awareness of climate change by sex differential (N=60)

		Sex of household head			
		Female		Male	
		Count	Percent	Count	Percent
Have you heard of the word "climate change" before?	Yes	2	13.3	19	42
	No	13	86.7	26	58

Source: Field survey, 2012

When the respondents' awareness of climate change is assessed in relation to their educational status, observations showed that as the level of literacy increases, their awareness of climate change also increases (see Table 4).

Table 4: Respondents' awareness of climate change by educational status (N=60)

		Have you heard of the word "climate change" before?			
		Yes		No	
		Count	Percent	Count	Percent
Educational status attended by HHs	Illiterate	9	19.1	38	80.9
	Read & Write	6	85.7	1	14.3
	First cycle complete	6	100	0	0
	Secondary education complete	0	0	0	0

Source: Field survey, 2012

4.3.1 Local community understanding and perception of changes in rainfall

All participants of FGDs, key informant and expert interviewees recognized there were changes in rainfall amount, its timing and distribution in the study area over the past 22 years. This was substantiated by household respondents. The survey result revealed that all (100%) the respondent household heads included in the survey perceived long-term change in pattern of rainfall amount and distribution. Most of the household heads (85%) showed that rainfall amount in Guba district in the last 22 years showed a decreasing trend whereas 8% perceived as increasing trend and the rest 7% perceived as there was change but the change was not uniform and some year increase and the other decreased.

In the survey, local people were asked to tell what indicators they have been using to perceive changes in rainfall over the last couple of decades. Their responses revealed that loss of livestock, wild animal and plant species (88.3%), increased frequency of occurrence of drought (78%), shortening of growing period (85%), rainfall comes early or lately (96.7%), decline of agricultural yields (81.7%) and decreased available water (100%) were reported as indicators of changes in rainfall in the area over the past 22 years.

4.3.2 Local community understanding and perception of temperature changes

In the FGDs and interviews, the local people and experts indicated that since the downfall of the Derg regime the temperature pattern has changed and shown an increasing trend in amount and intensity. The survey result revealed that out of the total household heads included in the survey, majority of them perceived there is long-term change in temperature in Guba over the past 22 years. 97% of households recognized increased in temperature and the remaining 3% felt there is no change in trend (Figure 4).

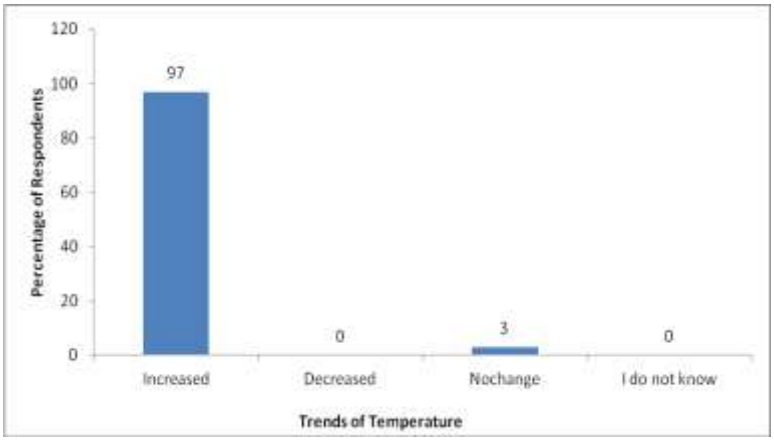

Figure 4: Local peoples' perception of changes in temperature in Guba, 2012.

Source: Field survey, 2012

In the survey, the respondents were asked to identify some of changes they have observed in the environment resulting from changes in temperature over the past couple of decades. Prevalence of newly introduced human and animal disease (95%), introduction of new plant species that were not common in the area (56%), change in clothing style (47%), dry up of rivers and streams (100%), and damage of crops caused by pests (95%) were some of indicators in the environment reported by the respondents as a result of changed temperature over time. FGD participants also show increasing water consumption, loss of indigenous seeds and melting of butter early in October are indicators of increasing temperature in the area.

As can be seen from Figure 4 above, about 97% of the respondents perceived increased temperature. This is in accordance with the trend analysis of both inter-annual mean minimum and maximum temperatures.

The key informants also pointed out that the patterns of temperature in Guba district changed. For instance, one farmer key informant explained:

> "I lived here in Guba district for about 70 years. I can tell you that temperature of Guba district during the Derg regime was different from that of today. For example, during the Derg regime the month of October was cold but now it is as hot as in the month of February. In addition, clothes that people were using changed from thicker to lighter ones."

4.3.3 Local peoples' perception of cause of climate change

Most peoples in Ethiopia consider climate change as an act of God and a few people associated climate change with anthropogenic factors. In line with this local people asked what is (are) the

cause of climate change. Accordingly, most people (42%) considered climate change as an act of God, which was regarded as punishment of people's wrong doing. Whereas 33% perceived as due to anthropogenic factor and the rest 17% and 8% considered as due to natural factors and human and natural factor respectively.

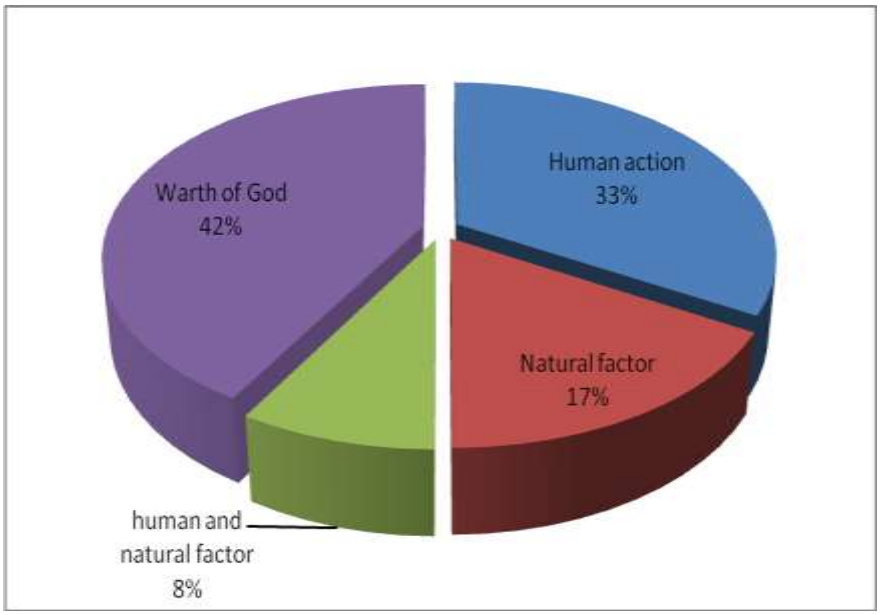

Figure 5: Local peoples' perception of cause of climate change in Guba district, 2012

Source: Field survey, 2012

The respondents also listed down some of human activities, which affected the local climate. From the 21 HHs who considered human activity as a factor of climate change, 95.2 % said loss of forest and 4.8% considered population pressure. They gave no credit for the contribution of fossil fuels, and air pollution to climate change.

Table 5: local peoples' perception on cause of climate change from human activities

Causes of climate change		Frequency	% of respondent
Use of fossil fuels	Yes	1	1.7
	No	59	98.3
Loss of forest	Yes	20	33.3
	No	40	66.7
Air pollution	Yes	0	0.0
	No	60	100.0
Population pressure	Yes	11	18.3
	No	45	75.0
Over cultivation	Yes	0	0.0
	No	60	100.0

Source: Field survey, 2012

Many of FGD participants, community representatives and experts also identified deforestation; population pressure; wrath of God; shifting cultivation and poverty as causes of climate change at local level.

4.3.4 Deforestation and climate change

Guba district is endowed with huge and diversified forest resources. However, the forest resources are dwindled terribly at alarming rate by continual deforestation. The main causes of

deforestation in the district were forest fire and indiscriminate cutting of trees. Forest fire was caused by two ways: deliberately firing of forest by human being and fire occurred naturally.

Figure 6: Manmade forest fire

According to respondents, FGD and key informants, both investor and local people were the main agents of forest fire. The main causes of forest fire in the district are as discussed follows:

i. **To clear land for foot path**: clearing of grass by fire to have foot path to cross from one village to another village and or from one *'kebele'* to another one. Unless grass is fired it is difficult to cross the area due to loosing the direction. In addition, people afraid to cross through forest due to harboring of wild animals that attack the people.
ii. **Agricultural investment and arable land expansion:** There are about 95 private agricultural investors engaged on crop production. A total of 48,291 ha of forest land provided for those investors. Therefore, those investors firing forest year to year to change the land from forest area to farm land. Once forest is firing, it is difficult to control and devastated unwanted forest areas which were not the holdings of investors.

In addition the local people practice hoe farm by shifting cultivation by demanding new and virgin land by clearing forest using fire. The virgin land gives better produce than the former

land practiced crop production. During firing, the fire lost much area of forest than their needed area due to unable to extinguish the fire.

iii. **Hunting of wild animals**: One of the sources of food and coping mechanisms of the local community is wild animal hunting. Culturally most wild animals are eaten by the local people. Therefore, community fired the forest in different direction and the wild animals inside the forest fired as well. Those fired animals collected by the community and take as a fried meat nice for them. On the other hand, the hunter fired forests on certain periphery and leaved some part of the forest so as to move to animal on the safe side to escape from forest fire. In that instance, people arrange a strategic place to kill wild animals by bullet and locally available weapon.

iv. **Wild honey collection:** In the district bee colonies are found at wild in perforated bark and stem of big tree and on caves of gully banks. To collect the honey local people used smoke. After honey harvesting the ruminant fire on the smoke extinguish the surrounding forest.

Figure 7: youths harvest and eating wild honey from the forest

v. **To grow new grass:** Since the area is covered by thick grass, the community has not been familiarized with collection of grass and/or straw for animal feed. Animals feed grasses

available at filed which is dried and unsuitable for digestion. Therefore, community fired the dried grass so as to have new young coppicing green grass easily palatable by their animal. This green and young grass reduced the water need of the livestock and helped to produce more cow milk. The fire used to fire dried grass for rejuvenation of new grass extensively fired the large mass of the forest for a long period of days until extinguished by itself.

vi. **For the collection of incense and gums:** The district is endowed with essence and gums resources in the natural forest area. There were three investors holding 37,000 ha of forest land to collect naturally available incense and gum (GDAO, 2012). Those investors hired daily laborers to tap and collect incense and gum. Therefore, the daily laborers fired grasses and bushes to clear the land in order to crossed and got the gum and incense trees. Unless the land was cleared from dense grass cover, daily laborers feared from snakes and other wild animals attack that might affect the laborer by harboring the dense vegetation cover. Due to this, surrounding forest was fired. In addition, illegal incense and gum collectors did the same thing of forest fire to collect and sell incense and gum.

Figure 8: Essence and gum collection from forest resources

From November to June the district covered by foggy of smoke due to forest fire. Forest fire produced CO2 which is the main contributor of green house gas. On the other hand loss of forest will reduce carbon sequestration. Therefore, the district forest fire contributes its share of CO2 for green house gas to the changing climate. FGD discussants pointed out that firing of forest increase the surrounding temperature.

On the other hand, deforestation was caused by cutting of trees for firewood and charcoal and selling of wood and wood products (mainly locally constructed furniture) to other neighboring country mainly to Sudan which border Guba district. Tree timber and bamboo were exported to Sudan by legal and illegal merchants. Due to this, the availability of bamboo is dramatically diminished.

Figure 9: Bamboo transported to Sudan and firewood collection and selling (left to right)

All interviewed people confirmed that there is change in LU/LC in the district. FGD and key informants assured the same. Data obtained from BSG FSEGP confirmed the same (Table 6).

Table 6: Percentage of LU/LC in the years 1987, 1998, and 2007 in Guba

Land use/cover class	Year		
	1987	1998	2007
Shrub land	20.89	39.01	50.74
Woodland	62.62	53.47	37.94
Bamboo	4.91	1.31	1.11
Cultivation	2.2	1.47	6.83
Grassland	4.6	3.24	2.7
Water	1.25	0.73	0.26
Natural Forest	2.05	0.77	0.41
Wetland	1.48	0.01	0.01
Bare land	0	0	0

Source: BSG FSEGP, 2011

As depicted from Table 6, in Guba there is change in LU/LC. Natural vegetation (shrub land and woodland) are still the largest coverage as compared to cultivated land. In 1987 woodland was the largest coverage and around 63% of the Worde was covered by this class. Next to woodland, shrub land was second largest and covered 20% of the total land. The other classes took the remaining 17% share. In 1998, though woodland was decreased it still took the largest share as compared to others. Except shrub land and cultivated land all other classes were decreased. In 2007, shrub land and cultivated land showed increase whereas all other classes decreased (Figure 10).

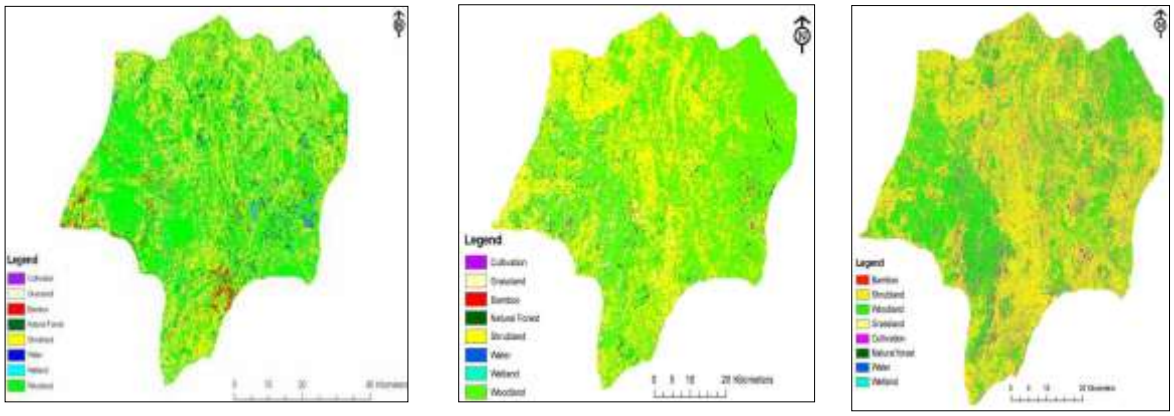

Figure 10. Map showing the LU/LC in the years 1987, 1998, and 2007 in Guba (from left to right)

Source: BSG FSEGP (2011)

4.4 Impacts of Climate Change on Food Security

4.4.1 Drought, pest and disease

In the study area, drought, pests and disease are recurring problems affecting agricultural activities and human wellbeing. All (100%) of the respondents assured that the existence of climate change induced-hazards of drought, pest and disease.

Drought: - Drought is not a new phenomenon in Guba district. The area experienced several droughts over the past years.

> For instance, one farmer from the district said that he lost about 20 cattle in 2010 due to limitation of water for livestock consumption. Similarly, on the same year most livestock holdings and wild animals were died due to limitation of water.

About 75% of the respondents reported that, the recurrence interval of drought has changed in recent periods. The re-occurrence interval became more frequent and takes 1-3 years, gave no

sufficient time to recover from its past impacts. Drought, which can include both insufficient amount of rainfall and uneven distribution over the rainy season, was the important cause of food insecurity in the district.

Pests and diseases: -climate change has direct and indirect impacts on prevalence and spread of pests and diseases (Aklilu & Alebachew, 2009a). Community representatives and experts indicated that the study area was exposed to human diseases, livestock diseases and crop pests. Livestock diseases were mainly pestidus pitite, tryponosomasis, sheep and goat pox, masitite and internal and external parasites. Crop pests were a chronic problem in the administrative zone of Metekel, of which the most hazardous were stalk borer (sorghum and maize), Aphids (all crops), cut worm, root rot, Striga (sorghum and maize), etc. The human diseases were malaria, diarrhea and typhoid.

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

Climate change and variability have had serious impact on crop production, livestock production, and wild animal and forest resources. Crop and livestock production, wild animal hunting and gathering of edible forest resources (wild fruit, root and tuber) are practiced in the district. As a result, their food security situation was mainly dependent on those sectors. Therefore, the source of food security and/or livelihood of people were sensitive to climate change. The main natural

constraints to accessing food and generating cash income included drought, pest infestation, and livestock and human disease.

According to GDADO, climate change and variability particularly reoccurrence of drought, early cessation and late onset of rain, heavy and unseasoned rain and pests have caused massive crop failure. Respondents were asked about the impacts of climate change induced-hazards in Guba. As shown in Table 7, the most commonly mentioned impacts of climate change were loss of crop production (98%), shortage of feed of animals (75%), loss of livestock (98%), shortage of water (100%), forced to out-migrate (27%), expose to disease (98%) and damage of infrastructure (15%).

Table 7: Respondents understanding of the impact of climate change (N=60)

Impacts of climate change	**Frequency**	% of respondents
Loss of crop production	59	98
Shortage of feed of animal	45	75
Loss of livestock	59	98
Shortage of water	60	100
Forced to migrate	16	26.7
Expose to disease	59	98
Damage of infrastructure	9	15

Source: Field survey, 2012

Some of impacts of climate change on livelihood of the people reported by FGD participants, community representatives and experts include: reduction of crop and animal production;

intensification of pests and diseases; shortage of water, food and feed of animals and reduction of wild animals and forest resources. These lead to reduction of food availability at household level.

4.4.2 Crop and livestock Production

Crop Production:

The household survey data shows that there is declining trend in the productivity of food crops in Guba district (Table 8). Generally, about 85% of the respondents reported that crop productivity was better in the past (22 years ago) than recent years (2012). Climate variability and change particularly drought, early cessation, late onset, heavy and unseasoned rain and pests and disease were the major reasons for the reduction of crop production. Most people in the district were suffered from insufficient rainfall for some years. On the other hand, unpredictable and unseasonal rain fall occurred. FGD pointed out that the increased temperature aggravated the limitation of crop water availability by increasing loss of soil moisture by evaporation. As a result, crop yields were low and market prices soared. Low crop yield and soared market price intern promulgated food insecurity

Table 8: performance of crop production over the past 22 years

		Frequency	% of respondents
Performance of crop production 22 years ago	Good	51	85
	Normal	8	13.3
	Poor	1	1.7
Performance of crop production in 2012	Good	7	11.7
	Normal	23	38.3
	Poor	30	50.0

Source: Field survey, 2012

Livestock production:

Looking at the grass and bush land potential of the region, one could expect the region to have a high population of livestock and therefore a main livelihood resource in animal husbandry. But the reality is different. The livestock population is very low and the contribution of the sector as a complement to crop production for households is negligible due to killer diseases affecting all types of livestock (especially trypanosomiasis), shortage of water and feed during peak dry seasons, poor livestock husbandry practices and other related (BG BoA, 2005).

Substantially, FGD and key informants declare that livestock productivity in Guba is constrained by climate change induced disease, increase in temperature, unpredictable rainfall, and limitation of water availability for livestock drink. Average ownership of animal per household in the sample showed that the number of domestic animal assets decreased over time. The average number of livestock per household has declined from 3 oxen, 6 cows, 17 goats and 5 sheep before 22 years to 1 ox, 2 cow, 8 goats and 3 sheep. This showed a declining trend of animal assets.

Livestock disease such as pestidus pitite, tryponosomasis, sheep and goat pox, and masitite were common. When rain fall increased the possibility of widespread of trypanosomasis and 'abolish' increased that killed so many cattle. The worst problem in livestock production was limitation of water. Cattle travelled to far distant area on hot temperature to got water. Some cattle died immediately after drunk much water on the boarder of river and some animal died on travel to got water. Limitation of veterinary post and vet drug, low level of awareness on livestock management acerbated the problem.

Limitation of wet grass and feeding of dry grass aggravated the problem of water demand of cattle. Before 22 years water for cattle was available in nearby rivers and ponds from July to February. However, since the last decades rivers and ponds were dried up early in October to November. Therefore, beginning from dried up month, local farmers went with their cattle in far distant area where water was available and come back to home when summer rain begun.

Due to this, people used milk and milk products for short period of time when cattle was found in their home and for the rest months people could not accessed milk products due to availability of cattle at far distant from home to milk. Only shepherd used small amount of the milk for drinking purpose.

In addition, due to far distant farmers cannot sell cattle when the owner wants to sell them and to use money to buy food crops and other basic need requirements. This is due to buyer cannot see the cattle at the nearby area to negotiate the price with seller. Therefore, low production of livestock due to limitation of water and high temperature effect, limitation of using milk and milk products and unable to sell livestock during needy season by owner results lowering income from livestock earning that leads today's food insecurity.

4.4.3 Natural resources and environment

Bio diversity: - The district is endowed with diversified of bio-diversity. It is the home base of diversified flora and fauna species. However, it is dwindle at alarming rate. Households were asked about the composition of biodiversity change and all of them (100 %) confirmed that since the last 22 years the biodiversity compositions of their surrounding were changing by decreasing the composition terribly. FGD and key informants stated that some tress species such as ebony (locally called *'Zobe'*) which is extinct in Africa are found in the district and now it is on the

state of loss in the surrounding area. Before 22 years ebony was found in dense in short distant to their home surrounding but now it is found far distant area with low in density. Similarly, some other tree species are reduced in number of availability in their surrounding area.

On the other hand, before 22 years there were plenty of wild life in the nearby area and currently some species are lost. For instance elephant and lion were found in radius of 5 to 10 kilometer of people's home but now they are not available in the surrounding area. Old men said that one of the constraints of livestock production in the past 22 years were their livestock hunted by lion. But now there is no lion. For instance one mountain is locally named as "*Zehon Terara*". *'Zehon'* means elephant and *'terara*' means mountain. Therefore, the compound name '*Zehon terara*' represents the mountain area where elephant living. At *'Zehon Terara'* large numbers of elephants were available there before 15 years. But now no elephant has been seen since the last 15 year at *'Zehon terara'* or any place of the *'kebele'*. One of the main reasons for the loss of wild animal was due to change in climate and other related human factors that altered habitat. In addition, FGDs and key informants declared that two sorghum crop species *'zawon'* and *'demarge'* were disappeared from the district due to change in climate that made unfavorable condition to the crops productivity.

HH respondents, FGDs and key informants asked about the emergence of new plant and animal species since the last 22 years and they confirmed that there was none in animal species and there are new crop species such as soybean, ground nut, haricot bean, maize, and different varieties of sorghum and sesame crops.

FGD revealed that due to decreased availability of tree species in their surrounding, local people travel far distance than before to gather edible wild plant produce. Similarly, the reduced number

of wild animals made difficult to the local people to hunt. They are forced to live in forest area from 2 to 3 days to hunt wild animal due to limited wild life availability. Therefore, both reduction of availability of plant and wild animal have negatively impact on food security of households as most of the people's source of food depends on.

Water: - Water is vital for living things. Water is used for drinking and sanitation purpose. In addition, key informants stated that it is used as a cooling system of their body during hot temperature. FGD realized that the consumption of water during hot season is increased.

All (100 %) of the respondent households indicated that the available water source is decreased over time. FGD and key informants stated that, before 22 years water is available in ponds, streams and sand rivers from July to February. However, since the last 22 years water availability is reduced in sand river, pond and streams. Currently, Water is dried up in October and November. In addition, the availability of ground water is reduced. Before 22 years ground water is available in shallow depth but now the water is found in deep and some former places totally lost ground water availability. Due to lack of surface water, large numbers of wild animals were died in 2010, particularly baboons. In the same year, some wild animals came to village and entered to home to search water and parts of the thirsty wild animals were domesticated for few weeks.

FDG and key informants were asked why both surface and subsurface water availability is reduced and they justified that the rain fall amount was small and erratic and much of the water lost as a runoff than infiltrated and recharged ground water. In addition, the increased in temperature lost water in the form of evaporation. Beside, the number of people is increased and used more water that reduced the quantity of water availability.

Soil Erosion: - From the household survey 67 % stated that there was an increased in soil erosion and the rest 33 % perceived that there was no change in soil erosion over time. FGDs participants and experts said that due to expansion of agricultural investors, immigration and resettlement that destroy forest and caused increase in soil erosion.

4.4.4 Which group of the community is more affected by climate change impact?

In the study area, women and children have several household responsibilities. They are taking care of children, fetching water, collecting firewood, and cooking food. As a tradition in the district women shoulder most farm activities. Impacts of climate change create additional burden on women and children. Table 9 shows participants of household members in basic household activities of fetching water and collecting firewood. Mainly female children and women carry out the routine household activities. Key informants and experts assured that children and women are more affected by climate change impacts.

Table 9: Participants of household members to fetch water and collect firewood

Activities		Frequency	% of respondents
Fetch water and collect firewood	Male adult	0	0
	Male children	2	3.3
	Female adult	26	43.3
	Female children	32	53

Source: Field survey, 2012

4.5 Responses to Climate Change

4.5.1 Local responses

For many years, the local people of the study area have struggled against the impact of different types of natural hazards. In order to adapt the impact of climate change hazards, which are noted in the preceding sections, the local communities have been applying different strategies. However, increased frequency and intensity of climate change impacts have reduced the capacity of local people to adaptation and cope with the problems.

The household survey indicated that it is possible to adapt with some of the impacts of climate change induced-hazards. About 80% of the respondents confirmed same. In line with this, household respondents were asked responsibility for the adaptation practice. About 96.7% of the responses established that adaptation to changing climate was the responsibility of individuals where as 15% of them considered it was the responsibility of international organization, 68.3% and 85% regarded as responsibility of the regional and local governments and local communities respectively (Table 10). Key informants and FGD participants confirmed the same.

Table 10: Respondents perception of responsibility for adaptation practices (N=60)

Who is responsible for the adaptation practice?		Frequency	% of respondents
International organization	Yes	9	15
	No	51	85
Local community	Yes	51	85
	No	9	15
Regional and local government	Yes	41	68.3
	No	19	31.7
Own initiative	Yes	58	96.7
	No	2	3.3

Source: Field survey, 2012

Respondents were also asked whether they were engaged or not in activities with the purpose of coping with local impacts of climate change. About 85% of them were engaged in activities related to coping with local impacts of climate change. Local peoples adopted a wide range of response measures to counteract the impacts of climate change induced-hazards. The household head were asked to identify their major adaptation strategies. Their responses were depicted in Table 11. In concrete terms, more than 80% engaged with growing short maturing crops, introduced new crop varieties, diversified income and change in cropping pattern, while 43 % sown different varieties, 13% grown high value tree crop and 2% of them harvested rainwater.

Table 11: Household's responses to climate change (N=60, Multiple response)

Responses to climate change		Frequency	% of respondents
Reforestation	Yes	0	0
	No	60	100
Rain water harvest	Yes	1	1.7
	No	59	98.3
Change in cropping pattern	Yes	51	85
	No	9	15
Growing short maturing crops	Yes	54	90
	No	6	10
Diversified income source	Yes	52	86.8
	No	2	13.3
Growing high value tree crop	Yes	8	13.3
	No	62	86.7
Introduced new crops	Yes	48	80
	No	12	20
Expansion of arable land	Yes	41	68.3
	No	19	31.7

Source: Field survey, 2012

Change in cropping pattern: The household survey indicated that change in cropping pattern, which was dominantly practiced by farmers, was reported by about 85% of the respondents. Rainfall in the study area is very erratic and unpredictable recently. As a result, farmers could not be certain about rainfall condition even after the onset of rain. According to them, even after the

onset, rainfall could be heavy or light or it might stop earlier or extended than the expected time. The farmers were aware about the type of crops planted in accordance with the characteristic (pattern) of the rain. As a result, the cropping pattern of the study area was changed.

Although government policies, market situation and population pressure are the cause of cropping pattern change, all of the respondents have had the opinion that the contribution of climate change is considerable (Table 12).

Table 12: Respondents perception of cause of cropping pattern change (Multiple responses)

Cause cropping pattern change		Frequency	% of respondents
Climate change	Yes	60	100
Soil erosion	Yes	12	20
	No	48	80
Land scarcity	No	60	100
Market situation	Yes	53	88.3
	No	7	11.7
Government policies	Yes	3	5
	No	57	95
Population pressure	Yes	8	13.3
	No	52	86.7

Source: Field survey, 2012

Growing short maturing crops: About 90% of the households planted early maturing crop types. According to FGD participants, early maturing crops were planted due to shortening of

growing season in the study area. For instance, due to shortage of rain fall *'wode-40'* sorghum is sown which is matured in 40 days long became more common crops recently.

Reforestation: None of the respondents involved in reforestation. FGD and key informants confirmed the same.

Rain water harvesting: Rainwater harvesting for growing crops is another viable option to compromise scarcity of water. However, only 2% of respondents practiced rainwater harvesting to curb the problem of food scarcity that resulted from erratic rainfall by growing vegetables in homesteads.

Diversification of household income sources: Diversification of household income sources is a method used by local people to increase their income to compensate the amount of earnings lost due to decreased agricultural productivity. The respondents asked whether they were engaged in diversifying sources of household income or not to cope with climate change impacts. Some households reported that they have diversified their income sources. The household survey showed that about 86.8% of the total households reported that they were engaged in non-farm activities because of climate change (Table 13). Of the total respondents 71.3% and 17.3% engaged in wage labor and gold panning, respectively, whereas, 3.8% of them engaged in pity trade and the rest 5.8% engaged in other income earning activities.

Result of FGD, community representatives and experts also showed that local peoples were more engaged in non-farm activities to subsidize their agricultural income. Wage labor, charcoal making, firewood selling, gold panning and construction of handicrafts are among the activities local people engaged.

Table 13: Activities that are diversifying households' income sources

Questions		Frequency	% of respondents
Did you (or your household members) engage in non-farm activities because of climate change?	Yes	52	86.7
	No	8	13.3
If yes, what were these non-farm activities?	Petty-trading	2	3.8
	wage labor	38	73.1
	Gold panning	9	17.3
	Other	3	5.8

Source: Field survey, 2012

Introducing new crop variety: To reduce the impacts of climate change and variability, local people used new crop varieties. From the interviewed people 86% of them introduced new crop varieties. Since Derg regime (22 years ago) soybean, ground nut, haricot bean, different sorghum varieties such as *'wode40', key mashila, tewzalie,* and sesame (*'gojam azene', 'abasina', and 'tejareb'*) were introduced. Most of these crops were introduced by private agricultural investors and from the neighboring people of Sudan.

Figure 11: Farmers field day on introducing soybean as a new crop to the district

Expansion of arable land: to increase crop production local people expand the size of land for shifting cultivation. 68% of the interviewed people expanded their arable land twice in the last five years.

4.5.2 Cultural Practices to bring and stop rain fall

Local people used traditional practices to bring rain fall when delayed from the normal condition and times gone up for sowing of crops. Similarly, they also used traditional practices to stop rain from falling when unseasonal rain comes during crop harvest. As a testimony two traditional practices at Icid *'kebele'* and Alemehal *'kebele'*s were presented as follows.

When Rain fall delay:

In Icid *'kebele'*:- When rain fall delay from the normal situation, local people doing cultural practices to beg God to give them rain fall so as to save their life and livelihoods. The cultural practice is doing in one individual home, Mr. Leku Abera. In his home there are two log and one white stone which are used for worship to bring rainfall when it delayed. The stone seems cylindrical in shape and weighted about 2 kg. Each individual household prepared food and drink in their respective home and bring all of them to Mr. Leku's home compound. Mr. Leku will bring out the temple of logs and white stone to his home compound and put in front of the people who gathered in his compound for worshipping. Between the stand logs water is filled in bucket and the white stone immersed to the water and washed by Mr. Leku . Then local people stand together and prey to those materials to give rainfall. Following the prey, they mix the foods brought from each individual and ate together. After eating and drinking of locally prepared food and drink they enjoyed with great singing and dancing for a day long (24 hour day and night).

According to the local people's belief, during this hot singing and dancing rain will raining and bathed them at that instance or will come on the following two to three days of the ceremony.

In Mr. Leku's home it is strictly for bidden someone to get in with shoes. Any people must remove their shoes before inter to the home. If someone forgets and get to home with shoes, he/she will forfeit $0.28 to 0.56 (Birr 5 to 10). As a family in Mr. Leku's home food is preparing for consumption as of other local people. However, when food is prepared, first small piece of food must be put in those logs before any one taste and eat the food.

In addition, every year local people consult with each other and assigned one people for one year to bring and sought one goat and one coke from his own holding in the month of May in Mr. Leku's home compound for the purpose of worship. If it is not done, the temple may punish the local people by delaying rain and bringing harsh season.

Almehal *'kebele':-* When rain fall delay than the normal, local people call each other and go to the nearby water source (river, spring, etc) and conduct prey ceremony. After prey to their God there will be boiled pulse crop, locally called "nefro" to be eat and coffee ceremony at the point of ceremony place. After prey and eating ceremony, local people did strong dancing a day long including night by fetching and sprinkling water up ward and bath the people each other. According to their belief, rain would raining during the ceremony or might be come within the next three days.

When unseasonal Rainfall comes:

As a working tradition of local people, matured crops collected by local people working together as a team locally called 'Debo' where by the team collect crops of every individual in a round base. During critical time of crop collection, unseasonal and unpredictable devastative rain fall

may come to devastate the ripen crop. The problem is pronounced in sesame crop which is easily affected by unseasonal rainfall. During this time, local people used traditional practices to prevent rain from falling in their farm land during crop collection.

When clods seems to produce rain on the crop stand collection day, the owner of the farm land, where crops collected by '*debo'*, at the morning bring two leaves from two plant species; one leaf from '*chelemeta'* plant and the other from '*Gebechewa'* plant and tie those two leaves by rope together with one ten cents and hung at the tip of splitted stick and pegged vertically in his compound nearer to the door. Whereas if the symptom of sky seems nice and comfortable day with no cloud at the morning to collect crop and unexpectedly change its feature to produce rain after people start collection at field, at that instant the owner of the field stake the same thing at the boarder of the field. Local people believe that these activities will prevent rain from falling from that field up to night until uproot the pegged materials.

4.5.3 NGOs responses

BSG FSEGP, Consortium of Canadian based NGO's project, operating in the study area, play a significant role in assisting local development activities. By considering the area as under developed and backward, BSG FSEGP has been implementing food security and economic growth project aimed at disaster impact mitigation and poverty reduction in the study area. Some of the activities of the BSG FSEGP are discussed in the following sections.

Assist and improve the assets and livelihoods of food insecure households

The recurring droughts and associated food shortages in the project areas forced the community to use destructive coping strategies like selling basic assets. This has consequently eroded the

household’s resilience, which increased vulnerability to further shocks. In order to tackle this destructive cycle BSG FSEGP has implemented various activities to protect and improve household's assets and livelihood such as provision of shoats, drought animals, improved seeds, and agricultural tools and training on improved technologies.

Early Warning and Response*:* - Improving the early warning system is the basis for proactively responding to the needs of vulnerable communities either through the existing resources or by seeking additional resources. Since 2010, BSG FSEGP has focused on strengthening early warning system of the existing government rather than introducing its own system. In order to attain this outcome, the BSG FSEGP has provided capacity building interventions to the government such as ToT training to district, zone and regional level government staffs that trickle down to the community and provided supportive materials to improve early warning information system.

Household income source diversification: - Currently economic risks related to income fluctuations and assets depletion among vulnerable households are envisaged to be addressed via market-led income generation and diversification activities. For this to be materialized in the study area, high-potential farm and off-farm value chains were researched with the objective of increasing and diversifying rural income by the BSG FSEGP. For instance, livelihood beneficiaries across the BSG FSEGP projects have used sustainable agricultural technologies. The technologies promoted and being used by the livelihood beneficiaries are proper cultural practices, improved high yielding and early maturing crop varieties, improving marketing system and improved livestock husbandry.

Improving Rural Infrastructure*:* **-** BSG FSEGP has also given special focus to improve rural infrastructure in the program operation areas. To this end, equipping of farmers training center (FTC) and veterinary posts were done since 2011. These activities have significantly contributed to the improvement of agricultural production. Equipping of vet post with veterinary equipment improved the health status of livestock.

4.5.4. Government responses

The government of Ethiopia has adopted national policies, sector strategies and programs. The priorities of the national policies, sector strategies and programs of the government are primarily targeted at promoting rural and agricultural development and poverty reduction. Ethiopia has no an explicit policy on climate change. As a result, climate change and adaptation issues are often treated indirectly in sector specific policies and programs since climate impacts are considered as a sub-component of the overall development goal particularly in relation to natural resources and environmental protection (NMSA, 2007). Government responses related to climate change and variability impacts in the study area are discussed as follows in relation to asset protection and livelihood enhancement and disaster risk reduction.

Asset protection and livelihood enhancement: - Protection of household and community assets reduces vulnerability to the impacts of climate variability and change. Households that have lost all or most of their agricultural products and livestock due to drought and outbreak of disease may face serious challenges that could eventually expose them to destitution (Aklilu and Alebachew, 2009). Government attempted to touch the problem by providing veterinary facility and assigning professionals to provide extension services to the local people. However, 97 % of respondents reported that awareness creation regarding to climate change and other adaptation

measure is low. Similarly, key informants added the government intervention with asset protection and livelihood enhancement is far behind as compare from the prevailing problems.

Disaster prevention and management: - In drought-prone areas like Guba, the role of government in disaster prevention and risk management is very crucial. In Guba district, there is Disaster Prevention and Preparedness Department (DPPD) under Agriculture Office that organized to provide early warning information, assess needs and monitor risks. However, the DPPD in Guba district is poorly organized, has limited capacity and human and material resources and finance constraints. Most respondent households of the study area (88%) reported that government responses to impacts of climate change were not effective.

FGD participants and key informants indicated that they were not satisfied with responses of the government particularly against droughts, disease and pests which affected the livelihood of the people in the area.

4.6. Food Insecurity Copping Strategies

Generally, the households in Guba faced declining trend of crop productivity and animal production because of erratic rainfall, intensified occurrence of pest and diseases, increased temperature and backward agricultural practice (hand hoe). Similarly, forest products such as fruits, tubers and leaves; and availability of wild animals are reduced. As a result, considerable portions of the households were exposed to food shortage. In line with this, household respondents were asked about food shortage and around 81.7 % of the total household heads reported that they faced food shortage, of which more than half (60.4%) households scarce for more than six months every year. In terms of sex, all female respondents (100%) were suffered from food shortage, of which 60.4% suffered more than six months per year (Table, 14).

Table 14: Number of households faced food gaps

Households faced food gaps				
Months of food gap	Male		Female	
	frequency	percent	Frequency	percent
3-4	2	6.1	0	0
5-6	11	33.3	6	40
> 6	20	60.6	9	60
Total	33	100	15	100

Source: field survey, 2012

Besides food gap, food utilization status was poor. People always consumed porridge prepared from sorghum floor as a stable food that limits the balance diet. As observed from the field food preparation is poor in sanitation. Therefore, local people suffered from nutritious food. The problem is pronounced on children.

Figure 12: Local food preparation and children affected by malnutrition (left to right)

Households were asked about the coping mechanisms used during food shortage and similar question was asked for FGD and key informants. The responses of household survey, FGD and key informants are as follows on Table 15.

Table 15: Food insecurity coping mechanisms (N=60, multiple response)

Coping mechanisms		frequency	percent
Gathering	yes	52	86.7
	no	8	13.3
Hunting	yes	34	56.7
	no	26	43.3
Borrowing	yes	37	61.7
	no	23	38.3
Selling of asset	yes	54	90.0
	no	6	10.0
Migration	yes	16	26.7
	no	34	56.7
Reduced number of meals	yes	56	93.3
	no	4	6.7
Gold Panning	Yes	15	25
	no	45	75
Sharing of food	yes	49	81.7
	no	11	18.3

Source: field survey, 2012

Wild food gathering (fruit, leaves and tuber):- During food shortage most people went to forest area and gathered edible fruit, leaves and tuber. 86.7% of the surveyed household used gathering of wild plant produce as a coping strategy during food shortage. FGD and key informants realized that when individual households finished food crops, the family members

went to the forest area and stayed some days to gather edible plant parts. After collection of some quantity, the families were come back to their home and used the gathered food for certain period of time. Some of the plant species whereby edible leaves were collected from: '*beda', 'enguda', 'elangaya', 'edenqua', 'era', ' echeri', 'letdewa', 'kudra'* and shoots of bamboo where as the fruits were: '*fequa', 'sewa', 'hengua', 'hiya', 'ewa', 'halela', 'tenga', 'bedengoga', 'degua'* and '*doma'*; and the tuber from: '*echa', 'mejuma', 'awna'*, etc.

Besides a coping mechanism, feeding of wild fruits, leaves and tuber can diversify the nutrition of the households as almost all households consume a staple food of sorghum porridge. In addition to their own consumption, few people engaged on collection and selling of wild food.

Hunting*:-* As a coping mechanism during food shortage and to satisfy the family meet demand, male people from the household were responsible to hunt wild animals and take the flesh to their family. Children and women also engaged in small animal hunting like bird species and others. From the interviewed people 56.7% practiced hunting. The common animals hunted by the people are: from mammals: '*dekula', 'agazen'*, porcupine, pig, 'kerkero', etc, and from birds: *'yerkunda', 'epara', 'dandergewot', 'sega', 'meha',* etc. There are also several wild animals that are eaten by local people.

Sharing of food with others*:-* Culturally Guba people shared the available cooked food at home with others. They prepare food in one's house with round turn base and ate together. For instance, if today food is prepared in one individual home, all the neighboring people invited and come together and eat the food and for the following day the other neighboring people as a turn prepared and invite all those people to eat together. At times when a household finished his sorghum crop, he would share cooked food from the other who had.

Borrowing money*:* - One of the constraints of development is poor financial services that render the society by accessing money to procure needy agricultural inputs and other goods and services. During hardships, 61.7% of the interviewed people used borrowing money from money lenders with high interest rate to purchase food crops. FGD and key informants stated that some farmers borrowed money from money lender by granting productive assets and others by granting future agricultural produce with least price. For instance in 2011, they sold future produce sesame crop by $ 0.56/kg (10 Birr) even if the current and expected future price at that time doubled. Others to bonded labor (creditor and their family worked continually for a certain period as a daily laborer for debtor on farming season) by leaved their own farms.

Selling of asset*:-* When the society faced short term shocks/problems they depleted productive assets by selling them to mitigate short term challenges. Poor infrastructures including absence of market and financial services exacerbated the problem.

90% of the interviewed people sold productive assets to purchased food crops. FGD and key informants stressed that due to lack of open air market some people exchanged goats with food grains from merchant with minimum price fixed by merchant to save life during short term food limitation.

Migration*:* - Seasonal migration was one of an alternative of coping mechanisms. 26.7% of the HHs migrated to neighboring country, Sudan, and employed as a daily laborer with better wage rate than Guba. The families got remittance from the migrant until he comeback to their home land.

Reducing number of meals*:-*. FGDs stated that the common practice of number of meals per day is twice and reduced when food shortage happens. Households asked the number of meals

taken during food shortage and 93.3% of them reduced the number of meals to one until they got other means of food source.

Gold Panning:- In the district there are few places where gold is found. 25 % of the surveyed households practiced traditional gold panning as a source of income to purchase food crops and other basic needs.

Others:- the other coping mechanisms during food shortage include daily labor, charcoaling, firewood selling, water fetching for the better people etc. to earn money to buy food crops.

4.7. Barriers to Climate Change Aadaptation in Guba

As shown in the above sections, a large number of local people consider that climate has become hotter and drier. All the respondents and most of the FGDs participants, experts and interviewed informants perceived changes in temperature and precipitation. Despite the higher level of perception, only 74 % of the respondents for changes in rainfall patterns and temperature changes took remedial actions. Even, 72 % of those who practiced adaptation confirmed that the adaptation options they employed were not successful due to various perceived limitations.

This survey assessed local peoples' perceived barriers to use various adaptation options. Survey results obtained from household respondents, FGDs, experts and key informants on barriers to taking up adaptation options indicated that poverty, water scarcity, market problem, lack of information about the weather or long-term climate change, lack of agricultural technologies and inputs, limitation of health service and microfinance, poor agricultural extension service, and limitation of experts were major constraints of adaptation for many peoples in the study area.

A study conducted by Bewket (2010) in Choke Mountain, East Gojjam, identified lack of access to water, market, information, and knowledge about the appropriate adaptations as barriers to adaptation. In a study made by Bryan, et al. (2010), it was reported that lack information represented barriers to adaptation climate change in Ethiopia. These studies support the findings of such study. The constraints of adaptation are discussed as follows:

Poverty: - Adaptation comes at a cost. Hence, poor households have low adaptive capacity. The local people in the area indicated poverty as a major constraint for not taking up the following adaptation options: changing crop pattern, diversify crop cultivated, digging water wells and rainwater harvesting, planting different fruit trees, transforming from hand hoe to animal traction, and adopting non-farm activities.

Water Scarcity*:* - Water scarcity was mentioned as one of the most critical constraints to climatic change adaptation. Irrigation, digging water wells, rainwater harvesting and planting trees for shade were potential adaptation measures to reduce climate related impacts especially rainfall variability. Although the peasants are aware on the importance of application of small-scale irrigation, digging wells, etc., most farmers could not employ them because of scarcity of water in the area. Most farmers traveled long distance in hot temperature to search water for livestock and household consumption.

Lack of Access to market*:* - All respondents indicated that market as a problem. Poor access to market facilities made difficult to undertake adaptation options including to change cropping pattern, crop diversity and reducing the number of livestock. According to local peoples, access to and information about different crop varieties that can better tolerate rainfall scarcity and variability, and drought came to them only through one formal channel through government.

However, most crop seeds came from informally from the neighboring country, Sudan, by the intimate and blood relationship of Guba people with Sudan people. Usually, such materials are scarce and not available in the district. Respondents also reported that lack of buyers (local market demand) for crops that were new to the local communities in the area but found to be more productive and can better adapt to changing climate is a problem. For instance, soybean was introduced in the district in 2011 and have good yield but there is no market at all. Farmers face similar problems of poor demand- to reduce number of livestock during period of forage or feed and water scarcity, famine, or drought due to market inaccessibility.

The worst problem, probably the only and peculiar to the region, is that no open air market in Guba district. Most goods are exchanged as a barter system kind by kind. This made poor negotiation power of the farmer and price has been fixed by the merchant that discouraged farmers on agricultural production.

Lack of meteorological and current information*:* - Lack of information was one of the most important barriers to adapt climate change in the study area. The respondents and agricultural experts found in the area declared that lack of access to timely meteorological reports (information) was one most pressing constraint for making adjustment to erratic or reduced rainfall to adjust planting dates. Weather forecasts related with onset and/or offset of rains have never been communicated.

Due to low elevation and far distant, there was poor coverage of national radio network, farmers and experts unable to listen the current affairs from national radio program. In addition, most farmers have no radio and have language barrier to listen national radio program.

Lack of agricultural technologies and inputs*:* - Large number of respondents considered lack of appropriate agricultural technologies and inputs as a barrier that constraint to change cropping pattern by introducing new and high value crops, diversify crops in their farms, improve farm productivity, putting trees for shade, and changing use of chemicals and fertilizers.

Poor health services*:* - A considerable proportion of the respondents and FGDs participants indicated that lack of animal health care centers and poor service in the area as one major constraint to adjust and improve livestock management. Due to frequent droughts and limitation of animal health service, livestock exposed to killer animal diseases.

Limitation of microfinance*:* - Microfinance play a great role in provision of financial services to procure agricultural inputs and other goods and services vital for agricultural production and other income generation schemes. FGD and key informants realized that there was limitation of microfinance institution. Only one micro-finance, BG MFI, was found in the district, at the capital town of Guba, and poorly accessed to the rural areas. Furthermore, the institution is poor in capacity to provide service to the rural people. In addition, there was no bank in the district. Therefore, limitation of financial institution contributes for the barrier of climate change adaptation.

Poor agricultural extension service*:* - Agricultural extension service is the corner stone for the growth of agricultural sector by accessing knowledge and improved agricultural technologies. Key informants, FGD and household survey found that the agriculture extension service was too poor as compared from other districts of the zone. Up to 2012 there were only two FTCs (11.8% coverage) in two *'kebele'*s of the district and the rest 89.2% of *'kebele'*s had no FTCs. Unavailability of FTC per *'kebele'* limited the extension service. Limitations of development

agents (DAs) at *'kebele'* level promulgated the limitation of extension service for mal-adaptation of climate change and variability.

Limitation of experts/ human resources*:* - Due to the remoteness of the district, most professionals were not interested to work in Guba. Key informants pointed out that there was high professional turnover in the district that leads to the instability and poor service of agricultural extension system. Even the existing experts are low in education status. More than 90 % of district agricultural office experts were diploma holders.

Low awareness of the community*:*- The level of community awareness towards development determines the extent of using improved agricultural technologies to boost agricultural production and productivity. FGD and key informants emphasized the district was marginalized and was not given due attention by past successive governments (BSG BoARD, 2005). FGD and key informants realized that the local people are low awareness on development. Mass of the community denied from formal and informal education and illiterate that account for the impediment of climate change adaptation.

Limitation of infrastructures*:* - There are few institutions that render social service to the community. Despite few in number, they were not properly functioned due to limitation of working equipments. There were only three veterinary health posts and one primary farmers' cooperative in the district (GDADO, 2012). In addition, the district is denied with electric power.

Scattered settlement*:* - The scattered settlement of the people made poor communication among the villagers. Most villages are poor social net work due to isolation by far distant among each other and the barrier of topography and dense forest coverage. The scattered settlement made

unreached for development extension service. Key informants realized that there are untouchable communities by government due to the scattered settlement nature of the people.

HTP and other social attitudes*:* - The farmers are attributed with clutches of HTPs and other cultural practices that prevent from development. The marginalization of the district developed strong social taboos that limit self development. They were just living for a while and not visionary for the future.

Other barriers*:* - The survey results showed that limitation of appropriate institutions that can assist and facilitate desired changes, high dependency on wild food gathering and hunting, rain feed agriculture and food scarcity were some of other barriers reported by the respondents and local community members.

CHAPTER 5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The survey result reveals that most of the local people perceived long-term change in pattern of rainfall amount and distribution and an increasing trend of temperature. Communities of Guba have been facing climate variability and change impacts but today the impacts have become more serious as there has been more climate variability and change-induced disasters as compared to the situation in the past. Generally, the people in Guba are facing declining trend of crop and animal productivity because of erratic rainfall, drought, and increased temperature, intensified occurrence of pest and diseases, and environmental degradation.

Although drought is a common phenomenon in the study area, it has become more frequent and intense in recent years. The drought reoccurrence interval has become shorter and prevails almost one to three years. Climate change resulted in an increase in the frequency of occurrence of pests and diseases in recent years. The disasters have caused increased vulnerability to poverty, food insecurity and loss of productive assets. For instance, production of crops and the number of livestock owned by households decreased considerably over the past two decades. Therefore, local people suffered on climate change induced food insecurity.

Women and children are most affected by the impacts of climate variability and change-induced hazards in the study area. Mainly female children and women carry out the routine household activities. The hazards created additional burden and make them more vulnerable to the impacts.

For many years, the local people of the study area have struggled against the impacts of different types of natural hazards. In order to adapt the impact of climate change hazards the households

and local communities have applied different adaptation strategies. However, increased frequency and intensity of climate change impacts have reduced the capacity of local people to adaptation and cope with the problems. The ever-increasing climate variability and change have challenged the coping and adaptation strategies and the people in the area confronted with a situation they are not equipped to handle the new situation. Some of the coping and adaptation strategies such as selling assets, charcoal making and fuel-wood selling are not only unsuitable but would also cause depletion of assets, resource degradation and even desertification. Hence, institutional support was vital to reduce impacts of the hazards. The NGOs operating in the study area has provided some assistance to communities in terms of asset protection and livelihood diversification. Though the contribution is encouraging, most of the efforts suffer from lack of continuity and community participation. The government has also played significant role in introducing adaptation strategies to climate variability and change impacts. However, government responses have been limited.

Without strong coordination and cooperation of all actors and stakeholders, neither the local people responses nor NGOs and government intervention will sufficiently address the complex impacts of climate variability and change. In this regard, all governmental and nongovernmental institutions have fundamental role to play in developing appropriate adaptation strategies to climate variability and change impacts. In the light of the main findings and conclusions noted above, the writer forwarded the following recommendations.

5.2 Recommendations

- **Empowering local people with information and education:** Creating and expanding awareness among the population and policy makers about climate change , its causes and consequences by providing reliable and up to-to-date information to take appropriate adaptive measures.

- **Build on existing local (indigenous) knowledge and practices:** Reviving traditional practices and improving indigenous knowledge on how to harvest rainwater, forest management, crop and livelihood diversification, provide ways of coping with different climatic variability. Interventions need to build on existing knowledge and coping strategies in order to insure sustainability of their activities. Therefore, before planning interventions, a proper assessment of locally available adaptations options and coping strategies should be considered and build upon indigenous knowledge.

- **Improve Agricultural Production:** The people in Guba are facing declining trend of crop productivity because of erratic rainfall, drought, intensified occurrence of pest and diseases, environmental degradation and increased temperature. With the ever-increasing climate variability, the problem shall continue in the future unless appropriate measures are taken. Hence, crop diversification, selecting appropriate variety of crops [i.e., drought and diseases resistant, early maturing and high yielding], improving the method of cultivation and agricultural technologies and promote traditional pest management are areas of critical concern. It is important to shift from hand hoe cultivation to animal traction to produce more crop.

- **Protect assets and diversify income sources:** The recurring droughts and associated food shortages in the project areas forced the community to use destructive coping strategies like selling basic assets and borrowing money with high interest rate from money lender. This has consequently eroded the household's resilience, which increased vulnerability to further shocks. Diversification of household income sources is also necessary to minimize exposure to climate variability and change shocks. For this to be materialized in the study area, farmers should be encouraged to take part in off-farm activities such as petty-trading, improving traditional gold mining, promoting handcraft and link with market are important. Improving road transport, market and storage & distribution infrastructure, extension services, training and credit facilities are also some areas of major concern that largely require the attention of government.

- **Forest protection:** It is real fact that part of the remnant of Ethiopia's forest is found in Guba. It is rich in biodiversity. However, this resource is dwindled at alarming rate due to deforestation particularly forest fire. Therefore, it is important to protect forest by implementing appropriate forest protection measures. There is a need of forest protection intervention to reduce terrible deforestation and improve carbon sequestration to reduce climate change.

- **Foster institutional linkages for livelihood sustainability:** Concerted actions by the national and regional governments and NGOs are needed to tackle the impacts of climate change. The ever-increasing climate variability and change impacts would require institutional involvement and integrated effort to enable rural livelihoods survive in the changing climate and its adverse impacts. In addition, mainstream adaptation and resilience to climate change in the development process.

- **Infrastructure development:** Infrastructure development is the corner stone of society development. There is no open air market in Guba district. Farmers are used as bartering to exchange commodities. Therefore, it is important to establish open air market where by farmers can exchange agricultural produce and other goods with fair price. Market access can encourage farmers to produce surplus crops in accordance with market demand and increase the power of price negotiation. In addition farmers can get the needed commodity in the local area and able to share ideas and experiences. Likewise, there is a need of establishing rural microfinance for financial service to promote agricultural production. Other infrastructure facilities such as electric power, road, FTC and telecommunication are also important to have sustainable development.

- **Human resource development:** Sustainable development can be realized if human resources are developed since attitude is the main block of development. In Guba the local people is attributed with HTPs and other cultural beliefs including to stop and bring rain fall. Therefore, the government and other development actors needs to give due attention to human (social) development intervention of attitudinal change to realize true development in the district.

- **Improve the coverage and quality of climate data:** Meteorological stations in Ethiopia are few in number; hence density of networks of stations is very sparse. Data for most of the stations is very scant and incomplete. There is one established (1984) meteorological station in Guba district. Hence, there is no reliable detailed information on aspects of climate of the area. Climate data is necessary to enhance the understanding, analysis and prediction of climate change and its impacts and for improved preparedness and

adaptation. It is therefore necessary to improve the coverage and quality of climate data in the study area in particular and in the country at large.

In the future, similar studies should be conducted which adequately address the issue of vulnerability to climate change, adaptation and the relative merit of each adaptation option to better guide policy options for adaptation to climate change and to develop a locality specific adaptation menu, which is able to account for impacts of climate change and variability.

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