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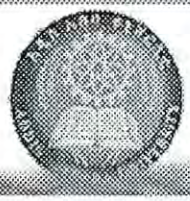

Local community understanding and response to climate change: The Case of Adea Wereda East Shewa Zone Oromia Region, Ethiopia.

Deresu Alagaw

Present in partial fulfillment of the requirements for the degree of Master of Arts (Center for Environment, Water & Development).

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ABSTRACT

Local Community Understanding and Response to Climate Change. The Case of *Adea Woreda. Oromia National Regional States, Ethiopia.*

Deresu Alagaw

Addis Ababa University, 2012

Climate change is expected to have serious environmental, economic, and social impacts in Ethiopia. In particular, rural farmers, whose livelihoods depend on the use of natural resources, are likely to bear the burden of adverse impacts. The extent to which these impacts are felt depends in large extent on the adaptation in response to climate change.

This study was carried out in Adea Wereda to assess the community perception about and response to the climate change. Farmers, kebele officials, Development Agents and other respective experts were used as sources of data. From the farmers in the study area 130 household heads were selected using systematic random sampling. FGDs, questionnaire, key informant interview and document analysis were the primary tools used to collect data. Data analysis was done mainly by descriptive statistics (percentage and frequency) with the help of software known as Statistical Package for Social Science (SPSS version 15.00). The finding of the study came up with the communities understanding as there was climate change though disparity among sex was observed on the level of understanding. Moreover, climate change was not perceived as the second major environmental problem next to deforestation. Finally, the possible recommendation were provided in relation to the local community understanding and observed gaps.

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Table of Content **Pages**

List of figures .....Page

List of Maps Page

List of tables Page

Acronyms

ADF VII	African Development ForumVII
CEEPA	*Center for environmental economics and policy in Africa*
DEFRA	*Department for environmental food and rural affairs*
EPA	*Environmental Protection Authority*
FAO	*Food and Agricultural Organization of the United Nation*
GDP	*Gross Domestic Product*
GHGs	*Greenhouse gases*
GTP	*Growth and Transformation Plan*
IPCC	*Intergovernmental Panel on Climate Change*
ISDR	*International strategy for disaster Reduction*
ICSU	*International Council of Scientific Unions*
INC/FC	*Intergovernmental Negotiating Committee for a Framework Convention*
LIFDC	*Low Income Food-deficit Countries*
MoFED	*Ministry of Finance and Economic Development*
MoWR	*Ministry of Water Resources*
MDG	*Millennium Development Goal*
NAPA	*National Adaptation Programmed Activity*
NMSA	*National Meteorological Service Agency of Ethiopia*
NAS	*National Academy of Sciences "Climate Change Science*
NASA	*National Aeronautics and Space Administration*
SPSS	*Statistical Package for Social Science*
UNDP	*United Nations development programmed*
UNFCCC	*United Nations Framework Convention on Climate Change*
UNEP	*United Nations Environment Program*
WFP	*World Food Program*
WCP	*World Climate programmed*
WMO	*World Metrological Organization*
WRI	*World Resources Institute*

CHAPTER ONE

INTRODUCTION

1.1. Background

Global warming is now becoming the main issue of concern of policy makers in respect of political, social and economic policies and decision makers due to the fact that our climate is unusually changing in a manner that seriously affects the welfare of people of the world, particularly those of developing countries. No region would be left untouched by changes of this magnitude, though developing countries are being affected adversely. The extreme poverty of many Africans resulting from frequent natural disasters such as droughts and floods, and agricultural systems heavily dependent on rainfall (IPCC, 2001), makes Africa the most vulnerable region to climate change.

In developing countries, like Ethiopia where the history and records of climatic data is low, the awareness of people about the atmosphere is also low. Ethiopia faces various socio –economic problem resulting from climatic variability and change. The crop fails, shortage of rain fall, the urban are hotter and hotter. Rivers and springs are drying up, malaria being spreads to new area. Significant climate change vulnerability is observed over Ethiopia in the past 50 years which includes frequency of drought, urban heat island, and flood vibrant climate change based diseases and shift of ecosystems. Various researches currently also concluded that there is a significant raise of temperature over the country and projections also predicted more changes in the future based on different climate models (NAPA, 2007).

There is an important distinction between climate change and variability i.e. time scale. Climate change is a long term while variability is generally more short term (Cracknell, 2001). Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

There are considerable gaps in the current status of the knowledge of Climate Changes, which include: lack of previously done works on climate change and attributions in the research interest area for comparison and references, few numbers of professionals on this research area, lack of understanding in the current status of the climate change in the research area, failure of getting well defined projected future changes in mean seasonal rainfall in Ethiopia, nonexistent models for analyzing impacts and policy options even though progress is being made to design environmental information systems, failure to achieve effective information systems and monitoring, lack of integration of many disciplines and methods of analysis for climate change. Among the aforementioned gaps and lack of levels of understanding, some are tried to be addressed by the findings of the research outputs (Aschalew Asefa, 2007).

In the theoretical debates over the role of perception in human behavior and its effect on decision making, it has been generally noted that if a community or government perceives a problem to be a very serious threat, then it is likely to initiate appropriate intervention measure (Shisanya and Khayessi, 2007). The importance of perception assessment is also noted in suggestion made by IPCC (2001) on research priorities. While different studies are not negating the need for good quantitative research, they are, nonetheless, arguing the qualitative research focused on the perception of the problem should be a necessary complement to existing quantitative research on the issue. A

meaningful assessment of the perception of the problem of climate change must be founded in an understanding of the likely level of priority and response that may be given to it by individual's communities and government (Bord et al, 1998).

Thus, climate change is an issue that demands a role for scientific expertise along with diverse perspectives from other areas of society local community understanding. Climate change does not seem to have advanced in recent years and hence there is little awareness of the contribution of everyday individual actions to the problem, and a tendency to place for mitigating climate change with international organizations rather than at the level of the individual. Therefore, this thesis investigates the local community understanding of and response to climate change.

1.2. Statement of the Problem

Lack of current knowledge of the extent and magnitude to which the climate of Ethiopia has been changed while the globe is warmed and is becoming continuously warming due to natural factors leads the researcher to address some of the gaps that are mentioned. Thus, the change in climate in Ethiopia remains to be the main problems of the research interest area. In recent year environment has become a key issue in Ethiopia. The main environmental problem in the country include land degradation, soil erosion, deforestation, loss of biodiversity, desertification, recurrent drought, flood and water and Air pollution (NAPA,2007).

Climate related hazards in Ethiopia include drought, floods, heavy rains, strong winds, frost, heat waves (high temperatures), lightning, etc. Though the historical social and economic impacts of all of these hazards are not systematically well documented, the

impacts of the most important ones; namely, droughts and floods are discussed. Understanding how social systems respond to climate change and variability requires knowledge of how they are affected by those conditions today and how they might respond in the future if those conditions change. Historical analogs give us some insight into climate changes and corresponding social responses. The major adverse impacts of climate variability in Ethiopia include: Food insecurity arising from occurrences of droughts and floods, Outbreak of diseases such as malaria, water borne diseases (such as cholera, dysentery) associated with floods and respiratory diseases associated with droughts, Land degradation due to heavy rainfall, Damage to communication, road and other infrastructure by floods, etc (NAPA, 2007).

Ethiopia farmers are already being affected from erratic rainfall patterns, the distribution of which is becoming increasingly unpredictable. Some reports suggest that both intensity and distribution of Rainfall has significantly changed in the last couple of years. This is attributed to the resultant effect of the change in the climate system among other factors; the country has been impacted with consistent crop failures and drought. According to NAPA (2007) current and future impacts of climate change in Ethiopia include Increasing climate variability and changing rainfall pattern will threat the livelihood of local community, increasing temperature will reduce agricultural production and lifestyle of many Ethiopians, biodiversity and associated cultures will be substantially reduced, drying wet lands and lakes and declining water resources will threaten water availability for millions of people, and disease such as malaria will spread further and threaten the lives of millions in the high lands etc.

Perception about climate change impacts and the necessary response mechanism to cope with climate calamities are important for any population in a given community. Level of awareness determines the scope of implementation that needs to be taken to mitigate the problem. Lower perception will make local intervention mechanisms to be very slow and untargeted.

Climate change is present everywhere in the world, In Adea wereda also present climate change. There was an increasing change temperature, intensity and duration of precipitation, and some climatic impacts, because of climatic change there was an impact and local communities were not aware .that is why select Adea wereda to the study Area.

This study attempted to assess the understanding of local community towards climate change, its causes and adaptation measure, indigenous climate change adaptation, and asses the relative importance of climate change issues as compared to other environmental problems, whether it is *Adea Wereda* Administration.

1.3. Research Objective

The general objective of the study was to assess the perception and response of local community to the climate change.

The specific objectives of the study:

1. To assess the understanding of local community about climate change, its causes and adaptation measures.
2. To assess the relative importance of climate change issues as compared to other environmental problems.

3. To assess indigenous climate change adaptation strategies in the study area.

1.4. Research question

1. Do the local communities in *Adea Wereda* perceive that the weather and the climate have changed?
2. To what extent is climate change perceived as a personal risk, priority environmental concern?
3. What are the main indigenous climate change adaptation strategies in the study area?

1.5. Significance of the Study

The outputs of the study were an input for governmental and non-governmental organizations working in climate change studies and environmental rehabilitation program in relation with climatic parameters and manmade factors. Perception of local communities toward climate change in Ethiopia has not been systematically studied and documented so far. However , the impacts of climate change in the country seems to be on the increase and associated with land degradation, soil erosion, deforestation, loss of biodiversity, desertification. Recurrent drought, flooding, water shortage, and air pollution Therefore, this assessment of local community's understanding of climate change could be used to inform and indicate policy makers to take possible intervention methods in order to raise the awareness of the community towards implementing local solution to climate change.

1.6. Scope and Limitation of the Study

This study attempted to assess local community understanding of the response to climate change in three *kebeles of Adea wereda* administration. Despite the wide ranging use of climate change perception in fields like metrology, the study only focused on the perception of house hold with due emphasis on the major factors such as temperature change, precipitation change, cause of climate change, indigenous climate change adaptation strategies etc, moreover, the analysis of the nature of temperature and rain fall variability using different models beyond the scope of the study. As a result, the study relied mainly on the perception of local people towards weather change and hence climate change in the study area.

In general, the limitation of the study is the delimitation of the study area to a single *wereda.* The main constraint in doing this proposal is time. It is very difficult and time consuming to collect all necessary reviews data within the limited period of time and work pressure.

CHAPTER TWO

REVIEW OF LITERATURE

2.1. Definition and Concepts

Climate Change: United Nation Framework Convention on Climate Change (UNFCCC) has defined climate change as a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods. Intergovernmental Panel for Climate Change (IPCC) has been used, which defines climate change as a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity.

Perception: 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. It is interesting to see that people infer about a certain situation or phenomenon differently using the same or different sets of information. Knowledge, interest, culture and many other social processes that shape the behavior of an actor who uses the information and tries to influence that particular situation or phenomenon (RECOFTC 2001, Cited by Banjade, 2003).Saarinen (1976) talks about perception as an extremely complex concept and confines social perception' which is concerned with the effects of social and cultural factors on cognitive structuring of our physical and structural environment. This varies with the individual's past experiences and present sets

or attitudes acting through values, needs, memories, moods, social circumstances, and expectations (Saarinen, 1976, Cited by Banjade, 2003).

Impacts: The effects of climate change on natural and human systems (IPCC, 2007). Depending on the consideration of adaptation, one can distinguish between potential impacts and residual impacts: *Potential impacts*: all impacts that may occur given a projected change in climate, without considering adaptation, Residual *impacts*: the impacts of climate change that would occur after adaptation.

Adaptation: Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects (IPCC, 2007). Various types of adaptation exist, e.g. anticipatory and reactive, private and public, and autonomous and planned. Adaptation is the adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which moderated harm or exploits beneficial opportunities (UNFCCC, 2009, cited by Sagun, 2009).

Adaptive capacities: Is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPCC, 2007). There are individuals and groups within all societies that have insufficient capacity to adapt to climate change. The capacity to adapt is dynamic and influenced by economic and natural resources, social networks, entitlements, institutions and governance, human resources, and technology (IPCC, 2007).

2.2. Global Trends of Climate Change

It is now well established that emissions due to anthropogenic sources during the last century have resulted in the excessive emission of greenhouse gases. This has raised the temperature of the earth's atmosphere at a much faster rate than in previous centuries, resulting in global warming, i.e., the warming of the earth's atmosphere. During the last 150 years, the global average surface temperature has increased by 0.76°C. The temperature increased by 1.22°C between 1955 and 2005. The warmest decade was 1990 to 2000, while 1998 was the hottest year. Over the next century, the global average surface temperature may increase by 1.4– 5.8°C.These seemingly small changes in temperature can disrupt weather systems, resulting in shifts in weather pattern, such as changes in rainfall pattern and in the frequency and incidence of extreme weather events—floods, cyclones, droughts, and storm*(IPPC, 2007)*.

Temperatures will increase by 0.2°C per decade for the next two decades. Increased precipitation is likely at high latitudes, while decreases are likely in most subtropical regions (such as Pakistan). Heat waves and heavy rainfall will become more frequent. There will be a decrease in snow cover. Due to past CO_2 emissions and future emissions, global temperatures will continue to warm the lower layers of the oceans, causing the sea level to rise even if emissions are controlled. Summer precipitation is likely to decrease in South Asia, as well as during December to February. There will be an increase in the inter-annual variability of daily precipitation in the Asian summer monsoon. An increase of 10–20% in tropical cyclone intensity is likely for a rise in sea surface temperature of 2–4°C relative to the current threshold temperature. Storm surge heights could increase as a result of stronger winds and increases in sea surface temperatures and low pressure.

These changes in climatic conditions vary from region to region. In our region, this has already been seen as the increased incidence of torrential rain, snowstorms, floods, droughts, and cyclones. As a result of these changes in climate, local economies have been seriously affected; communities that depend heavily on their natural resource base and have no alternative sources of income are affected most. This has a long-term impact on human life and wellbeing *(IPPC, 2007)*.

2.3. Cause of Climate Change

Greenhouse Gases: The presence of greenhouse gases in the atmosphere is a natural component of the climate system and helps to maintain the Earth as a habitable planet. Greenhouse gases are relatively transparent to incoming solar radiation, allowing the sun's energy to pass through the atmosphere to the surface of the Earth. The energy is then absorbed by the Earth's surface, used in processes like photosynthesis, or emitted back to space as infrared radiation. Some of the emitted radiation passes through the atmosphere and travels back to space, but some is absorbed by greenhouse gas molecules and then re-emitted in all directions. The effect of this is to warm the Earth's surface and the lower atmosphere. Water vapor (H_2O) and carbon dioxide (CO_2) are the two largest contributors to the greenhouse effect. Methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs) and other greenhouse gases are present only in trace amounts, but can still have a powerful warming effect due to their heat-trapping abilities and their long residence time in the atmosphere. Without the greenhouse effect, Earth's average temperature would be -0.4°F (-18°C), rather than the present 59°F (15°C) (IPCC, & NAS, 2001).

Land-use Change: The combustion of fossil fuels is not the only anthropogenic source of carbon dioxide. When ecosystems are altered and vegetation is either burned or removed, the carbon stored in them is released to the atmosphere as carbon dioxide. The principal reasons for deforestation are agriculture and urban growth, and harvesting timber for fuel, construction, and paper. Currently, up to a quarter of the carbon dioxide emissions to the atmosphere can be attributed to land-use change (IPCC & NAS, 2001).

Sulfate Aerosols and Black Carbon: Sulfate aerosols and black carbon are two important additional examples of anthropogenic forcing. Sulfate aerosols, which enter the atmosphere naturally during volcanic eruptions, are tiny airborne particles that reflect sunlight back to space. Industrial activity has recently increased their concentration in the atmosphere primarily through the burning of fossil fuels containing sulfur. Anthropogenic emissions of sulfate aerosols have been associated with a net cooling effect. Black carbon is soot generated from industrial pollution, traffic, outdoor fires, and the burning of coal and biomass fuels. Black carbon is formed by incomplete combustion especially of coal, diesel fuels, bio fuels and outdoor biomass burning (IPCC, & NAS, 2001).

2.4. Global Response to Climate Change

The First World Climate Conference recognized climate change as a serious problem in 1979. This scientific gathering explored how climate change might affect human activities. It issued a declaration calling on the world's governments to foresee and prevent potential man-made changes in climate that might be adverse to the well-being of humanity. It also endorsed plans to establish a World Climate Programmed (WCP) under

the joint responsibility of the World Meteorological Organization (WMO), the United Nations Environment Programmed (UNEP), and the International Council of Scientific Unions (ICSU) (UNEP, 2002).

A number of intergovernmental conferences focusing on climate change were held in the late 1980s and early 1990s. Together with increasing scientific evidence, these conferences helped to raise international concern about the issue. Participants included government policy-makers, scientists, and environmentalists. The meetings addressed both scientific and policy issues and called for global action.

2.4.1. The UN Framework Convention on Climate Change

2.4.1.1. Mitigating Climate Change

Mitigating climate change and its impacts lies at the heart of the Convention's objective. Stabilizing GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, which is the ultimate objective of the Convention, can be achieved in two ways. The first is by limiting or, as appropriate, reducing anthropogenic GHG emissions by sources and the second by preserving or, as appropriate, enhancing sinks and reservoirs of GHGs (UNFCCC, 2006).

2.4.1.2. General Policy Aspects of Mitigation

Article 3.3 stipulates that Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. In order to ensure global benefits at the least possible cost, such policies and measures should take into account different socio-economic contexts, be comprehensive, cover all

relevant sources, sinks and reservoirs of GHGs and adaptation and comprise all economic sectors(UNFCCC, 2006).

2.4.2. FAO's Response to Climate Change

From global impact assessments to national and local action, FAO promotes adaptation and mitigation in agriculture, fishery, forestry and other sectors as an integral part of development. FAO integrates adaptation and mitigation into agricultural and food security planning and policy advice, including institutional and technical capacity building. FAO advocates better targeting of the agricultural sectors within financing and technology transfer mechanisms, including incentives for adaptation-mitigation synergies and environmental services. In this context, FAO actively supports the UNFCCC process (MoFED, Aprile1997).

Knowledge management and sharing FAO plays an active role in raising awareness, disseminating information and providing a neutral forum for discussion. Current activities include: Forum for discussion, Communication and awareness rising, Technology transfer, Mainstreaming, and Capacity Building (MoFED, Aprile1997).

2.5. Local Community Understanding of Climate Change

Despite the scientific warnings to earlier decades, climate change did not become a significant public issue until 1998 at that time the hottest year since the middle of the nineteenth century and the year in which D.R James Hasen, director of the NASA godder institute of space studies and a leading climate modeler, testified before the U.S congress that, ''the green house effect has been detected and it is changing our climate now '' (Christianson, 1999). Hasen's testimony becomes front page news around the world.

Since 1988, numerous public opinion polls have found that Americans, Europeans, and Japanese are increasingly aware of and concerned about global climate change and supportive of a wide range of mitigation and adaptation policies. Regular assessment of local community attitudes on general environmental concern began both in the United States and other countries, in the 1970's. These surveys demonstrate increasing local community knowledge and concern towards the environment (Dunlap and Scarce, 1998). Many social analysis argue that there has been a worldwide revolution in environmental awareness to the degree that traditional ways of understanding the world have been replaced by a new environmental paradigm'' (Dunlap and Vanliere, 1978) interest in and concern for the specific issue. Of climate change (the green house effect) is a relative late comer as a survey topic. Surveys including climate change items surfaced in the early 1980's and full-blown interest emerged in the late 1985and continued.

By the same token, Maddison (2006) argued that adaptation to climate change is a two-step process, which involves perceiving that climate is changing in the first step, and a second step of responding through adaptation.

2.5.1. Belief and Knowledge about Climate Change

In 1999, globe scan. Asked respondents, "how convinced are you that human activities are significant cause of changes to the earth's climate & long term weather patterns?" They found that a large majority of respondents around the world were somewhat to totally convince. However, the United States, the dominant emitter or green house gases, was relatively less convinced with 21% of respondents saying they were either not very (14%) or not at all (7%) convinced. This is because acceptance of this fact is likely a

critical determinant of support for mitigation policies and willingness to engage in individual emission reduction.

By comparison, a number of developing countries, including argentine, Egypt, Kazakhstan, India & china were all much more likely today they were totally convinced. (Leiserowitz, 2007a: 14). The preliminary evidence from a number of agriculturalist already perceive that the climate has become hotter and the rains less predictable and shorter in duration. The data indicated that across the countries studied significant numbers of farmers believed average temperature had increased the majority of farmers also believed that rainfall levels had decreased. They also witnessed a change in the timing of the rains (Maddison, 2006).

2.5.2. Knowledge on Climate Change Cause

A 2002 national survey (Leiserowitz, 2003) asked Americans to identify the primary cause of climate change. A large plurality (47%) Said that damage to the ozone layer is the primary cause, confirming that many Americans (and other around the world) continued to confuse & conflate these two different environmental issues. By contrast, only (23%) of Americans correctly identified the burning of fossils fuels as the primary cause of climate change. Fortunately, relatively few identified nuclear power plants, toxic waste, oraerosol spray can as the (incorrect) primary cause, yet a separate question In this same study found that many Americans incorrectly believed that these also contribute to climate change (50%, 66% & 70% respectively) According to this study the understanding of the cause of climate change remains quite limited in the united state.

2.5.3. Seriousness of Climate Change Issue

Awareness of the problem is a necessary, but insufficient condition to motivate on individual or collective response. Meanwhile, social science research has demonstrated that risk perception is critical components of local community and social responses to hazards. In depth studies often assess local community perceptions of the likelihood and severity of potential consequences. Unfortunately, no in-depth study on international risk perceptions of climate change has yet been conducted. So very little is known about how the global or diverse national local communities perceive this issue (Brechin 2003; 107). There are, however limited data on the perceived seriousness of climate change. In a 2000 surveys of 34 countries, globe asked respondents, how much climate change is perceived as a serious problem. They found that majorities in each country said that climate change was a somewhat to very serious problem. It is interesting to note that many developing countries viewed this global risk as more serious than most developed countries (Leiserowitz, 2007b; 45). Global concerns about climate change, however, maybe increasing in 2006 globe scan resurveyed many of these same countries and found that the percent of respondents saying climate change was a "very serious problem " had increased significantly in many countries. This may be for a variety of reasons, ranging from increased scientific certainty, media and policy maker attention, observed impacts around the world, or the diffusion of basic awareness of the problem worldwide. However, stating that a problem is "very serious "is not the same a stating that it is an urgent or high priority, as discussed below. Based on the limited data currently available, it appears that climate change remains a relatively low priority globally, compared to other, more pressing issue /war, poverty, unemployment, etc (Leiserowitz, 2007).

2.5.4. Methods to Assess Perception and Adaptation to Climate Change

In developing countries, the common approach to studying the perception of farmers to climate change is based on comparing farm survey or farm group discussion results with data records from meteorological stations (David et al., 2007; Hageback et al., 2005; Vedwan and Rhoades, 2001). Although informative in terms of understanding the level of awareness of farmers and the possibility of validating farmers' claims of perceptions of change against meteorological data, these approaches do not explicitly identify factors influencing awareness of climate change.

We base our study on plausible methodological similarities among agricultural technology adoption, climate change adaptation methods and other related models involving decisions on whether to adopt or not a given course of action and the steps economic agents take in the process of action. Agricultural technology adoption models are based on farmers' utility or profit maximizing behaviors (Norris and Batie, 1987; Pryanishnikov and Katarina, 2003). The assumption here is that farmers adopt a new technology only when the perceived utility or profit from using this new technology is significantly greater than the traditional or old method. While utility is not directly observed, the actions of economic agents are observed through the choices they make.

2.6. The Climate of Ethiopia

Climate is often described by the statistical interpretation of precipitation and temperature data recorded over a long period of time for a given region or location. Mean annual rainfall distribution over the country is characterized by large spatial variation which ranges from about 2000 mm over some pocket areas in the Southwest to less than 250

mm over the Afar and Ogaden low lands. Rainfall during a year occurs in different seasons. Unlike most of the tropics where two seasons are common (one wet season and one dry season), three seasons are known in Ethiopia, namely Bega (dry season) which extends from October-January, Belg (short rain season) which extends from (February-May), and Kiremt (long rain season) which extends from June-September. Temperatures are also very much modified by the varied altitude of the country. In general, the country experiences mild temperatures for its tropical latitude because of topography. Mean annual temperature distribution over the country varies from about 10^0C over the highlands of northwest, central and southeast to about 35^0C over north-eastern lowlands (NAPA, 2007).

The average annual temperature (1961-1990) was 23.08'C. Ethiopia is characterized by diverse climates which translate into diverse vegetation zones. According to the Koeppen- Geiger climate classification system, Ethiopia has 10 climate types, including: the Hot Arid, Hot Semi-Arid, Tropical with distinct dry winter, Tropical Monsoon Rainy with short dry winter, Warm Temperate Rainy with dry winter and Warm Temperate Rainy without distinct dry season. Coldest temperatures - about 5°C (November to January) over the highlands of Central, North, and Southeast Warmest temperatures - about 37°C (March to May/June) in Northeast (Afar) and SE Lowlands The annual average temperature between 2070-2099 is projected to be 26.92 °C. (Cline 2007) According to the country's First National Communications to the UNFCCC, temperature across the country could rise by between 0.5 and 3.6 degrees Celsius by 2070(NAPA, 2007).

2.7. Mitigation and Adaptation to Climate Change

Though agriculture itself partly contributes to the climate change threat as source of greenhouse gas (GHG) emissions, it has much untouched potential to minimize emissions through changes in land use and agricultural practices (IPCC 2001). However, these practices need to be linked with carbon sequestration so that carbon financing support sustainable mitigation on the basis of emerging market for trading carbon emissions which encourage developing countries like Ethiopia. The current agriculture and food system are responsible for at least a quarter of global GHG emission and the resulting damages (Kotschi, 2006). However, almost half of these damages can potentially be reversed through organic agriculture and localized food and energy systems entailing major climate change adaptations and mitigation (Ho and Lim, 2008). In this regards, initiatives on conservation agriculture and organic agriculture that increasingly based on crop landraces and indigenous genetic resources in farmers' fields are underway to increase agricultural production and promote adaptation option in Ethiopia (Edwards, 2008).

2.7.1. Mitigation

Greenhouse gas (GHG) reduction opportunities in Africa are found in sustainable land and forest management, clean energy use and expansion (such as for hydropower, geothermal, solar and wind), and the creation of sustainable urban transport systems. Demand for energy and transportation is growing rapidly in many African countries. The investment that takes place in the next two decades could lock in very high emissions for the next half century or present an opportunity to move the continent on a green growth trajectory. Investment in energy efficiency can reduce demand growth, and low-carbon

technologies can further reduce the impact on climate change. **(ADF VII, 2010)** ***Innovation and market penetration***: Application of newly developed climate-friendly technologies plays a key role in reducing the energy intensity of production in developed countries. Enhanced participation from the private sector is required for the technological innovations that will support a low-carbon growth path for Africa. **(ADF VII, 2010).** ***Technology transfer and capacity enhancement*:** Technology transfer encompasses more than just physical movement of equipment. It also involves transfer of requisite skills and know-how for operation and maintenance, including knowledge, expertise and experience for generating further innovation. The private sector drives significant transfers of relevant technologies through markets, joint ventures, foreign direct investments and within policy frameworks such as the Clean Development Mechanism **(ADF VII, 2010).** ***The carbon markets*:** The carbon market has been identified as the main private sector financing source for mitigating climate change impacts. In 2009, the market grew to $144 billion, an increase of six per cent in comparison to 2008, despite the financial crises. This implies that Africa can no longer afford to lag behind in this huge market. Thus far in Africa, private investments have surpassed public funding in terms of project-based mechanisms in the carbon markets. Prospects for scaling up lie in the enhancement of capacities of local financial and banking sectors, potential investors and the private sector as a whole.

2.7.2. Mitigation and adaptation:

Adaptation and mitigation are two types of policy response to climate change, which can be complementary, substitutable or independent of each other. Irrespective of the scale of mitigation measures, adaptation measures will be required anyway, due to the inertia in

the climate system. Over the next 20 years or so, even the most aggressive climate policy can do little to avoid warming already 'loaded' into the climate system. The benefits of avoided climate change will only accrue beyond that time. Over longer time frames, beyond the next few decades, mitigation investments have a greater potential to avoid climate change damage and this potential is larger than the adaptation options that can currently be envisaged *(IPCC, 2007)*.

2.8. Climate Change Adaptation Strategies in Ethiopia

Ethiopia has made substantial efforts to incorporate climate change adaptation strategies in its national development plans. The climate change adaptation strategies adopted in Ethiopia are categorized at the household and national levels. At the household level, climate change adaptation policies include, Changing cropping and planting practices (for example, using mixed cropping to diversify risk and early planting to escape drought), Reducing consumption levels During drought, households ration the amount of food consumed by each household member, Collecting wild foods to supplement other foods, Increasing petty commodity production, Searching for employment through temporary or permanent migration, selling assets such as agricultural tools and livestock, Mortgaging land and obtaining credit from merchants and money lenders, Using early-warning systems and Appealing for food aid (NAPA Ethiopia, 2007). At the national levels, climate change adaptation policies cover air quality, agriculture, natural resources management, water resources, health, and energy. To improve air quality, Ethiopia is, Developing a federal strategy, standards, and law to improve urban air quality, Launching environmentally sound investments and other programs that foster CDM funding, including emissions trading, Implementing awareness-creation programs about the effects

of greenhouse gas emissions, climate change, and natural environment. Agriculture and Natural Resources Management, In agriculture, the strategies include, Using various water-harvesting technologies and familiarizing farmers with effective and efficient water use methods, Implementing natural resources conservation and development projects (tree planting, soil conservation, protection of water resources, and the introduction of appropriate water-harvesting techniques) ,Introducing programs/projects that promote improved farming practices, drought resistant and early-maturing crop varieties, and supply inputs that increase crop yield and productivity, Improving land management, moisture and soil conservation, and flood control methods in both the high- and lowland areas, Developing improved water use (water harvesting, small-scale irrigation) in drought- prone areas to alleviate rain shortages that cause crop failure, Promoting improved/productive animal breeds to reduce herd size and pressure on land, Introducing agro forestry systems to plant multipurpose trees that can be used to produce feed, conserve soil, and produce fruits for human consumption. Water Resources, In water resources, the strategies include, Construction of small check dams and using rainwater-harvesting schemes to meet water supply for domestic use and irrigation, Undertaking soil conservation measures that help to reduce soil erosion and siltation and also protect against the pollution of water sources, Implementing watershed management and water conservation programs, as well as projects that promote local community participation (NAPA Ethiopia, 2007).

2.8.1. Adaptation to and Perception of Climate Change

Adaptation and mitigation can both be used to reduce the negative impacts of climate change. Mitigation refers to reducing climate change by reducing the GHG emissions. Adaptation to climate change refers to the adjustment in natural or human systems in response to actual or

expected climatic stimuli or their effects to moderate harm or exploit beneficial opportunities (IPCC 2001). Even though mitigation targets uprooting the major causes of climate change and offers long-run solutions, adaptation is much more important for the group of developing countries (Fussel,2007) argues that emphasis should focus on adaptation because human activities have already affected climate, climate change continues given past trends, and the effect of emission reductions will take several decades before showing results, and adaptation can be undertaken at the local or national level as it depends less on the actions of others. Adaptation to climate change impacts in general and to the agriculture sector in particular is an existing phenomenon. The agriculture sector has the capacity to adapt provided that technologies, resources, and management changes have been undertaken relatively quickly (Mendelsohn, 2000).

Throughout human history, societies have adapted to natural climate variability by altering settlement and agricultural patterns and other facets of their economies and lifestyles. In the past human history, adaptations to climate have been remarkably successful. Scholars in the field characterized human beings as the most adaptable of animal species. Coping with climate has not always been easy or successful as the records of collapsed societies reveal and there are still limits to adaptations. This long record of adapting to impacts of weather and climate is through changes in behavior, choices of technology and infrastructure, use of market instruments and public policies. Crop diversification, weather and seasonal climate forecasting, drought and hurricane early warning systems, flood protection, weather derivatives, and establishment of coastal-setbacks are only a few examples of proactive adaptation measures. Adaptation can be reactive such as emergency response, disaster recovery, and even migration (Kurukulasuriya and Rosenthal, 2003).

2.8.2. Trees on Farms Enhance Resilience to Climate Change.

Trees on farms help adaptation to climate change by reducing vulnerability to climate impacts. The ability of agro forestry to generate more income and hence raise the adaptive capacity of smallholders.

Trees on farms can diminish the effects of weather extremes such as droughts or heavy rain. Research has found that the tree components of agro forestry systems stabilize the soil against landslides and raise infiltration rates. This limits surface flow during the rainy season and increases groundwater release during the dry season. With rainfall intensities expected to raise with climate change this feature of agro forestry systems to prevent landscape degradation will become more important in the future. At the other extreme, agro forestry has been shown to redistribute water in the soil profile, providing annual crops with greater water availability. (Neufeldt H, et al, 2009).

2.8.3. Climate Risk and Agricultural Water Management

Increasing the control of water resources is a direct method for managing the risk associated with climate change and water storage is the most common approach to increasing water control. Storage options range from bounding and on farm impoundments to retain runoff from individual storms for supplemental irrigation, to large scale dams that can retain high flows, reducing the damage from floods and also providing water during dry seasons or droughts. In general, wealthy nations have invested in large scale storage infrastructure to achieve reliable water supply for domestic use and agriculture and for protection from extreme climate events, such as floods and drought. It is apparent that the nations with the lowest per capita GDP have the greatest needs for additional storage. On average, less developed countries face greater climate variability

and the resulting accumulated economic losses hinder their ability to invest in the storage needed to mitigate the variability effects (Casey Brown and James Hansen, 2008). The degree of water control that storage provides is a function of the size of the storage, the variability of the water flows and the magnitude of water demand. Large scale storage captures runoff from a distributed spatial area over which the heterogeneity of rainfall in space and time is smoothed. As a result, it is more reliable than storage that captures runoff from smaller spatial areas. Depending on the size storage volume, large scale storage may also accommodate a second growing season, provide protection from floods and generate hydroelectricity. However, environmental and often social costs often increase with storage volume, due to submerged areas that displace people or habitat. (Casey Brown and James Hansen, 2008).

2.9. National Response to climate change

2.9.1. Environmental Policy of Ethiopia

This is a policy document adopted by the council of ministers in April 1997. One of the 10 sect oral policies adopted with in this government document focuses on "Atmospheric pollution and climate change" it states that the Ethiopian government foresees to;

a) Promote a climate monitoring program as the country is highly sensitive to climate variability.

b) Recognize that even at an insignificant level of contribution to atmospheric green house gases, a firm and visible commitment to the principle of containing climate change is essential and to take the appropriate control measure of a moral position from which to deal with the rest of the world in a struggle to bring about its

containment by those countries which produce large quantities of green house gases (EPA, 1997a)

2.9.2. Natural Resources Management and Climate Change

In adequate moisture areas in order to ensure sustainable agriculture growth, appropriate natural resources conservation practices will be done with vigor in the context of the scaling up strategy. In the next five years in all areas which require physical soil and water conservation works will be fully implemented through proactive and organized community participation. Forestry development, protection and utilization will be done with increased effectiveness by the participation of communities (MoFED).

2.9.3. Ratification of the Climate Regime

This expressed will further substantiated by the ratification of the UNFCCC and Kyoto protocol. These instruments were ratified by proclamation number 97/1994 and proclamation number 439/2005 respectively. According to the latter law, the environmental protection Authority (EPA) is the national institution vested with the task of coordinating efforts and taking the necessary action to implement the Kyoto protocol (EPA, 1997b).

2.9.4. Measure Taken by the Ethiopian Government

Ethiopia has ratified the United Nations Framework Convention on Climate Change (UNFCCC), the Biodiversity Convention, Desertification Convention, Convention and Protocols to protect the Ozone Layer, etc. Accordingly relevant governmental institutions have been entrusted to discharge responsibilities in the area of environment and

development and amongst which, the NMSA is mandated to deal with climate related affairs. Ethiopia has not yet developed specific climate change policies, programs and measures. However there are a number of environmentally oriented policies, strategies and action plans already in place that can directly or indirectly contribute to the objectives of the Climate Convention. These policies, strategies and action plans include the 1994 Environmental Policy, Conservation Strategy of Ethiopia, Population Policy, Science and Technology Policy, Energy Policy of Ethiopia, Agricultural Policy, Water Policy, Forestry Action Plan, Disaster Prevention and Preparedness and Early Warning Policy, Health Policy, Development Plan of the Addis Ababa City Council, etc. Support for the implementation of these relevant policies, strategies and action plans in the form of funding, technical assistance, training and technology transfer through the Convention mechanisms is extremely essential(UNFCCC, 2001).

2.9.5. Local Community Responses and Coping Strategies

Climate variability has always been a fundamental concern in rural Ethiopia and people have been trying to cope with and adapt to changing climatic, environmental and socio-political circumstances. Rural Ethiopians have long developed and accumulated body of knowledge, practices and symbolic representations about their environment. In the highland areas, local coping strategies include traditional practices in the areas of soil and water conservation, changes in cropping and planting practices, indigenous agro-forestry, diversification of income and livelihood sources through petty commodity production and trading, inter-household transfers and loans, mortgaging of land, and seasonal migration. In the dry lowlands, pastoral households employ a diverse portfolio of strategies to cope with climate related adversity including seasonal mobility, herd diversification and

splitting, rotational grazing, and rangeland differentiation into wet and dry grazing reserves. Opportunistic farming, livestock marketing, petty trade, seasonal migration and consumption adjustments also serve as additional socio-economic coping strategies. However, the capacity of most of the traditional household and community coping strategies are too weak or limited to help them adequately cope with the impacts of climate change. On the other hand, some coping strategies based on short-term survival considerations (such as cultivation of unsuitable areas, charcoal making and fuel-wood selling), are not only unsustainable but would also cause further degradation and weaken local resilience (NAPA, 2007).

2.9.6. The Ethiopian NAPA

As a Party to the UNFCCC, Ethiopia is obliged by several Articles of the Convention to address climate change through the preparation of a national adaptation document and the integration of climate change in its sect oral development policies. Pursuant to this, the country has prepared its first NAPA in 2007. Through the NAPA process, eleven high priority project ideas were identified to address immediate climate change adaptation needs of the country. These projects broadly focused in the areas of human and institutional capacity building, improving natural resources management, enhancing irrigation agriculture and water harvesting, strengthening drought and flood early warning systems, awareness raising, community based carbon sequestration and establishing a national research and development center for climate change. Through "stakeholder consultations" and "expert Assessments", the ecologically arid, semi-arid and dry sub-humid parts of the country were identified as the most vulnerable to drought. Sect orally, agriculture is prioritized as the most vulnerable to climate variability and

change. In terms of livelihoods, small scale rain-fed subsistence farmers and pastoralists are identified the most vulnerable (NAPA, 2007).

2.10. Environmental Problems

2.10.1. Major Environmental Issues

Environmental problems constitute one of the key challenges on the African continent in the 21st century. Focus is gradually shifting from politics, wars, and poverty to environmental issues. This is mainly the result of the development of new technologies, which has generated an increase in solid mineral mining, oil exploration, an increase in the number of plants and factories, and the overall upsurge in the application of manufacturing tools (Africa Society, 2008). The quality and richness of terrestrial, freshwater, and marine environments have been polluted and subsequently declined. It is therefore safe to say that new developments in industry and manufacturing are the root causes of environmental degradation over the past three decades. This has been exacerbated by rapid population growth, urbanization, energy consumption, overgrazing, over-cultivation of lands, and industrial advancements engendered by globalization (Africa Society, 2008).

2.10.2. Deforestation in Ethiopia

Deforestation in Ethiopia occurs when the indigenes clear forests for fuel (firewood), hunting, agriculture, housing development, and even religious purposes. Deforestation is destructive as it entails removing the forest ecosystem by cutting the trees and changing the structure of the land to suit individual usage. With the second largest population in Africa, Ethiopia has been the victim of famine due to rain shortage and a depletion of its

natural resources. Its low rainfall has been lowered even further by deforestation, which continues to worsen with population growth (Africa Society, 2008). In general, forests play a key role in preventing erosion, since the roots of trees protect the soil against washouts. Trees also retain soil water and, through the absorption of carbon monoxide, reduce global warming. Because Ethiopia lacks sufficient trees, the Blue Nile carries its soil and nutrients by water to the neighboring countries of Sudan and Egypt, where the land is very fertile.

2.10.3. Pollution of Air and Water

The emission of any impurity into the air, such as smoke (including tobacco smoke), dust, cinders, solid particles, gases, mists, fumes, odors and radioactive substances. **Water Pollution** Chemical pollution of surface water can create health risks, because such waterways are often used directly as drinking water sources or connected with shallow wells used for drinking water. In addition, waterways have important roles for washing and cleaning, for fishing and fish farming, and for recreation. Another major source of drinking water is groundwater, which often has low concentrations of pathogens because the water is filtered during its transit through underground layers of sand, clay, or rocks. However, toxic chemicals such as arsenic and fluoride can be dissolved from the soil or rock layers into groundwater. Direct contamination can also occur from badly designed hazardous waste sites or from industrial sites. In the United States in the 1980s, the government set in motion the Superfund Program, a major investigation and cleanup program to deal with such sites (U.S. Environmental Protection Agency 2000). **Air Pollution**: Air pollutants are usually classified into suspended particulate matter (PM) (dusts, fumes, mists, and smokes); gaseous pollutants (gases and

vapors); and odors. Suspended PM can be categorized according to total suspended particles: the finer fraction, PM10, which can reach the alveoli, and the most hazardous, PM2.5 (median aerodynamic diameters of less than 10.0 microns and 2.5 microns, respectively). Much of the PM2.5 consists of secondary pollutants created by the condensation of gaseous pollutants—for example, sulfur dioxide (SO2) and nitrogen dioxide (NO2). Types of suspended PM include diesel exhaust particles; coal fly ash; wood smoke; mineral dusts, such as coal, asbestos, limestone, and cement; metal dusts and fumes; acid mists (for example, sulfuric acid); and pesticide mists. Gaseous pollutants include sulfur compounds such as SO2 and sulfur trioxide; carbon monoxide; nitrogen compounds such as nitric oxide, NO2, and ammonia; organic compounds such as hydrocarbons; volatile organic compounds; polycyclic aromatic hydrocarbons and halogen derivatives such as aldehydes; and odorous substances. Volatile organic compounds are released from burning fuel (gasoline, oil, coal, wood, charcoal, natural gas, and so on); solvents; paints; glues; and other products commonly used at work or at home (McGranahan and Murray 2003; WHO 1999).

2.10.4. Land Degradation

Land degradation is the decline of the natural land resources, commonly caused by improper use of the land. It is also defined as the reduction or loss of the biological or economic productivity and complexity of land, resulting from human activities. The more degradation is allowed to advance, the more difficult and costly it gets to restore the land to its original state. If the land becomes irreversibly degraded, its potential for agricultural production is permanently lowered or even destroyed. Land degradation encompasses soil degradation and the deterioration or loss of vegetation and landscape

functions. Soil degradation has physical, chemical, and biological dimensions. The breakdown of soil structure affects the buffering, filtering, and moisture- retaining properties of soils. This breakdown may be caused by factors such as inappropriate tillage practices and excessive trampling by grazing animals. Yields will decrease, and the protective groundcover on cropland and rangeland will be reduced. On bare, unprotected soils, the processes of soil erosion remove large quantities of fertile topsoil. (Hans van Ginkel and Ramesh Thakur: 2002). In sloping areas, water-induced erosion processes dominate, while on flatter land and in drier environments wind-induced erosion can be significant. Soil removed by erosion processes is permanently lost, as are the nutrients and organic matter that are essential components of soil fertility. The increase in suspended matter in the atmosphere from wind erosion enhances greenhouse effects, thereby contributing to global warming (Hans van Ginkel and Ramesh Thakur: 2002).

The main causes and initiators of land degradation processes are inappropriate land-use practices that fail to take into account the capabilities and the limitations of the land. Depending on the dominant processes, land degradation displays different forms and effects on the land's productivity. All forms of land degradation will ultimately lead to a reduction of the soil's fertility and productivity.23 the general overall effect is reduced plant growth, leading to loss of protective soil cover and increased vulnerability of soil and vegetation to further degradation. To break this self-accelerating cause-and-effect chain, it is important to have a good understanding of the underlying causes of land-use practices leading to degradation. (Hans van Ginkel and Ramesh Thakur: 2002).

2.10.5. Soil Erosion by Water and Wind

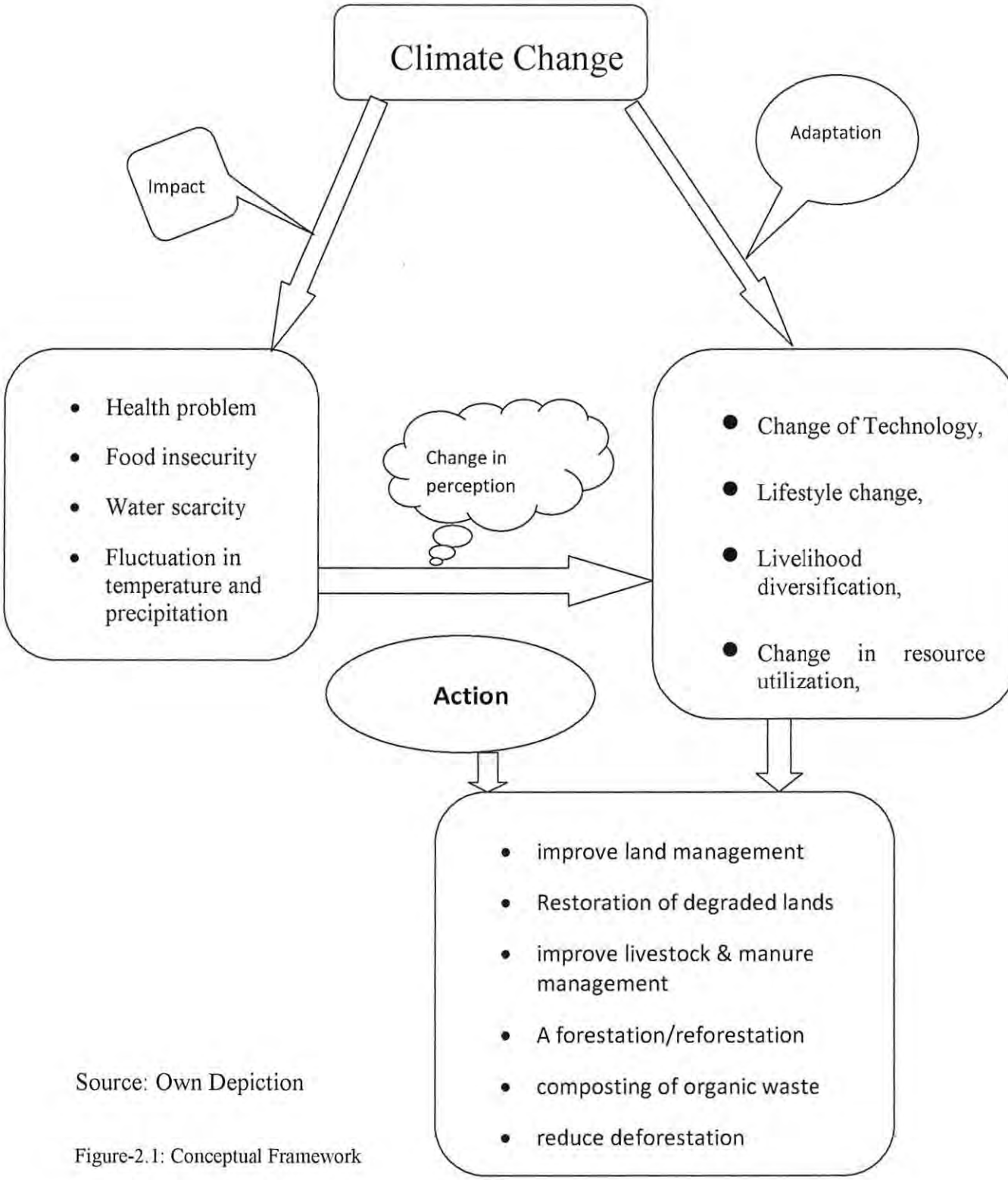
Soil erosion is one form of soil degradation along with soil compaction, low organic matter, and loss of soil structure, poor internal drainage, salinisation, and soil acidity problems. These other forms of soil degradation, serious in themselves, usually contribute to accelerated soil erosion. Soil erosion is a naturally occurring process on all land. The agents of soil erosion are water and wind, each contributing a significant amount of soil loss each year in Ontario. Soil erosion may be a slow process that continues relatively unnoticed, or it may occur at an alarming rate causing serious loss of topsoil. The loss of soil from farmland may be reflected in reduced crop production potential, lower surface water quality and damaged drainage networks. The rate and magnitude of soil erosion by water is controlled by the following factors (Rainfall Intensity and Runoff, soil Erodibility, slope gradient length, Vegetation, etc.

2.11. Conceptual framework

This analytical conceptual framework helps focus on the sequential links between climate change, impact of climate change, adaptation measure and interventions action to help manage impact of climate change.

Risks related to climate change can impact household assets, livelihoods and well-being directly and indirectly, for example Health problem, Food insecurity, Water scarcity and Fluctuation in temperature and precipitation, so a multi-dimensional approach to risk management is required. Because of this local community Change in perception then Climate risk management (or adaptation) has to be multidimensional and span interventions at household, community, national, and (increasingly) international level.

Local community change in perception by observing the climatic impact and aware to manage by different adaptation strategies like Change of Technology, Lifestyle change, Livelihood diversification, Change in resource utilization, and etc. local communities then made an action to adapt the climate change like improve land management, Restoration of degraded lands, improve livestock & manure management, Aforestation/reforestation, composting of organic waste, Reduce deforestation, and etc.



Source: Own Depiction

Figure-2.1: Conceptual Framework

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Description of the Study Area

3.1.1. Location and Access

Geographically area of *Adea woreda* found in Eastern shewa zone of Oromia National regional state & located approximately between 8^0 43' – 8^0 45' N latitudes and 38056' – 39^0 01' E longitudes. *Gimbiechu Woreda* borders in the South, *Liben Woreda* in the North, *Akaki Woreda* in the west and *Lume Wereda* borders in the East. According to the *Adea wereda* rural administration (2007), the geographic coverage of the rural *wereda* is estimated to be 91,680km^2(76,517 km^2 of arable). The rural *wereda* has structured under 27 *kebeles*. The average distance of the *kebele* administrative units from *bishoftu* town is also 15.5 km (see figure 3.1).

3.1.2. Population

According to CSA (2007), the total population of the *wereda* is 131,273 (male 68,381 and female 62,892. It comprised 20,099 agricultural households, which 99% of them engaged in agriculture. Center of the town is located 47 km south east of Addis Ababa and 52 km North West of *Adama* town. *Genda Gorba, kaliti, and kurkura denbi* of the rural *kebeles* border the town on east west and south parts respectively. It is surrounded by chain of mountains to the north and south, mount "yerer" & "zikual" which are the landmark in the vicinity, are found respectively (Adea wereda, 2010/11)

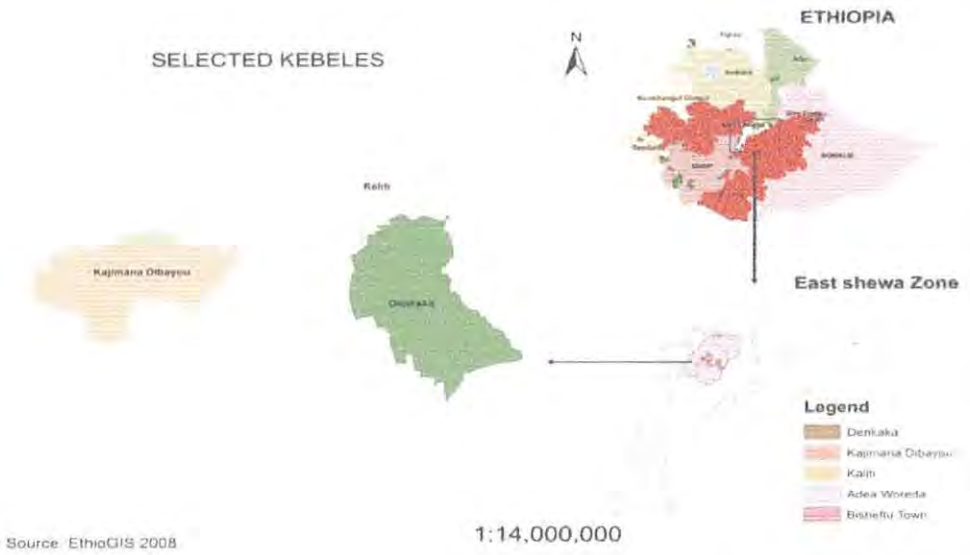


Figure: 3.1-Map of the study area

3.1.3. Climate

In a mountainous tropical country like Ethiopia, altitude is by far the most important factors in controlling the climate. Climate is a major resource, which can affect nearly all human activities. In Ethiopia the major factor which causes variation in climate is altitude. As a result of the effect of altitude, three major vertically stratified temperature zones are found in the *woreda.* However, the study area is largely found in the agro climatic zone of *Woina-Dega*, which covers 96%. *Dega and Kolla* account for 6% and 0%, respectively. According to the National Meteorological Services Agency, the altitude of the study area ranges from 1600 up to 3100 meters (2200 meters average) above sea level with mean annual temperature minimum 7.82 maximum 28.75^0c in degree and rainfall minimum 47.8 maximum 95.04 mm (NMSA, 2010). Depending up on the amount and the distribution of rainfall and temperature patter the farmers study area's economic activity is commonly depend on cereal crops such as teff, wheat, barley and maize, Beans/chickpea, and cash crops such fruits.

3.1.4. Major Economic Sectors

In the study area, agriculture is the most common and dominant economic activity. Mixed farming which both crop production and animal rearing are practiced in the *woreda*. Major cereal crops produced in the *woreda* based on their volume of production from the highest to the lowest level are 'Teff', wheat, check peas, beans, maize and sorghum. Central statistical Authority (2009) described the *wereda* among the *weredas* that have the highest wheat and 'Teff' production in east shewa zone. According to 2010/11 production year report, 626681 and 718520 quintal of wheat and teff had been harvested. Similarly, 328,952 and 42,345 quintals of check peas and bean had harvested in the woreda. Generally, 71378.5 of land was cultivated and 1,655,213 quintals of grains and vegetables had harvested in 2010/11 (*Adea wereda* rural and agricultural development office, 2010/11).

3.2. Data Source

Both primary and secondary source of data were used for this study.

3.2.1. Primary Data

The primary data were gathered through household survey, group discussion, and key informant interviews. The study was based cross-sectional data were collected using pre-tested structured questionnaire. The household survey generates quantitative data pertaining to their socio-economic and demographic characteristics; aspects of participation and perception etc.

3.2.2. Secondary Data

Different literatures that were relevant for the research were reviewed. These included books, research works, journals, Discussion papers, reports & others. In addition secondary data from NMA, CSA were used in this study. They are meant to augment the data to be collected from primary sources.

3.3. Sample Size and Sampling Methods (design)

The study primarily were focused on parts of the *Adea wereda,* there were 27 *Kebeles* in *Adea wereda* that used the agriculture for different purposes. However, the peasant association is being implemented in three selected *kebeles* by Random sampling. Finally, after selecting the three *kebeles,* a list of household members in selected *kebeles* were prepared using documents available at project in collaboration with kebeles officials particularly the development agents, Agricultural experts and used as a sampling frame to select the households for the study. Then, simple random selection of household members using systematic random selection methods. Concerning the sample size determination among different methods developed by different researchers, Finite Population Correction sample size formula was used (Daniel, 1999).

3.4. Methods of Data Collection

3.4.1. Data Collection Instrument

As to data collection instruments structured & semi structured questionnaire that contain open & closed ended questions, checklist and interview guide line were employed. The questionnaires were made to generate date on: demographic characteristics, general

environmental concern, and environmental issues that most concern them, about their perceptions of changing weather patterns, awareness & knowledge and Adaptation measure in relation to climate change.

Checklists were prepared aiming at eliciting the required information through FGD. Every effort had made to create a favorable condition in which participants could feel free and fully participate during the discussion. The discussion points were largely focused on issues about their perceptions of changing weather patterns knowledge in relation to Climate change. An interview guide was developed for the purpose of conducting the interview. The broad topics that were covered in the Interviews were, Understanding of climate change (including cause) and adaptation measure.

3.4.2. Data Collection Procedure

First, contacts were made with the concerned *Adea wereda* administration to get permission and support for the research. Then, a visit to the selected *kebeles* was made to establish a common understanding with the officials. Furthermore, during the visit, informal discussion is conducted with representatives of *kebele* briefing and building thus and confidence to that they would cooperate and provide information. Prior to understanding the actual data gathering activities the draft questionnaire were pretested taking four respondents From sample population, after completion of the pretest, the response were checked whether the respondents understand The questionnaire properly. On the basis of the feedback from the pretest, some amendments were made prior to Duplication. Finally the adjusted questionnaires were distributed among sample respondents enumerators were selected and trained on how to fill the developed

questionnaires. This has enabled enumerators to have a clear idea of what is required from households and how to efficient administer the questionnaire at the household levels and generate the required information.

3.5. Data Analysis

Regarding the analysis, the survey data was analyzed employing mainly descriptive statistics such as frequency, percentage of computation with the help of statistical software's (SPSS). Further, the results of descriptive statistics were supplemented by qualitative information generated through focus group discussion, key informants interview. The process of analysis was carried out by using qualitative description and descriptive statistics. The portion of data that was readily quantifiable (information from the closed questions of the questionnaire) was discussed using tabulation of variables with percentage values and other descriptive statistics. Readily non- quantifiable data (information from open-ended questions, key informant interviews, and focused discussions) were discussed through qualitative description.

CHAPTER FOUR

Result and Discussion

4.1.Characteristics of Sampled Households

This section gives analysis and discussion of the major findings on the demographic and socio-economic characteristics of the respondents in the study area. Different data were generated such as sex, age, religion, marital status, literacy status, family size, landholding of household, work status, income of household, etc. The demographic and socio economics of the sample households are summarized as follows.

4.1.1. Gender

Gender is one of the important variables because many social and economic conditions are a function of Gender. Gender distribution of household heads as illustrated in Table 4.1 is largely dominated by male headed, which accounts for 67.7% of the sampled households.

Table: 4.1- Distribution of respondents by gender (N=130)in the study area

Sex	Number	Percent
Male	88	67.7
Female	42	32.3
Total	130	100.0

Source:-Household survey, 2012

4.1.2. Age

The age composition of respondents indicate that out of the 130 the sample households, the overwhelming majority 73.8% are below the age of 50 (fidure 4.1). The minimum age of house hold heads was 20 and the maximum 65.

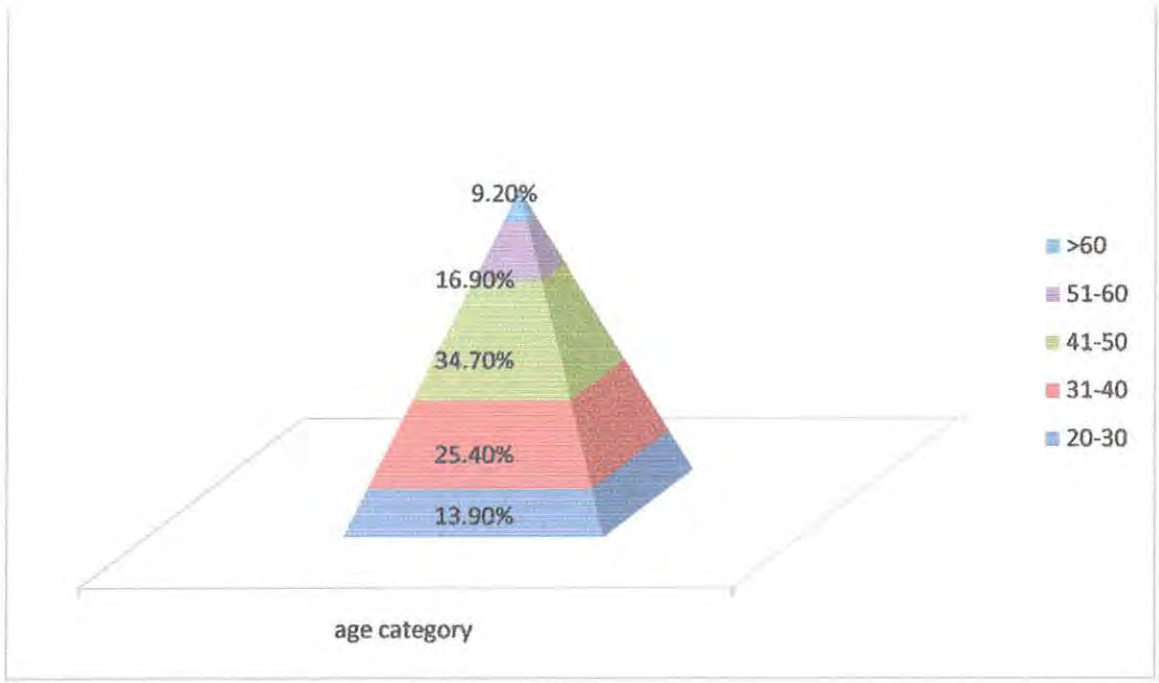


Figure 4.1. Age category of sampled respondents

4.1.3. Family composition

The family composition and family size structure refers to the composition of a study population according to age and sex. According to the field survey family composition and family size the composition of the sampled population is presented in table 4.2. Accordingly, the average number of male per family was 48.26%; the average number of female per family was 51.74% and the dependency ratio was 37.18%. Sex wise the vast majority of the family size was females which was about 313 in number and 51.74 % where as males constituted the remaining proportion (48.26%). The sex ratio of family compositions that were included in the sample was 107.2% which mean that there are more than 107 females for every 100 males.

Table 4.2. Family composition

No	Age group	Male		Female		Total	
		No.	%	No.	%	No.	%
1	0-14	66	42.86	88	57.14	154	100
2	15-64	222	50.34	219	49.66	441	100
3	≥65	4	40	6	60	10	100
Total		292	48.26	313	51.74	605	100

Source:-Household survey, 2012

4.1.4. Marital Status

Table 4.3 show the distribution of population age 20 years and over by marital status. Changes in the distribution of marital status have an important bearing on the size and structure of families and households. As it is indicated in Table 4.3, 61.5% of the respondents were currently married. Analysis of the data also indicated that 94.6 percent of the population was ever married (married, widowed, separated and divorced) while the remaining 5.4 percent were single.

Table 4.3. Percentage distribution of respondents by marital status, Adea Woreda (2012)

Marital Status	Number	Percent
Single	7	5.4
Married	80	61.5
Widowed	7	5.4
Divorced	36	27.7
Total	130	100.0

Source:-Household survey, 2012

4.1.5. Literacy Status

Literacy Status would have a great influence for the awareness of farmers regarding to climate change issues. The data presented here with was collected in such a manner to include the Literacy Status of respondents. Among the category, 24.6 percent of the respondents were illiterates; where as 75.4 percent were literate.

4.1.6. Means of livelihoods

According to the sample survey of respondents 97.7 percent farmers their means of living were based on on-farm activities whereas the remaining 2.3 percent of households were based on off farm activities.

4.1.7. Landholding and Income of sampled household.

Table 4.4 shows that 54.6 % of the farmers have more than 1.51 hectares on average whereas 11.5 percent of the household have less than 0.5 ha. The land holding of respondents is high.

Table:-4.4 Land Holding of Farmers by Size Categories

Holding Categories	Number of Farmers	Percent
<= 0.5	15	11.5
0.51 – 1.00	22	16.9
1.10 – 1.50	22	16.9
1.51 – 2.00	24	18.5
Above 2.00	47	36.2
Total	130	100.0

Source:-Household survey, 2012

The following Table 4.5 shows the percentage distribution of the sample population by household income. Accordingly, most of the respondents mean annually income had less

than 10,000 birr. As it is indicated in Table 4.9 about 70 percent of respondents had mean annually income of up to 20,000 birr and 23 percent of the respondents had 20,000–50,000. Whereas, 6.9 percent of the respondent had above 50,000 birr.

Table:-4.5 annual income of sampled

Household Income	Number	Percent
0 - 10,000	38	29.2
10,001 – 20,000	53	40.8
20,001 – 30,000	18	13.8
30,001 – 40,000	8	6.2
40,001 – 50,000	4	3.1
Above 50,000	9	6.9
Total	**130**	**100.0**

Source:-Household survey, 2012

4.2. Local Community Understanding of Climate Change

4.2.1. Respondents' Understanding of Climate Change.

Table 4.6 indicated that the respondents feeling of climate change in the study area. Accordingly, 98.5% of respondents were well aware about existence of climate change.

Table 4.6. Respondents feeling on climate change (N=130)

Feeling of household	Number	Percent
Yes	128	98.5
No	2	1.5
Total	**130**	**100.0**

Source:-Household survey, 2012

The key informants also pointed out that the pattern of temperature of Adea Wereda was changed. For example one informant explained.

"I lived here in Adea wereda for about 35 years. I can tell you that the temperature of Adea Wereda before twenty years is totally different from that of today for instance, this year we expected the month of October to be colder but it becomes hot. When we expect the month to be hot it becomes colder and when we expect the month to be hot it will be colder." (Tadese Senbeto, from Denkaka Kebele).

As a result of change in temperature the focused group discussion participant explained in the change that has occurred. As they explained the increasing trend of temperature exacerbated drying up of streams, rivers and traditional wells in the area. In consistent with this finding, the national metrological agency of Ethiopia, demonstrated that in all the parameters of temperature i.e. annual mean temperature, maximum and minimum temperature and daily temperature is above normal and observed to show a tendency to increase over time (NMA,2010). Perception of local households on temperature change was also assessed and most of the respondents' (70%) were indicated as there was the impact of temperature change in the past 10 years in the study district (Table 4.7).

Table 4.7. Perception of sample households on temperature.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	92	70.8	70.8	70.8
	No	28	21.5	21.5	92.3
	Don't know	10	7.7	7.7	100.0
	Total	130	100.0	100.0	

Source: Household Survey, 2012

Respondents were also asked their feeling of precipitation change of Adea wereda for the past ten years. Accordingly, perception of local households on precipitation was assessed and most of the respondents' (74.6%) were indicated as there was a change in precipitation in the past 10 years in the study district (Figure 4.2). This indicates most of

the local households were well aware about the precipitation of *Adea wereda* had changed for the past ten years.

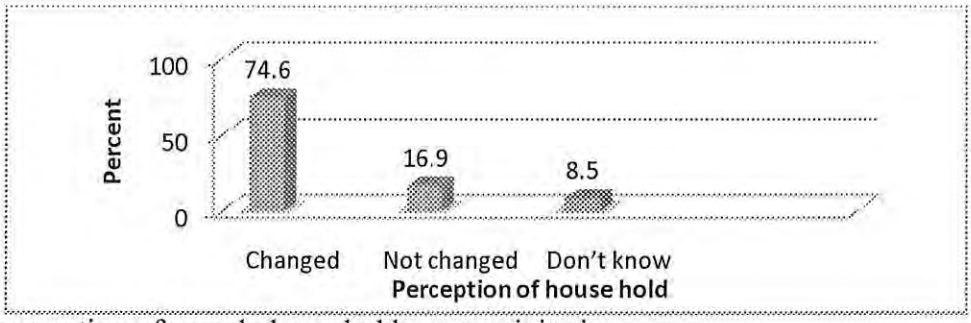


Figure-4.2: perception of sample households on precipitation

Source: Household survey, 2012

FGD participants disclosed that the timing of rainfall has changed, the rainfall variability, could not be practiced and there has been a change in the amount, timing and frequency of rainfall.

According to respondent:

"Rainfall in the recent past, with the expectation of 2011, has been declining in both duration and intensity" (Lema Alemu, from Denkaa Kebele).

The finding is consistent with Funk et al (2005) which has noted that there is an erratic rainfall in the southeast and northeast Ethiopia. Monthly rainfall data obtained from NMA (appendix IV)

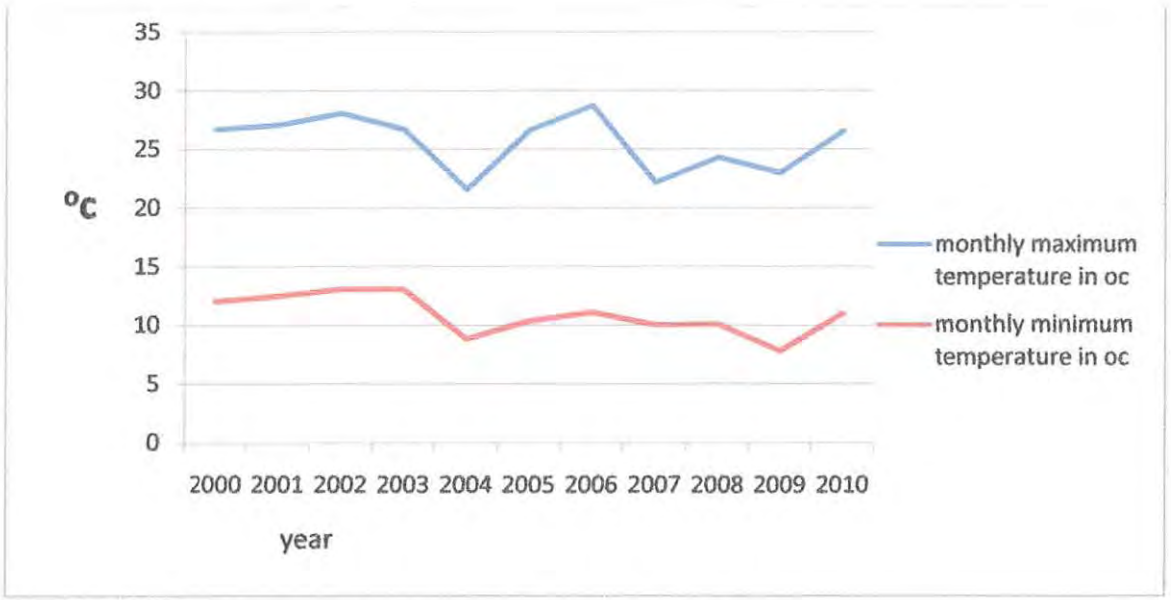


Figure 4.3:- Temperature of Adea wereda from 2000-2010

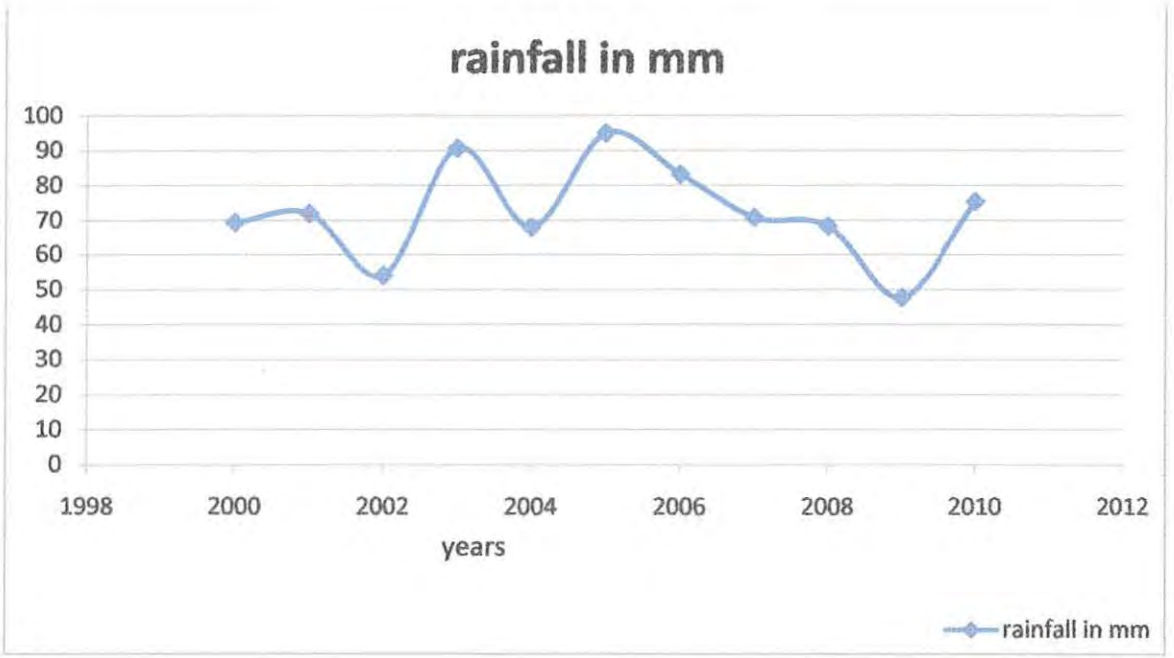


Figure 4.4: Rainfall of Adea wereda from 2000-2010

Which spans from 2000 to 2010 for Adea wereda station has confirmed the precipitation of the respondents. When responding to open ended question number 5 (what change has

occurred as a result of change in precipitation?) they mentioned drought, crop failure, decreased recharge of ground water, etc has occurred due to lack of rainfall.

In general, the data indicates that significant numbers of respondents believed that temperature had increased. The majority of respondents believed rainfall levels had decreased. Most participant of FGD and key informants felt that the timing of rainfall had undergone changes and the *wereda* is drier and drier. These findings consistent with studies of UNFCCC (2001) which shows that there has been a general trend of atmospheric warming in the region where average annual minimum and maximum temperatures have been increasing at 0.25^0c and 0.1^0c per decade, respectively UNFCC (2001). In connection with this Muna (2006) also reported an increasing trend of 0.3^0c per decade for the mean minimum and maximum temperature in Ethiopia highlands.

The other question presented to the respondents is whether they feel that the pattern of weather is changing in *Adea wereda*. Accordingly 75.4 % of the respondents felt that the weather is changing, 19.2 % felt that it is not changing and 5.4 % do not know it.

Those households who responded that generally there was climate change in the study area further questioned the cause of climate change. Therefore 64.6% of the respondents indicated human action, 10% of them respond natural process, 23.1% of them responded wrath of God and 2.3% of them was not know the cause for climate change (figure 4.5). This indicates the cause for climate change was known by most of the inhabitants of the study area.

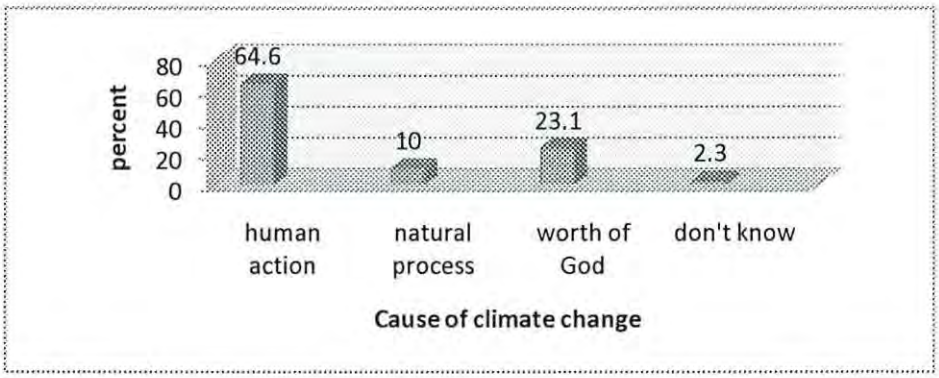


Figure-4.5: Response of sample households on cause of climate change

Source: Household survey, 2012

Assessment of sample households perception weather human activities cause of climate change was asked. As a result 86.9% of sample households were responded.

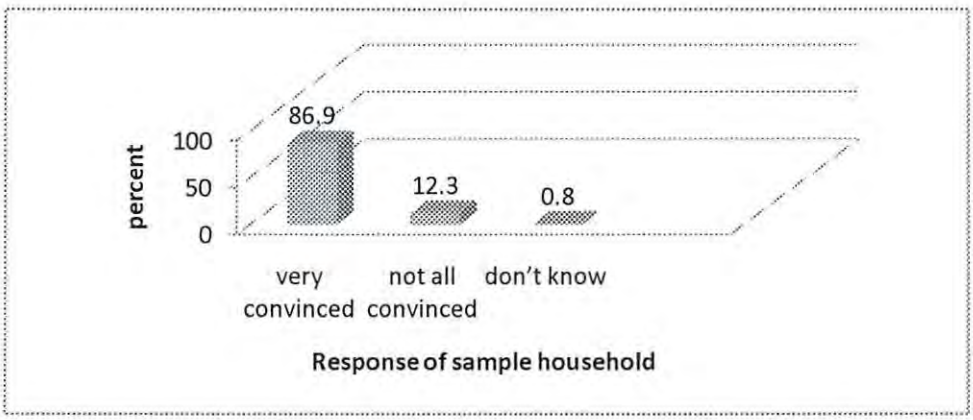


Figure- 4.6: Sample households weather human activity were caused of climate change

Source: Household survey, 2012

4.2.2. Awareness and Knowledge of Climate Change.

One of the current issues with climate change is that we hear about the term and concepts in virtually every media outlet, be it on TV, Radio or newspaper. Awareness about climate change, its causes, adaptation measure and the necessary responses mechanism to cope with climate calamities is important for any population in a given community level

of awareness determines the scope of implementation that needs to be taken to mitigate problems, lower perception will make local intervention mechanisms to be very slow and untargeted.

One of the investigation areas of this research is whether respondents have heard about climate change or not. In *Adea wereda* out of the total 130 sample 99 of respondents have heard of climate change and (31 % of) of the total sample said they had not heard of climate change (Table 4.8). In *Adea wereda*, it appears that although majorities of local communities have heard of climate change, some, remain unaware of this issues, thus, the findings show that, the local community awareness (and understanding) of climate change does not seem to have advanced in recent years and hence, there is little or no awareness of the issues of climate change among members of respondents.

Table: 4. 8 Respondents awareness of climate change (N=130)

Have you heard about climate change	Number	Percent
Yes	99	76.2
No	31	23.8
Total	130	100

Source:-Household survey, 2012

The result from the qualitative inquiry also indicated that participants of FGD and informants have heard about climate change.

One key informant explained as follows

"There is a lot of talking going on, today on the Radio, TV about climate change, different meetings are being held at international and national level, but I do not know the detail"(Jiru Gemechu, from Kajima Dibayou Kebele)

When respondent awareness of climate change is investigated in relation to sex, the result of the study shows that among those respondents who are aware of climate change 50 % are male 6.1 percent are female. the proportion of women who have heard of climate change in the study area is 8 % and 34 % of women do not have heard of climate change.50 % of men respondent have heard of climate change 17.6 % men respondent do not have heard of climate change as shown in the table 4. 9 below.

Table: 4.9 Respondents' awareness of climate change by sex

Have you heard of climate change	Male		Female	
	No.	%	No.	%
Yes	65	50	8	6.1
No	23	17.6	34	26.1
Total	88	67.7	42	32.3

Source:-Household survey, 2012

4.2.3. Acquisition of Information on Climate Change

The other question presented to the respondents is where they get the information about the climate change in *Adea wereda.* Accordingly 6.9 % of the respondents getting information from television, 45.4 % of the respondents from radio, 44.6 % of the respondents from government offices/information and 2.3% of the respondents from friends/families as shown in Figure 4.7.but the study does not identified whether farmers have television or Radio.

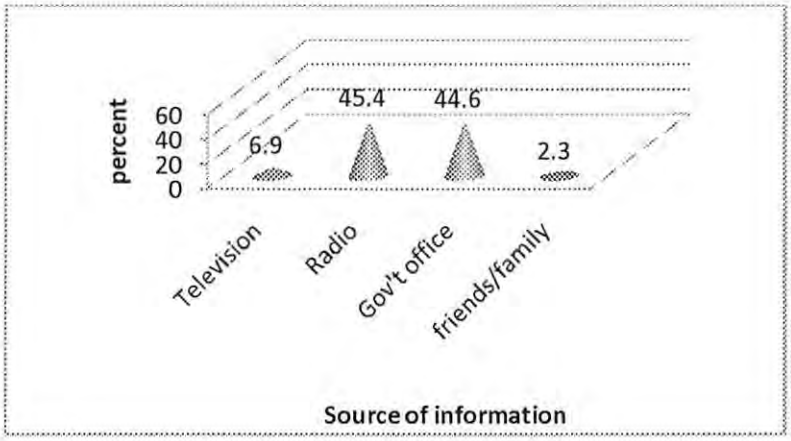


Figure-4.7: Response of sample households how they heard climate change

Source: Household survey, 2012

When respondents' awareness of climate change is investigated in relation to their literacy status, as the level of their literacy level increase, their awareness of climate change also increase as shown from table 4.10 below.

Table: 4.10 Literacy status attained by HH head and awareness of climate change.

Literacy status	Have you heard about "climate change"?			
	Yes	Percent	No	Percent
Illiterate	7	5.3	25	19.2
Literate	74	56.9	24	18.5

Source:-Household survey, 2012

Assessment of sample household's perception how the issue of climate change was important. As a result 87.7% of sample households responded as very important. While 12.3% of them responded not at all important.

Table-4.11 Response of sample households how the issue was important

	Frequency	Percent	Valid Percent	Cumulative Percent
very important	114	87.7	87.7	87.7
Not at all important	16	12.3	12.3	100.0
Total	130	100.0	100.0	

Source: Household survey, 2012

4.2.4. Adaptation Measures to Climate Change.

Sample households were asked if they know adaptation measures to climate change. Accordingly 76.9% responded as they know adaptation measure to climate change.

Table 4.12. Response of sample households on knowledge adaptation measures to climate change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	100	76.9	76.9	76.9
	No	22	16.9	16.9	93.8
	don't know	8	6.2	6.2	100.0
	Total	130	100.0	100.0	

Source: Household survey, 2012

When further asked how they adapted the climate change in their locality the majority of them (78.5%) responded as they used by planting different types of trees on degraded land, by composting agricultural land, by conserving soil and water and by reducing deforestation. while 16.9% responded as they did not take any measure and 6.2% don't know .

Table-4.13: Response of sample households on adaptation mechanism

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	All activity	102	78.5	78.5	78.5
	No action	28	21.5	21.5	100.0
	Total	130	100.0	100.0	

Source: Household survey, 2012

4.3. The Relative Importance of Climate Change Issues as Compared to Other Environmental Problem

Previous research has indicated that in survey the majority of people claims to be concerned or worried about most environment issues (Bord et al. 2000; DEFRA,2002) This research, therefore, examined concerned about climate change relative to other environmental issues. The survey asked respondents to select their environmental issues that concerned them most from a list of eight (Table 4.14) below, show the proportion of all respondents selecting each of the environmental concerns listed. The low ranking of climate change amongst people. Concerns is reflective of a wide spread perception that climate change does not pose a direct, personal threat on them. While there is acceptance that climate change is beginning to manifest in changing weather, there seems to be a prevailing belief in the community that climate change is essentially is a distant and future problem (Norton and Leaman, 2004) studies made by (Bord et al, 2000) also have indicated that, climate change is not generally considered as a direct personal risk. It is more often conceptualized as a distant in space and time, with impacts affecting the wider environmental & future generations.

Pair wise ranking is often used by social scientists, and increasingly by community development workers, as a means of prioritizing or ranking lists prepared by communities. Pair wise ranking in which each items on a list is compared in a systematic way with each other provides such a method. The number of times a problem had been found to be more important was measured by counting the number of items its problem number appeared in the matrix.

Sample households were asked the most Relative importance's of climate change issues as compared to other environmental problems. The number of times a problem had been found to be more important was measured by counting the number of items its problem number appeared in the matrix. Accordingly to the respondents out of eight environmental problems more important was Deforestation at the first stage, in the second level climate changes, in third level Land degradation etc. Whereas Reduced/heavy rainfall, Human health impact, and Loss of biodiversity had got less rank by respondents. This indicates the respondents were not giving more attention to climate change rather than other environmental problems as shown table 4.14.

Table: 4.14 The Relative importances of climate change issues compared to other environmental problems.

No	Environmental problems	Score	Rank
1	Climate change	452	2
2	Deforestation	496	1
3	Pollution of the environment	266	4
4	Land degradation	332	3
5	Drought	239	5
6	Reduced/heavy rainfall	197	6
7	Human health impact	130	7
8	Loss of biodiversity	7	8

Source:-Household survey, 2012

4.4. Perceived Threat from Climate Change.

The low ranking of climate change amongst people concerns is reflective of a widespread perception that climate change does not pose a direct, personal threat on them. While there is acceptance that climate change is beginning to manifest in changing weather, there seems to be a prevailing belief in the community that climate change is essentially is a distant and future problem (Norton & Leaman, 2004) studies made by (Bord etal, 2000) also have indicated that, climate change is not generally considered as a direct personal risk. It is more often conceptualized as a distant in space and time, with impacts affecting the wider environment & future generations.

The respondents were then asked if climate change is something that is affecting or is going to affect them personally. Accordingly, it was found that 80.0 % of survey respondents feel that climate change is something that affecting or is going to affect them

personally while 12.3 % do perceive that climate change will not affect them personally & 7.7% of the respondent don't know it as shown from figure 4.8.

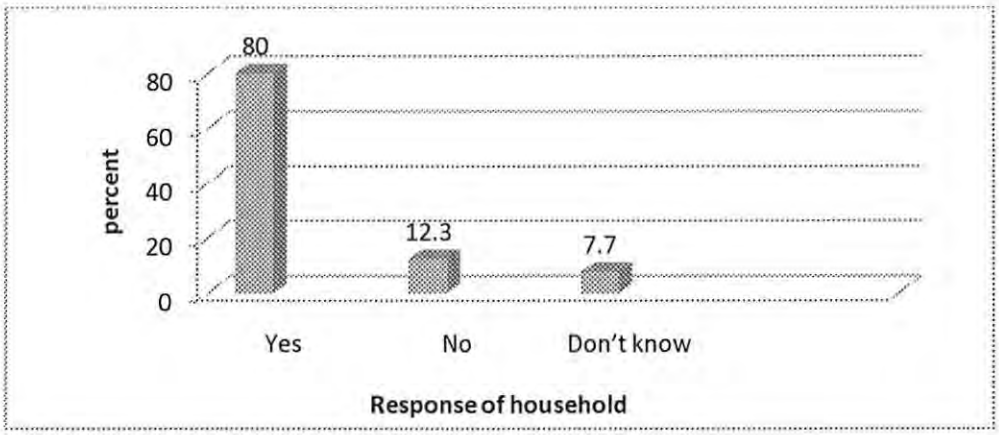


Figure 4.8. Response of sample households who replied climate change affects them personally

Source: Household survey, 2012

When asked how they feel climate change does or will affect them, during the FGD they referred explicitly to adverse affects climate change such as: Human health, warmer weather, shortage of water, reduced/ heavy rainfall etc.

Sample households were asked if they perceived climate change as serious problem. As a result 97.7% of respondents replied as they perceive seriously and 2.3% not accepted. When further asked how much they worried about climate change 91.5% responded as a great deal, 8.5% little bit. This indicates the majority of the Adea district inhabitants understand climate change impacts as well as they can contribute on adaptation mechanism for the impacts.

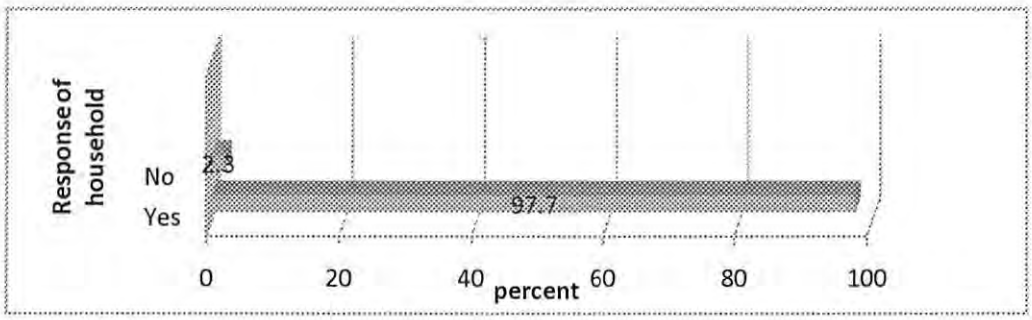


Figure-4.9: Response of sample households perceived climate change as serious problem

Source: Household survey, 2012

Table 4.15: perception of sample households on how they worried

	Frequency	Percent	Valid Percent	Cumulative Percent
little bit	11	8.5	8.5	8.5
a great deal	119	91.5	91.5	100.0
Total	130	100.0	100.0	

Source: Household survey, 2012

The respondents, were asked, "Do you consider climate change as a very serious problem? It was found that, (97.7 %) of men and (97.6 %) of women consider climate change a very serious problem. Another key measure of perceived risk is the degree of personal worry respondents have regarding climate change. The respondents were then asked "How much do they personally worry about climate change? And found level of worry generally higher than perceived seriousness.

Table 4.16. Personal importance seriousness and personal worry of climate change by sex.

Climate change perceive as important and serious problem	Response	Sex of household head			
		Male	%	Female	%
Do you consider climate change a very serious problem?	Yes	86	97.7	41	97.6
	No	2	2.3	1	2.4
	Don't know	-	-	-	-
	Total	88	100	42	100.0
How much do you personally worry about climate change?	a little bit	8	9.1	3	7.1
	A great deal	80	90.9	39	92.9
	Not at all	-	-	-	-
	Total	88	100	42	100

Source:-Household survey, 2012

When we see the seriousness of climate change issue with respect to the age of the respondents the survey studies indicate that younger and older have equal people are less worried than older age groups about climate change as shown in table 4.17.

Table 4.17 Respondents' age and seriousness of climate change issue.

Age	Do you consider climate change a very serious problem						
	Yes	%	No	%	I don't know	%	Total
20-25	7	100	-	0	-	-	100
26-30	11	100	-	0	-	-	100
31-35	11	91.7	1	8.3	-	-	100
36-40	21	100	-	0	-	-	100
41-45	22	91.7	2	8.3	-	-	100
46-50	21	100	-	0	-	-	100
51-55	12	100	-	0	-	-	100
56-60	10	100	-	0	-	-	100
Above 60	12	100	-	0	-	-	100
Total	127	97.7	3	2.3	-	-	100

Source:-Household survey, 2012

4.5. Climate Change Adaptation Strategies.

4.5.1. Personal action & Adjustment in farming to the long term shifts in temperature and rainfall.

Ethiopia has made substantial efforts to incorporate climate change adaptation strategies in its national development plans. The climate change adaptation strategies adopted in Ethiopia are categorized at the household and national levels. At the household level, climate change adaptation policies include, Changing cropping and planting practices (for example, using mixed cropping to diversify risk and early planting to escape drought), Reducing consumption levels During drought, households ration the amount of food consumed by each household member, Collecting wild foods to supplement other

foods, Increasing petty commodity production, Searching for employment through temporary or permanent migration, selling assets such as agricultural tools and livestock, Mortgaging land and obtaining credit from merchants and money lenders, Using early-warning systems and Appealing for food aid (NAPA Ethiopia, 2007).

The most practiced activity in the study area of Local households on climate change was assessed (Q 31). As a result the majority of the respondents (73.1%) replied Using improved crop varieties, early planting (19.2%), Use short season crops (6.3%) and Inter cropping (0.8%). Sample households of the study area were further asked what adjustment made to the long-term shift in temperature and rainfall (Q 35). Accordingly 60% of them replied as Change crop variety, 17.7%of them Put trees for shading, and 14.6% of them Implement soil conservation technique, and7.7% of them replied Irrigate more. This indicates at the household level, climate change adaptation policies practiced and adjustment made to the long-term shift in temperature and rainfall.

Table 4.18. The most practiced activity in the study area

Most practice	Number	Percent
Early planting	25	19.2
Late planting	-	-
Use short season crops	9	6.9
Inter cropping	1	0.8
Using improved crop varieties	95	73.1
Total	130	100

Source:-Household survey, 2012

Table: 4.19 Adjustment made to the long term shift in temperature & rainfall

What adjustment made to the long term shift in temperature & rainfall	Number	Percent
Change crop variety	78	60
Build a water harvesting scheme	-	-
Implement soil conservation technique	19	14.6
Irrigate more	10	7.7
Put trees for shading	23	17.7
Total	130	100

Source:-Household survey, 2012

4.5.2. Clearing Forest Accelerate the Climate Change.

As trees and bushes are cleared, less rainfall is intercepted and surface runoff increases resulting in less water for the soil, plants, and animals. Le Houerou (1995) notes that as vegetation is striped from land, the surface dries out and reflects more of the sun's heat. This would alter the thermal dynamics of the atmosphere and suppresses rainfall, which would, in turn, dry out more land, lakes, streams and rivers.

Even though forests play such an essential role in developing countries such as Ethiopia, they have been treated as free environmental goods to which everyone has the right of access. The heavy dependency on forests for fuel wood, fencing, farm implements, and construction poles as well as for other economic purposes has contributed to the increasing rate of forests and woodland destruction.

Deforestation in Ethiopia occurs when the indigenes clear forests for fuel (firewood), hunting, agriculture, housing development, and even religious purposes. Deforestation is destructive as it entails removing the forest ecosystem by cutting the trees and changing

the structure of the land to suit individual usage. With the second largest population in Africa, Ethiopia has been the victim of famine due to rain shortage and a depletion of its natural resources. Its low rainfall has been lowered even further by deforestation, which continues to worsen with population growth (Africa Society, 2008).

During the survey, the respondents were asked question to reply changes in the vegetation cover over the last 10 years. The data given in (Table 4.20) show the percentage distribution of the sample population by feeling of changes in the vegetation cover over the last 10 years. Accordingly, most of the respondents 85% replied vegetation cover changed, 29.2% replied vegetation cover not changed, and 5.4% of them replied don't know as it is indicated in table 4.20.

Table 4.20. Changes in the vegetation cover over the last 10 years

Have you seen changes in the vegetation cover over the last 10 years?	No.	%
Yes	85	65.4
No	38	29.2
Don't know	7	5.4
Total	130	100

Source:-Household survey, 2012

Sample households of the study area were further asked clearing forest accelerates the climate change. Accordingly 71.5% of them replied as strongly agree clearing forest accelerates the climate change, and 28.1% of them replied as agree clearing forest accelerates the climate change. This indicates the household of the respondents strongly agree clearing forest accelerates the climate change and they have knowledge.

Table: 4.21. Clearing forest accelerates the climate change.

Do you agree clearing forest accelerate the climate change?	Number	Percent
Strongly agree	93	71.5
Agree	37	28.5
Disagree	-	-
Strongly disagree	-	-
Total	130	100.0

Source:-Household survey, 2012

FGD participants disclosed that Deforestation in Ethiopia occurs when the indigenes clear forests for fuel (firewood), hunting, agriculture, housing development, and even religious purposes. Deforestation is destructive as it entails removing the forest ecosystem by cutting the trees and changing the structure of the land to suit individual usage.

According to one participant of the FGD:

"I live in this area for 29 years, the coverage of forests by that time and now had a great difference, There is so many wildlife in the forest, Plant and Animal species that were in local area before two decade but not now" *(Admasu Lema, from Kajima Dibayou Kebele).*

The finding is consistent with (Le Houerou, 1995)) which has noted that As trees and bushes are cleared, less rainfall is intercepted and surface runoff increases resulting in less water for the soil, plants, and animals. As vegetation is striped from land, the surface dries out and reflects more of the sun's heat.

4.5.3. Adaptation to the Impacts of Climate Change.

Climate variability has always been a fundamental concern in rural Ethiopia and people have been trying to cope with and adapt to changing climatic, environmental and socio-political circumstances. Rural Ethiopians have long developed and accumulated body of knowledge, practices and symbolic representations about their environment. In the highland areas, local coping strategies include traditional practices in the areas of soil and water conservation, changes in cropping and planting practices, indigenous agro-forestry, diversification of income and livelihood sources through petty commodity production and trading, inter-household transfers and loans, mortgaging of land, and seasonal migration. In the dry lowlands, pastoral households employ a diverse portfolio of strategies to cope with climate related adversity including seasonal mobility, herd diversification and splitting, rotational grazing, and rangeland differentiation into wet and dry grazing reserves. Opportunistic farming, livestock marketing, petty trade, seasonal migration and consumption adjustments also serve as additional socio-economic coping strategies. However, the capacity of most of the traditional household and community coping strategies are too weak or limited to help them adequately cope with the impacts of climate change. On the other hand, some coping strategies based on short-term survival considerations (such as cultivation of unsuitable areas, charcoal making and fuel-wood selling), are not only unsustainable but would also cause further degradation and weaken local resilience (NAPA, 2007).

Adaptation and mitigation can both be used to reduce the negative impacts of climate change. Mitigation refers to reducing climate change by reducing the GHG emissions. Adaptation to climate change refers to the adjustment in natural or human systems in response to actual or

expected climatic stimuli or their effects to moderate harm or exploit beneficial opportunities (IPCC 2001). Even though mitigation targets uprooting the major causes of climate change and offers long-run solutions, adaptation is much more important for the group of developing countries (Fussel,2007) argues that emphasis should focus on adaptation because human activities have already affected climate, climate change continues given past trends, and the effect of emission reductions will take several decades before showing results, and adaptation can be undertaken at the local or national level as it depends less on the actions of others. Adaptation to climate change impacts in general and to the agriculture sector in particular is an existing phenomenon. The agriculture sector has the capacity to adapt provided that technologies, resources, and management changes have been undertaken relatively quickly (Mendelsohn, 2000).

During the survey, the respondents were asked question to reply it is possible to adapt to the impacts of climate change. The data given in (table 4.22) show the percentage distribution of the sample population by it is possible to adapt to the impacts of climate change. Accordingly, most of the respondents 73.1% replied it is possible to adapt the impact of climate change, 26.9 % No it can not possible to adapt to the impacts of climate change as it is indicated in table 4.22.

Table 4.22. Possibility to adapt to the impacts of climate change

Do you think it is possible to adapt the impact of climate change?	No.	%
Yes it is possible	95	73.1
No it cannot possible	35	26.9
Total	130	100

Source:-Household survey, 2012

Sample households of the study area were further asked what are the Limitations to adapt to the impacts of climate change. Accordingly 54.6% of them replied as Lack of

integration, 29.2% of them replied as Finance problem, 13.1% of them replied as Lack of awareness/knowledge, 3.1% of them replied as Lack of communities to weather & climate related information. This indicates the household of the respondent's adaptation is limited by lack of integration, financial problems, Lack of awareness, and others, which suggests that farmers may be willing to adapt, but that they do not have the financial resource and lack of integration.

FGD participants disclosed that the household of the respondent's adaptation is limited by lack of integration, financial problems, Lack of awareness, and others.

According to one participant of the FGD: *"Farmers may be willing to adapt, but that they do not have the financial resource and lack of integration" (Debele Tesema, from Kajima Dibayou Kebele).*

Table: 4.23. Limitations to adapt to the impacts of climate change.

What is the limitation to adapt to the impacts of climate change?	No.	%
Finance problem	38	29.2
Lack of integration	71	54.6
Lack of awareness/knowledge	17	13.1
Lack of information	-	-
Lack of communities to weather & climate related information	4	3.1
Total	**130**	**100.0**

Source:-Household survey, 2012

CHAPTER FIVE

CONCLUSION & RECOMMENDATIONS

5.1. Conclusion

This chapter presents what has been learned from the study as conclusion and forwards suggestion for various stakeholders to address the issue of climate change. Very recently the term "climate change" has become a catch phrase in the global and regional forums. It has captured the attention of several government, business and civil societies of the world. The issue was also the top agenda in the World.

The primary impact of global warming, proven by many research centers is the rise in minimum, maximum and mean temperature coupled with an increase or decrease in the amount of rainfall. One of the direct impacts of global climate change on Ethiopia is the change in local weather condition. This research has revealed that out of 130 respondents perceive climate is changed 128 of them which are (98.5%) and, 92 of them which are (70.8%) believed that average temperature has increased. Also, (97) respondents which are (74.6%) also believed that rainfall levels and decreased in *Adea wereda.* In addition to this most key informants and FGD participants felt that the timing of rainfall had undergone changed.

The findings also confirmed that weather is changing solely due to anthropogenic (human activity) cause. It was also believed by some respondents that the cause of weather change is linked with some kind of a supernatural phenomena or the wrath of God, although spiritual explanations of weather change are incompatible with scientific

explanation. Still it was identified that the change in climate is just one event in the natural processes.

Based on the survey result, it appears that although 99 respondents which are (76.2%) of the 130 respondents are aware and heard of climate change. However, 31 respondents which are (42.1%) of the respondents said they had not heard of climate change. In this study, it appears that although majorities of the local communities' have heard of climate change. Some remain unaware of this issue, and thus, the findings show that, the local community understanding of climate change close not seems to have advanced in recent years and hence, there is no or little understanding of the issue of climate change among some respondents.

The Relative importance's of climate change issues as compared to other environmental problems of the survey asked respondents to select their environmental issues that concerned them most from a list of eight shows the proportion of all respondents selecting each of the environmental concerns listed. Based on the survey result local community select Deforestation about score of 496 at the first level, climate changes score 452 at the second level and Land Degradation score 332 at third level. Respondents not give more attention to loss of biodiversity and human health. Climate change is not generally considered as a direct personal risk. Studies demonstrate that concern for climate change has over the past two decades, become widespread. The findings of this study substantiated that respondents feel climate change is very important to them personally, climate change does not rank as high as more tangible and immediate threats to well-being, such as deforestation.

Local knowledge, practices and innovations are important elements for community-based coping and adaptation mechanisms. There were few examples of adaptation strategies in agriculture such as change in cropping patterns, choice of crops, and improvement in the system. There was limited awareness, knowledge and capacity at local level to understand climate change scenarios, address issues, and conduct long-term planning. Coping strategies and adaptation mechanism were limited at the study area. Adaptation to climate change is limited by the perception whether climate change is a treat for their farm business or not. Although most of the participated farmers indicated that climate change is a threat for their business, other issues are more important to adapt to. Furthermore, adaptation is limited by the commodity prices, which suggests that farmers may be willing to adapt, but that they do not have the financial resource, And Lack of integration, Lack of awareness, and others.

5.2. Recommendations

Current climate change is already imposing a significant challenge to Ethiopia by affecting food security, water and energy supply, poverty reduction and sustainable development efforts. As well as by causing natural resource degradation and disasters. These challenges are likely to be exacerbated by anthropogenic cause of climate change. However, local community Understanding of climate change in Ethiopia does not seem to have advanced in recent years and hence, there is little awareness of the contribution of everyday individual actions to the problems, Adaptation to climate change is limited by the perception whether climate change is a treat for their farm business or not. Although most of the participated farmers indicated that climate change is a threat for their

business, other issues are more important to adapt to: - On the bases of the results from this study, the following points have to be taken in to consideration.

1. Creating and expanding awareness among the population and policy makers about climate change, its cause, adaptation measure of climate change and its consequences by providing reliable and up-to-date information to the public is needed in order for them to take appropriate adaptive measures.
2. Expansion of new varieties of crops and diversification from traditional crops to other types of crops which can with stand drought and higher temperature, There should be a great need for the government through the meteorological department, research and extension, private sector and non-governmental organizations to provide adequate extension information services to ensure that farmers receive up-to date information about rainfall and temperature patterns in the forthcoming season so that they can make well informed decisions about their planting dates.
3. Promoting economic development in the best adaptation strategy to adapt the adverse effects of climate change. Efforts must be intensified to raise productivity level and encourage intensification of production to minimize resource exploitation. In addition non agricultural employment opportunities need to be expanding in rural areas to minimize the burden on land. Thus considering the nature of the climate change as a crosscutting issue, it will be useful to incorporate some of the climate change /adaptation interventions reduction as a sub-component.
4. Collective action by international community, National/regional governments and individuals is needed to adapt the impact of climate change.

5. Policies must aim at promoting farm-level adaptation through emphasis on the early warning systems and disaster risk management and also, effective participation of farmers in adopting better agricultural and land use practices
6. It is evidenced from this study that farmers are experiencing change in climate and they have already devised a means to survive. It is from this point that policy of reliable and effective measures of adaptation need to be implemented and must be accessible to the end users.
7. Looking at the issue of climate change adaptation, the role of agriculture is significant to raise both the consciousness of the need to climate change adaptation and possible methods of mitigation to both the end users and policy makers.
8. The issue of climate change is more or less a recent phenomena and has not been addressed by available information on environment is fragmented and not well coordinated. Therefore, further research need to be conducted.

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Appendix I

Structured Questionnaire to be Completed by Household Head

Title. Local communities understanding and response to climate change: The case of Ade'a wereda administration, East Shewa zone of Oromia Regional state, Ethiopia.

This is a primary data survey for MA thesis of Addis Ababa University in the Institute of Development Studies. This questionnaire survey is intended to assess Local communities understanding and response to climate change. Therefore, I kindly request you to fill the appropriate answers for the questions provided below.

Note that:

1. All you responses will be held confidential
2. Your name will not be written on this form and will never be used in connection with any information you tell me.
3. Please feel free to ask any questions you may have about the questionnaire.
4. You have the right to obtain information about the findings of the research and about how they will be used after the research is completed.
5. Household survey will be collected for the production season **December-January 2010 (2002/2003E.C).**

Your genuine participation by responding patiently to the questionnaire is highly appreciated and thanks you for giving your time and the willingness to participate in filling this questionnaire.

I. General information

1. Household identification number/ code number _____
2. Kebele of the households head _____
3. Name of data collector _____
4. Name of supervisor _____
5. Date _____

II. Household head characteristics.

1. Sex of household head. 1=Male 2= Female
2. Age of household head_____ (in years)
3. Religion of household head
   1=Christian (orthodox) 2=Muslim 3= Christian (protestant)
   4= Christian (catholic) 5=Others (specify)_____
4. Ethnicity of household. 1= Oromo 2=Tigre 3=Gurage 4= Amhara 5=others (specify) ----------
5. Marital status of households head. 1= Single 2=Married 3=Divorced 4= Windowed
6. Place of birth of household head.

   1= Ade'a wereda 2= other wereda & the same region

   3=other regions 4= others (specify) _____
7. If not 1, for how many years have you lived in this area? _____(in year)
8. Have you ever attend formal school? If yes, what is your Educational Status?

   Attained by households head? ---------- (in years) 0= if Illiterate 1= if basic
9. Current occupation of the households head.

   1=Farmer 2=Government employee 3= Daily laborer
   4=petty trade 5= Unemployed 6=pension
   7=other (specify) _____
10. Number of Household members at time of survey including household head & economically

    Dependant families. 1=male _____2=Female_____ 3=Total_____

NO	House hold member (m1, m2...)	Sex	Age	Education level
1				
2				
3				
4				
5				
6				

11. Size of land holding by land use type(ha).

Land Use Type	Size(ha)	Remark
Crop land		
Grazing land		
irrigated land		
Forest/Wood/shrub land		
Others		

12. What are the main cash expenditures of household?

Table1. Expenditures of household/year.

No	Types of expenditure	Expenditure(in birr)
1	Building materials	
2	crop inputs	
3	Fuel wood	
4	Soil and water conservation activities its inputs	
5	Clothing	
6	School of children	
7	Seeds	
8	Others	
9	Totals	

Table 3:- Expenditure for cropping

Types of Crop	**Amount buying**	**Expenditure (in birr)**
Field crop		
Tef		
Wheat		
Maize		
Oats		
Niger seed		
Millet		

Barely		
Bean (Bakela)		
Pea (Ater)		
Chickpeas		
Sorghum		
Others		
Horticultural crop		
Vegetables Onion		
Tomato		
Pepper		
Cabbage		
Others,		
Total		

Table4:- Expenditure for livestock

Types of Livestock	**Number of Livestock buying**	**price**	**Expenditure (in birr)**
Sheep			
Goat			
Donkey			
Cattle			
Oxen			
Cows			
Mule			
Horse			
Others			

Total			

13. Household income /year. Put the source of your livelihood incomes (diversification of livelihood).

Table2.House holds income /year.

No.	Income source of household	Income (in birr)
1	Sale of wood and charcoal	
2	meat ,skin & hide	
3	milk and milk products	
4	**Non farm activities**	
5	• Service(employee)	
6	• Business	
7	• Remittance	
8	• Income from rental land	
9	• Sale of handcraft	
10	Others	
	Total	

Table 3:- Farm income in 2002/2003 E.C cropping year season

Crop	Amount produced	Amount used /to be used	Amount sold	Income from sale
Field crop				
Tef				
Wheat				
Maize				
Niger seed				
Millet				

Oats				
Bean (Bakela)				
Pea (Ater)				
Chickpea				
Barely				
Sorghum				
Others				
Horticultural crop				
Vegetables Onion				
Tomato				
Pepper				
Cabbage				
Others,				
Total				

Table4:- Income from livestock

Livestock	**Amount used**	**Livestock**	**sold Income from sale**
Sheep			
Goat			
Oxen			
Cows			
Horse			
Mule			
Donkey			
Cattle			

Others			
Total			

III. Local communities understanding of climate change, its causes and adaptation measure.

14. How do you perceive climate change of your area?

    1= It has changed 2= It is not changed 3= don't know

15. Do you feel that the temperature of Adea woreda has changed during the past ten years?

    1= it is hanged 2= it is not changed 3= don't know

16. Do you feel that the precipitation of Adea woreda has changed during the past ten years?

    1= it is hanged 2= it is not changed 3= don't know

17. Do you feel the patter of weather is generally changing in Adea wereda?

    1= Yes 2= No 3= don't know

18. What do you think is the cause of climate change?

    1= Human action 3= Wrath of god, curse etc

    2 =Natural process 4= don't know

19. Have you heard of "climate change"? 1= Yes 2= No 3= don't know

20. Where have you heard about climate change? (Multiple answers are possible)

    1= Television 5= Friends (family)

    2= Radio 6= Government offences / information

    3= News paper 7= other (please write) _____

    4= Schools /college

21. How important is the issue of climate change to you personally?

    1= Very important 2=Not at all important 3= don't know

22. How convinced are you that human activities are significant cause of changes to the earth's climate and long term weather patterns? 1= Very convinced 2=Not at all convinced 3= don't know.

23. Do you know the adaptation measure of climate change? 1= Yes 2= No 3= don't know

24. If Yes, How do you adapt the climate change in your area? (Multiple answers are possible)

    1=by planting different type of trees on degraded land

    2=by composting agricultural land

    3=by conserving soil & water

    4=by reduced deforestation 5=all activities 6. No action

IV. **The relative importance of climate change issues as compared to other environmental problems.** Table3. Pair wise ranking in which each item on a list is compared in a systematic way with each other.

25. Please look at the following list of environmental issues and compared in a systematic way with each other.

No	Environmental Problems	Environmental Problems number								Score	Rank
		1	2	3	4	5	6	7	8		
1	Climate change										
2	Deforestation										
3	Pollution of the environment										
4	Land degradation										
5	Drought										
6	Reduced/ heavy rainfall										
7	Human health impact										

8	Loss of biodiversity										

26. Do you consider climate change as a very serious problem? 1=Yes 2= No 3= don't know

27. How much do you personally worry about climate change?

1=a little bit 2=a great deal 3= Not at all

28. Do you think climate change is something that is affecting or is going to affect you, personally?

1= Yes 2= No 3=don't know

V. Indigenous climate change Adaptation strategies

29. Do you made discussion on climate change and its adaptation on coffee ceremony and/or social group? 1=yes 2=No

30. Where do you get your information about climate change adaptation strategies from?

1= Television 4= Friends (family)

2= Radio 5= Government offences / information

3= News paper 6= other (please write) _____

31. Which one is the most practiced activity in your area? (Multiple answers are possible)

1=Early planting 2= Late planting 3= Use short season crops
4= intercropping 5= using improved crop varieties

32. Where do you get improved & short season crops varieties to adapt climate change?

1= Fro Research center 2= Use local seeds 3=Agricultural office

33. Have you noticed any long-term changes in the mean temperature over the last 20 years?

1=Yes 2=No 3=don't know

34. Have you noticed any long-term changes in the mean rainfall over the last 20 years?

1=Yes 2=No 3=don't know

35. What adjustments in your farming have you made to these long-term shifts in temperature & rainfall?

1= Change crop variety 2= Build a water-harvesting scheme
3=Implement soil conservation techniques 4=Irrigate more 5= Put trees for shading

36. Do you plant different types of trees in your farm land and/or homestead? 1= Yes 2= No

37. If your answer for question number 31 is "yes", do you know the advantage of planting different types of trees in relation to climate change? 1= Yes 2= No

38. Do you agree planting different types of trees have been enhanced the adaptation process?

    1= Yes I agree 2= No I do not agree 3= don't know

39. Have you seen changes in the vegetation cover over the last 10 years? 1=yes 2=No 3=don't know

40. Where do you get wood for construction of house, fuel and different purpose uses?

    1=from farm land 2=from forest 3=buying from other area

41. Do you agree clearing forest accelerate the climate change?

    1=strongly agree 2=agree 3=disagree 4=strongly disagree

42. Do you think it is possible to adapt to the impacts of climate change by action in your locality?

    1= Yes it is possible 2= No it can not be adapt through local action

43. What are the limitations to adapt to the impacts of climate change?
    1=finance problem 2=lack of integration 3= lack of awareness/knowledge 4=lack of communities to weather & climate related information 5=others (specify) --------

44. Is there any Plant and Animal species that were in local area before two decade but not now? 1=Yes 2=No 3= don't know

45. As a result of climate change, which one was happened in your area? 1= Wetland area drying

    2= Infectious disease vectors occurred 3=Extinction of wild species 4=Local extinction of plant and animals species 5=Impact on genetic resource (local seeds)

Appendix II

Semi-structured Interview Questions

No	Item
	A- Local communities understanding of climate change, its causes and its adaptation measure
1	Do you feel the pattern of weather is generally changing in Adea wereda? Why do you think this might be?
2	Have you heard of "climate change?" what do you know about it?
3	What do you think causes of climate change?
4	What change has occurred as a result of increased temperature?
5	What change has occurred as a result of change in rain?
6	Do you know the adaptation measure of climate change in your Area?
7	How do you adapt the climate change in your area?
	B- Concern and personal importance of the climate change issue.
8	Do you think climate change is something that is affecting or is going to affect you, personally, as a community? In what way(s) it is affecting you or it is going to affect you?
9	What impacts, if any, do you think climate change may have? Which of these possible impacts of climate change most concerns you personally? , If any? Why?
10	How important is the issue of weather change to you personally? Why is it important to you? How much do you personally worry about climate change? Why?
11	Have you experienced any form of climatic damage? (Including to your home, garden or community?)
12	What do you think is the cause of climate change in Adea wereda is the climatic damage due to change in climate?
	C- Indigenous climate change adaptation strategies.
13	What are indigenous climate change adaptation strategies in your locality? Do you think it is possible to adapt to the impacts of climate change by action in your locality?
14	Do you think anything can be done to indigenous climate change adapting? What do you think can be done to adapting climate change?
15	What local actions do you think are possible with in your capacity to adapted climate change? Have you ever taken or do you regularly take any

	action out of concern for climate change?
16	Have you ever taken or do you regularly take any action out of concern for climate change? What did you do/are you doing?
17	Has any program ever been held to boost awareness on climate change, its adaptation measure, etc? If yes, what was the focus of the awareness program?
18	What were the responses taken and adapting strategies in the past against climate change effects? Are there programs that are working with this indigenous adaptation?

Appendix III

FGD Questions

Well come to our group discussion we are here today to discuss about issues related to local communities understanding and response to climate change. There is no right and wrong answers. All answers both positive & negative are well come. Please feel free to disagree one with another. We would like to have many points of view. All comments are confidential and used for research purpose only. We will be happy to answer any question you have at the end of this discussion.

Discussion topics	Guiding questions
A, Local community understanding of climate changes	• How was the vegetation cover of the high land part of Adea wereda in the past years? • Is there a change in temperature and rainfall patterns? • Do you feel the pattern of weather is generally changing? Why do you think this might be? • Have you heard of "climate change"? What do you know about it? • How important is the issue of climate change to you as a group? Why is it important to your? • What do you think causes climate change? • What impacts, if any, do you think climate change may have?
B, concern and personal importance of the climate change issue.	1. Do you think climate change is something that is affecting or is going to affect you, personally, as a community? In what way(s) is it affecting you, or is it going to affect you? 2. How important is the issue of climate change to you personally? Why is it important to you? 3. What possible impacts of climate change most concern you personally, if any? Why? 4. How much do you personally worry about climate change? Why? 5. Does climate change is some thing that is affecting or is going to affecting you? Personally? 6. Have you experienced any form of climatic damage (including to you home, garden, or community?) 7. Would you tell me briefly about the nature of climatic damage in Adea wereda; in terms of its coverage, seasonality, frequency & duration? 8. What do you think is the cause of climatic damage

	in Adea wereda? 9. What types of households are the most vulnerable to climatic damage? Why?
C, indigenous climate change adaptation strategies.	1. What is indigenous climate change adaptation in your locality? 2. Do you anything can be done to adapt climate change? What do you think can be done to adapt climate change? 3. What do you think are the different adaptation strategies mechanisms to cope with climate change? 4. Have you ever taken, or do you regularly take, any action out of concern for climate change? What did you do /are you doing? 5. Has any program ever been held to boost awareness on climate change, its adaptation measure, etc? If yes, what was The focus of the awareness program? 6. What were the responses taken and adapting strategies in the past against climate change effects? Are there programs that are working with this indigenous adaptation? 7. Is there any Plant and Animal species that were in local area before two decade but not now? 8. Do you think it is possible to adapt to the impacts of climate change by action in your locality? 9. As a result of climate change, what was happened in your area?

Appendix IV

NATIONAL METEOROLOGICAL AGENCY

lement Monthly Max. Temp. in °C
egion SHOA
ation D\ZEIT

ear	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	26.7	28.2	29.7	29.4	29.1	27.5	24.8	23.7	24.9	25.1	25.5	25.8
2001	26.5	29.2	27.7	29.1	28.4	26.7	24.6	24.1	26.9	27.6	26.9	27.6
2002	27.2	29.9	29.3	30.4	31.4	29.1	26.8	25.3	26.4	27.9	27.3	26.3
2003	26.9	28.9	28.9	27.8	30.2	27.6	23.6	24.0	25.0	26.6	26.3	24.7
2004	x	x	27.5	26.5	28.6	26.7	24.0	24.1	25.3	25.5	25.5	25.4
2005	26.2	29.0	28.6	28.7	27.1	27.2	24.0	24.8	25.6	26.9	25.9	25.9
2006	27.1	28.3	27.8	27.3	29.1	28.0	24.6	24.1	23.6	26.7	26.2	25.6
2007	26.7	28.1	29.3	28.6	28.7	26.6	24.0	24.0	24.6	25.6	x	x
2008	26.8	26.7	29.3	28.7	29.1	26.6	24.5	23.4	25.0	26.5	25.2	x
2009	26.3	27.9	29.7	29.2	30.2	30.1	25.4	24.5	x	25.9	26.8	x
2010	26.6	27.0	27.1	28.0	27.3	27.9	24.0	24.5	25.6	27.7	26.6	26.2

Source: - NATIONAL METEOROLOGICAL AGENCY

NATIONAL METEOROLOGICAL AGENCY

Element Monthly Min. Temp. in °C
Region SHOA
station D-ZEIT

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	9.0	10.3	12.5	14.3	13.3	12.9	13.6	13.2	13.3	11.5	10.5	9.9
2001	10.2	11.1	13.7	13.8	14.1	13.3	13.9	14.5	12.6	11.8	9.8	11.1
2002	11.4	11.8	14.3	14.4	13.7	14.2	14.3	14.1	13.3	12.2	10.8	12.6
2003	11.4	13.0	14.0	15.1	14.1	14.1	14.2	14.4	13.7	11.2	11.4	10.0
2004	x	x	10.5	11.9	9.9	11.9	13.1	13.0	11.9	8.4	7.3	8.3
2005	8.1	8.0	12.1	12.3	13.1	12.2	13.0	13.6	12.6	8.2	7.4	3.9
2006	7.9	10.3	10.5	12.1	11.2	12.5	13.5	13.8	12.2	10.6	8.4	10.5
2007	10.0	11.8	11.7	13.2	13.2	13.3	13.8	13.6	12.8	7.1	x	X
2008	9.0	10.1	9.3	12.7	12.5	13.2	12.9	12.9	12.0	9.0	7.8	X
2009	8.4	9.2	11.7	12.6	12.1	12.4	13.7	13.8	x	x	x	x
2010	7.8	12.2	11.9	13.3	13.5	12.0	13.6	13.8	12.3	8.8	6.6	6.1

Source: - NATIONAL METEOROLOGICAL AGENCY

NATIONAL METEOROLOGICAL AGENCY

Element: Monthly Rainfall in mm
Region: Shoa
Station: Debrezeit

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	0.0	0.0	8.6	50.4	65.4	77.4	244.3	181.4	139.4	40.0	23.4	3.4
2001	0.0	4.6	166.4	21.8	104.0	79.5	242.3	143.4	64.3	38.2	0.0	0.0
2002	8.6	0.0	48.0	34.6	11.0	109.1	179.3	178.0	58.4	0.0	0.0	21.3
2003	38.3	55.4	64.4	100.3	21.1	81.4	277.9	285.5	120.0	6.0	3.6	35.4
2004	x	x	68.1	119.9	2.0	133.5	172.5	209.1	79.6	22.6	10.3	0.0
2005	21.8	225.2	122.1	77.3	86.5	96.7	168.0	186.7	153.3	0.0	2.9	0.0
2006	5.0	108.8	0.0	52.2	32.2	108.2	329.0	141.4	122.8	78.3	5.2	16.1
2007	5.8	0.0	0.0	57.9	92.0	77.4	326.8	155.1	123.2	13.2	X	x
2008	0.0	0.0	0.0	41.1	47.6	55.5	226.3	253.5	148.6	3.2	45.2	x
2009	40.9	0.0	13.9	26.9	16.8	38.0	125.1	243.9	0.0	67.5	0.6	x
2010	0.0	36.2	87.0	129.7	37.2	100.7	197.9	189.9	126.6	0.0	0.0	0.0

Source: - NATIONAL METEOROLOGICAL AGENCY