ADAPTATION STRATEGIES OF SMALLHOLDER FARMERS TO CLIMATE CHANGE VULNERABILITY THE CASE OF ASSOSA DISTRICT OF BENESHANGUL GUMUZ REGIONAL STATE, ETHIOPIA

MSc THESIS

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THE CASE OF ASSOSA DISTRICT OF BENESHANGUL GUMUZ REGIONAL STATE, ETHIOPIA

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Approval sheet 1

This is to certify that the thesis entitled "Adaptation Strategies Of Smallholder Farmers to Climate Change Vulnerability; the case of Assosa District Of Beneshangul Gumuz Regional State, Ethiopia" is submitted in partial fulfillment of the requirement for the degree of Master of Sciences with specialization in climate smart agricultural landscape assessment.

It is a record of original research carried out by Aklil Brhane Id. No GP CSALR/003/11, under my supervision; and no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been duly acknowledged. Therefore, I recommended it to be accepted as fulfilling the thesis.

Tsegaye Bekele (Professor) _____ _____

Name of major advisor Signature Date

_____ _____ _____

Name of Co-advisor Signature Date

Approval Sheet 2

We, the undersigned, member of the Board of the final open defense by Aklil Brhane have read and evaluate his thesis entitled " Adaptation Strategies Of Smallholder Farmers to Climate Change Vulnerability; the case of Assosa District Of Beneshangul Gumuz Regional State, Ethiopia" and examined the candidate. This therefore to certify that the thesis has been accepted in partial fulfillment of the requirement for the degree of Master of Science.

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List of Abbreviations

AEZS	Agro ecological zone system
BGBoARD	Benishangul Gumuz Bureau of Agriculture and Rural Development
CBO	Community based organization
CSA	Central statistics agency
DFID	Development for International Development
FAO	Food and agricultural organization
GHG	Greenhouse gas
IFAD	International Fund for Agricultural Development
IFPRI	International food policy research Institute
IPCC	Inter governmental panel for climate change
ITCZ	Inter tropical convergence zone
MoA	Ministry of Agriculture
NGO	Nongovernmental organization
NMSA	National Meteorological Service Agency
UNFCCC	United nation frame work on climate change convention
VIF	Variance inflation factor
FGD	Focused group discussion
KII	key informant

Adaptation Strategy of Smallholder Farmers to Climate Change Vulnerability in Assosa district Benishangul Gumuz Regional State, North western Ethiopia.

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Abstract

Climate change is a threat to the environment as the whole and to agriculture in particular. It aggravates drought, pests, diseases, and other related environmental shocks and food security. This study was conducted on adaptation strategy of smallholder farmers to climate change vulnerability in Assosa district Benishangul Gumuz Regional State, western Ethiopia. The main objective of the study was to investigate the adaptation strategies of smallholder farmers to reduce climate change vulnerability towards sustainable livelihood in the study area. The study was used both probability and non - probability sampling technique procedures and target population comprised 3880 small farmer households from Assosaworeda12 sample kebeles. Sample size of 340 small farmer households that 9 % of the total HH was determined using Kothari formula and 20 key informants selected using Purposive sampling technique for interview. The study utilized questionnaires, interview and 32 FGD was used as an instrument for data collection. Secondary data was obtained from published documents such as journals, reviews, magazines and reports to supplement the primary data. The data was analyzed by use of both qualitative and quantitative method through SPSS software version 22. To achieve the objectives of the study both descriptive and econometrics analysis was conducted. The finding showed that age and distance from extension services are negatively significant affect climate change adaptation strategy, with p-value 0.070 and 0.001 and odd ratio 0.949 and 0.899 respectively, and gender, education level, awareness creation, existences of early adopter neighbors and access to credit were positively and significant affect with p-value 0.001, 0.018, 0.026, 0.001and 0.030 and odd ratio 3.336, 1.334, 2.887, 5.814 and 3.027 respectively, for climate change adoption strategy. Therefore, policy should focus on awareness creation on climate change through different sources, strengthen adult education service, opening up other options and strengthen extension services to build up adaptive capacity against climate change anxieties.

Key words: *Adaptation strategies, climate change vulnerability, logit regression.*

Chapter One

1. Introduction

1.1 Back ground

Climate change has become a real environmental and development threat that need global concerns (Abid et al., 2015). Developing countries are affected by climate induced events due to their social, economic and environmental conditions (Neil and Jyoti., 2007, IFAD., 2010). Climate change is projected to decrease agricultural productivity in the developing world by 10 - 20% over the next 40 years (Nelson et al., 2009). Particularly in Africa climate change affects livelihoods of the peoples because of many poor small holder depend on agricultural with few alternative (IPCC, 2001b).

The magnitude of climate change is now being felt at almost all scales and in all regions with extreme events such as drought, excessive rainfall, heat waves as well as dry spells affecting much of rural Africa (Adger., 2000). IPCC, (2001a) indicates that scientific evidence of human-induced global warming is unequivocal, worse than previously estimated. Many climate models predict negative impacts of climate change on agricultural production and food security in large parts of sub - Saharan Africa (SSA) (Nanduddu, 2010). Increase in temperatures, the drying up of soils, increased incidences of pests and diseases, shifts in suitable areas for growing crops and livestock, floods, deforestation, and soil erosion are all indicators that climate change is already happening and represents one of the greatest environmental, social and economic threats facing Africa (UNFCCC, 2007).

Agriculture is generally one of the most affected sectors by climate change and variability (IPCC 2014). The vulnerability of Ethiopian agriculture to climate change and variability is attributed to environmental, socio demographic and economic factors (Dercon 2004; Deressa 2010). Land degradation and loss of productivity is a major contributor to the widespread poverty and climate change vulnerability of communities in the area (Alemayehu and Bewket, 2016). Farming community is the most vulnerable society group, even within the farming community small scale small holder farmers are more vulnerable to climate change related hazard like drought (Temesgen., 2006).

Adaptation to climate change is an effective measure at the farm level, which can reduce climate vulnerability by making rural households and communities better able to prepare themselves and their farming to change and support them in dealing with adverse events (IPCC 2001). Assosa woreda is located in BenishangulGumuz Regional state in the western parts of Ethiopia. In Assosa woreda agriculture is main sources of livelihood and income. During meher rain seasons these rain fluctuation causes decrease water for human and livestock production and also for crop loss with decreased livestock productivity.

This study was conducted to investigate the most vulnerable social group to climate change and to identify farmer's adaptation responses to climate change and constraints faced by farmers to adapt to climate change.

1.2. Statement of the problem

Recent studies shows that climate change will decreasing rain fall in arid, warmer temperature increasing severity and frequency of extreme weather events (IPCC, 2007). The poor small holders are the most affected as they do not have enough capacity to adapt to adverse shocks and further exacerbating the countries poverty and food security situation (FAO, 2008). The farmer living in the study area are mostly suffering drought and erratic rain fall during both meher and belg season, This issue is leads to declining crop production and its consequences to food in security' in the study area. Climate change affects the welfare of the small holder farmers and also households are poor in wealth status, less land held, absence of employment opportunity, low agricultural technological capability and their main livelihood depend on annual crops. It is known that, smallholder farming is characterized by small size farm, low technology and low capitalization (Seyoum, 2015). Adaptation is necessary strategy to facilitate farm to cope with adverse effects on climate change and variability which in turn increase the agricultural production of the poor farm households (Yusuf et al., 2008)

The impact of climate change, vulnerability of agriculture has increased or exacerbated by the impact of other non-climatic drivers such as in appropriate land and land degradation, population pressure, subsistence farming, low technology as well as low policy implementation use in Assosa woreda agricultural office. Because of this climate change will severely affected their livelihood and agriculture productivity. Studies so far in the study area gives less emphasis to consider the factors such as access to credit, education level, early adopter neighbors and extension workers are not include in identifying the adaptation strategies of climate change. As site specific issues require site specific knowledge, therefore, it is very important, to clearly understand what is happening at community level on adaptation

strategies of climate change. Unless, the impacts of climate change are known and expressed at community level and understood the local people and established the right way of adaptation strategies. It would be difficult to convince and motivate local communities to undertake adaptation actions.

As far as the researcher's knowledge concerned, there is no study conducted on adaptation strategies of smallholder farmers to climate change vulnerability with the defined variables in study area. Therefore, this study was contribute to bridge these gaps and attempt to reveal farmers adaptation strategies to climate change vulnerability in the context of sustainable livelihood.

1.3. Objectives

1.3.1. General objectives

To investigate the adaptation strategies of smallholder farmers to reduce climate change vulnerability towards sustainable livelihood in Assosa district of Benishangul gumuz Regional state.

1.3.2. Specific objectives

- ✓ To identify those farming households in the study area those are most vulnerable to climate changes.
- ✓ To determine and describe current adaptation strategies used at farm level in response to climate change in the study area.
- ✓ To determine major constraints of agricultural adaptation strategies to climate change in the study area.

1.4. Research questions

In order to meet the above objective, the research questions for this study are

1. Who are the most vulnerable to climate change?
2. What are adaptation strategies used by farmers in responses to climate change?
3. What are the constraints faced by farmers to adapt to climate change effects?

1.5. Significance of the study

This study was to reveal farmers adaptation strategies vulnerability and good understanding of relative vulnerability of farmer within the context of climate change based on agro ecological location by identifying vulnerability groups and investigating adaptive capacity and adaptation technologies on specific area and community is importance. This study would inform and provide compressive information to decision makers, experts and farmers in the Assosa woreda, zone and regional levels, Moreover the study also contribute knowledge to the existing limited empirical literature in the area and serve as a base for other researchers who have interest to investigate further. This study focused on site-specific issues for those require site-specific knowledge and experience (IPCC,2007).

1.6 Scope and Limitations of the Study

1.6.1 Scope of the Study

With regard to livelihood system the study has focused on one woreda at three agro ecological location i.e. low land (kola), mid land (Weynadega), and high lands (Dega) kebelle to analyze adaptation strategies to climate change vulnerabilities in these three agro ecological zones. The case of rain fed agricultural livelihood of Ethiopia is limited (Temesgen et al ., 2010). The farmer's livelihood in this study area mainly depends on agriculture. The farmers have

been exposed to vulnerability. Therefore, these farmers need to special attention. In terms of response measure to climate change, the scope of this study was focused on adaptation strategies rather than mitigation of climate change because, to reduce greenhouse gases it will take time, require international cooperation and its scale of effect is at the global level (Fussel and Klein,2005). The second reason is benefits of adaptation is incremental income through sustainable intensification or diversification, poverty reduction and the growth of the economy, functioning environmental services and reduced carbon emissions (IFAD, 2013). The third reason is Ethiopia's National Metrological Agency produced a National Adaptation Program me of Action (NAPA) in 2007 with the aim of identifying priority activities that respond to urgent and immediate needs for adaptation to climate change. Because of these reasons the study was focused on adaptation rather than mitigation of climate change.

1.6.2 Limitation of the Study

The study was contacted at micro level in the process, primary data collection problem such as households' unwillingness, frustration and knowledge gap that slow down the data collection will be face. Concerning, secondary data sources, some government officials may not willing to give required documents. In addition, shortage of local empirical studies and well documented evidence in the woreda administration, shortage of time and finance would be the major challenges throughout the study.

1.7 Organization of the Study

The document is structured in five main chapters. The first chapter deals introduction part which includes the background of the study, problem statement of the study, basic research questions and objectives of the study, the scope and limitation of the study and the significant

of the study. The second chapter deals with literature review which mainly defines the theoretical literature and conceptual framework of the study. The third chapter deals with the methodology of the study. Under this section the selection and study area description, data type and source, sampling design, data collection procedure, model specification and diagnostic test were included. The fourth chapter constitutes the analysis and discussion part and the fifth chapter deals with conclusion and recommendation. Finally, the reference materials and appendices also included.

Chapter Two

2. Review of Literature

2.1. Climate change and variability

There is acceptance by the scientific community, as well as growing body of evidence, that the composition of the global atmosphere has been altered, and that the global climate is changing. Available data show that air temperature near the earth surface rose by 0.74 °C from 1906 to 2005 and scientists estimate that it could increase by as much as 6.4 °C on average during the 21st century. The cause of such warming has been identified as mainly increasing atmospheric emission of greenhouse gases (GHGs) (IPCC, 2007). Some of the evidence of global warming already observed include changes in mean temperature and precipitation patterns, shifts in seasons and sea level rise (IPCC, 2001a; Benson and Clay,1998; Aslanyan, 1999). These are predicted to be characterized by extreme droughts and very wet periods due to flood events. (IPCC, 2001a). Even though the impact of climate variability and change is a global concern, the impact is particularly significant in Africa. This is attributed to the continent's low adaptive capacity, over-dependence on agricultural sector, marginal climate and existence of many other stressors. Experts and scholars predict that climate change will particularly be devastating for developing countries, since they have poor financial, institutional, technological, and human capacities to cope with its consequences (Aslanyan, 2009).

It is however important to understand that there is a significant difference between climate change and climate variability (Smitet al., 2000). IPCC, (2001a) defines climate change broadly as any change in climate over time whether due to natural variability or as a result of

human activity. The United Nation's Framework Convention on Climate Change (UNFCCC) on the other hand defines 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 which is in addition to natural climate variability observed over comparable time periods.

2.2 Vulnerability to Climate change and variability

A wide range of disciplines use the term 'vulnerability' from economics and anthropology, to psychology and engineering, as well human geography and ecology. The concepts and definitions used by different scholars revolve around the explanation of lack of adaptive capacity in both social and natural systems (Adger, 2000; Adger and Kelly, 1999; Cutter, 1996; Downing 1991). IPCC, (2001b) describes vulnerability as: "The degree to which a system is susceptible to, or unable to cope with adverse effects of climate change, including climate variability and extremes". 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. Therefore, vulnerability to climate change within this IPCC vulnerability context is defined as a characteristic of a system and as a function of its exposure, sensitivity and adaptive capacity (Adger, 2000).

2.3 Adaptation to Climate Change and Variability

Adaptation to climate is the process through which people reduce the adverse effects of climate on their health and well-being, and also take advantage of the opportunities that their climatic environment provides (Smit et al.,2000). One of the more commonly used definitions for adaptation, in the climate change context, is suggested by the IPCC (2001a) who define adaptation as an adjustment in human or natural systems in response to observed or expected

changes in climatic stimuli and their effects and impacts in order to alleviate adverse impacts of change or take advantage of new opportunities.

This includes the ability to prepare for climate impacts and opportunities in advance, as well as the ability to respond to its effects (IPCC, 2001a). Effective adaptation strategies imply reducing present and future vulnerability to climate change and include coping strategies or changes in practices and processes in light of the perceived climatic change. Such actions can be taken by individuals, households, governments and other stakeholders. Adaptation may include policy measures that reduce vulnerability and enhance adaptive capacity, or the ability of people and systems to adjust to climate change (Smit et al.,2000).

2.4 Agro ecological features of Ethiopia

The climate of Ethiopia is mainly controlled by the seasonal migration of the inter tropical convergence zone (ITCZ), which follows the position of the sun relative to the earth and the associated atmospheric circulation in conjunction with the country's complex topography (NMSA, 2001). The most commonly used classification systems are the traditional and the agro ecological zone systems (AEZS).

According to the traditional classification system, which mainly depends on altitude and temperature, Ethiopia has five climate zone (MoA, 2000).

Table 1.Traditional climatic zones and their physical characteristics.

S/N	Zones	Altitude (m)	Rainfall(mm/yr)	Average annual temperature (°c)
1	Wurch (upper highland)	>3,200	900-2,200	>11.5
2	Dega (high land)	2,300-3,200	900-1,200	17.5/16.0-11.5
3	Weynadega (mid land)	1,500-2,300	800-1,200	17.5/16.0-20.0
4	Kola (low land)	500-800	200-500	20.0-27.5
5	Berha (desert)	<500	<200	>27.5

2.5 Theoretical and Conceptual framework

2.5.1 Political Economy Approach

The political economy/political ecology framework is also known as the social constructivist framework. Its perspectives on vulnerability emphasizes the socio-political, cultural, and economic factors that together explain differential exposure to hazards, differential impacts, and most importantly, differential capacities to recuperate from past impacts and/or to cope and adapt to future threats (Eakin & Luers, 2006). This approach introduces a household perspective on vulnerability, and replaces the eco - centric approach to environmental change. It argues that vulnerability should be treated as a condition of people that derives from their political-economic position and it is therefore ‘dangerous’ to use it loosely or as a characteristic of exposure to hazards alone, since this allows for the key components of power and income distribution to be played down and prominence given to technical fixes. Political economy denotes the social and economic response capacity of individuals and groups to a

variety of stressors, with its main concerns being; who is most vulnerable and why? (Fusel, 2005).

However, Eakin and Luers (2006) argue that the absence of a clearly defined vulnerability outcome within this framework has produced only generic descriptions of inequities in resource distribution and relationships that relate to the differential susceptibility to harm. The political economy approach has been shown to have utilitarian and theoretical value in the two main elements encountered in this study that is vulnerability and adaptation to climate change and variability. It also provides a broad multidisciplinary framework capable of incorporating a myriad of factors including economic, social and political elements, which are necessary for the explanation of the research findings (Watts, 1983). Political economy is particularly helpful in showing how people who are affected by climate change and variability may be differentially vulnerable (Watts 1983; Downing *et al.* 2001). According to Downing et *al*.,(2001), vulnerability depends on human infrastructure as well as socioeconomic conditions. Furthermore, household vulnerability may be generated by economic, social and political processes that influence how climate affects them in varying ways and differing intensities. Such root causes are normally a function of the economic structure, legal definitions of rights, gender relations and other elements of the ideological order. (Watts 1983)

2.5.2 Vulnerability to climate change

For vulnerability, mostly depending on the disciplines of their origin (Adger, 2006). Nelson *et al.,* (2010) pointed out that definitions of vulnerability should not be confused with conceptual frameworks. While definitions describe the components of vulnerability, conceptual frameworks give meaning to the definitions so that they can be analyzed according to the

analytical context in a transparent and repeatable way (Nelson *et al*., 2010). However, it is essential first to clarify and understand what is meant when vulnerability is spoken and written about in the climate change context (Eakin and Luers, 2006; Janssen and Ostrom, 2006). A consistent and transparent terminology helps to facilitate the collaboration between different researchers and stakeholders, even if there are differences in the conceptual models applied (Downing and Patwardhan, 2005; Fussel, 2007; cf. Laroui and van der Zwaan, 2001; Newell *et al*., 2005).

The Intergovernmental Panel on Climate Change (IPCC) is considered to be the leading scientific international body for the assessment of climate change, and consequently the starting point for this paper is vulnerability as defined by the IPCC. According to the IPCC (2007) definition, vulnerability in the context of climate change is "the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity". Thus, agricultural vulnerability to climate change can, for example, be described in terms of exposure to elevated temperatures, the sensitivity of crop yields to the elevated temperature and the ability of the farmers to adapt to the effects of this exposure and sensitivity by, for example, planting crop varieties that are more heat-resistant or switching to another type of crop. The definition of the IPCC (2007) specifically highlights three components of vulnerability in the climate change context: exposure, sensitivity and adaptive capacity. It implies that a system is vulnerable if it is exposed and sensitive to the effects of climate change and at the same time has only limited capacity to adapt. On the contrary, a

system is less vulnerable if it is less exposed, less sensitive or has a strong adaptive capacity (Smitet al., 1999; Smit and Wandel, 2006).

In the climate change context, **exposure** relates to "the nature and degree to which a system is exposed to significant climatic variations" (IPCC, 2001). Exposure represents the background climate conditions and stimuli1 against which a system operates, and any changes in those conditions. Thus, exposure as a component of vulnerability is not only the extent to which a system is subjected to significant climatic variations, but also the degree and duration of these variations (Adger, 2006). For vulnerability assessments the climatic variations can be aggregated as climate variability or specific changes in the climate system (e.g. temperature increases, variability and change in rainfall, etc.). It has to be noted that systems are often exposed to natural climate variability, independent of future climate changes; however, climate change can alter and increase the future exposure (Lavell *et al*., 2012). With regard to exposure it is also important to define the exposure unit, i.e. the activity, group, region or resource that is subjected to climate change (IPCC, 2001).

The **sensitivity** of a system to climate change reflects the "degree to which a system is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise)" (IPCC, 2007). Sensitivity reflects the responsiveness of a system to climatic influences, and the degree to which changes in climate might affect it in its current form. Thus, a sensitive system is highly responsive to climate and can be significantly affected by small climate changes.

Exposure and sensitivity together describe the potential impact that climate change can have on a system. However, it has to be noted that even though a system may be considered as being highly exposed and/or sensitive to climate change, it does not necessarily mean that it is vulnerable. This is because neither exposure nor sensitivity account for the capacity of a system to adapt to climate change (i.e. its adaptive capacity), whereas vulnerability is the net impact that remains after adaptation is taken into account. Thus, the adaptive capacity of a system affects its vulnerability to climate change by modulating exposure and sensitivity (Yohe and Tol, 2002; Gallopin, 2006; Adger*et al*., 2007).

The IPCC (2007) defines **adaptive capacity** as the ability (or potential) of a system to adjust successfully to climate change (including climate variability and extremes) to: (i) moderate potential damages; (ii) to take advantage of opportunities; and/or (iii) to cope with the consequences (IPCC, 2007).

Adaptive capacity comprises adjustments in both behavior and in resources and technologies (Adger*et al*., 2007). Recent literature emphasizes the importance of socio-economic factors for the adaptive capacity of a system, especially highlighting the integral role of institutions, governance and management in determining the ability to adapt to climate change (Smith and Pilifosova, 2001; Brooks and Adger, 2005; Adger *et al*., 2007; Engle, 2011; Williamson, Hesseln and Johnston, 2012). Accordingly, the adaptive capacity of a system can be fundamentally shaped by human actions and it influences both the biophysical and social elements of a system (IPCC, 2012). Research points out that some socio-economic determinants of adaptive capacity are generic (like, for example, education, income and health), whereas other determinants are specific to particular climate-change impacts such as floods or droughts (e.g. institutions, knowledge and technology) (Adger *et al*., 2007). In

general, the determinants are not independent of each other nor are they mutually exclusive as, for example, economic resources facilitate the implementation of new technologies and may ensure access to training opportunities. Lower levels of adaptive capacity in developing countries are very often associated with poverty (Handmer, Dovers and Downing, 1999; IPCC, 2012).

Adaptive capacity is generally accepted as a desirable property or positive attribute of a system for reducing vulnerability (Engle, 2011). The more adaptive capacity a system has, the greater is the likelihood that the system is able to adjust and thus is less vulnerable to climate change and variability.

Vulnerability, its three components (exposure, sensitivity, adaptive capacity) as well as their determinants are specific to place and system and they can vary over time (i.e. they are dynamic), by type and by climatic stimuli (e.g. increasing temperature, droughts, etc.) (Smit and Wandel, 2006; Adger *et al*., 2007). Thus, vulnerability is context-specific, and the factors that make a system vulnerable to the effects of climate change depend on the nature of the system and the type of effect in question (Brooks, Adger and Kelly, 2005), i.e. the factors that make farmers in semi-arid Africa vulnerable to drought will usually not be identical to those that make farmers in Northern Europe vulnerable to extreme weather events (cf. Schröter *et al*., 2005a; Challinoret *et al.,* 2007).

2.5.3 Adaptive capacity versus coping range

It is important to distinguish between adaptive capacity and coping range because both concepts are associated with different time-scales and represent different processes (Smithers and Smit, 1997; Folke *et al.,* 2002; Eriksen and Kelly, 2007). A certain extent of variability is an inherent characteristic of climate, and most social and economic systems (including agri-

culture) are able to cope with some variations in climatic conditions – however mostly not with extremes of climate variability. The capacity of a system to accommodate deviations from "normal" climatic conditions describes the "coping range", which can vary among systems and regions. Towards the edges of the coping range outcomes might become negative but are still tolerable, whereas beyond the coping range (i.e. beyond the vulnerability or critical threshold) the tolerance of the system is exceeded and it runs into a vulnerable state (Smit and Pilifosova, 2001; Yohe and Tol, 2002; Jones and Mearns, 2005; Carter *et al*., 2007; For example, agricultural activities depend on local weather and climate conditions and can cope with some variability in these conditions, e.g. if it rains more or if it is drier over a given period of time (such as a specific month, season or year). However, if the conditions become too extreme (e.g. heavy rainfall, floods or extended droughts) and exceed the coping range, then this may result in severe effects for productivity levels and diminish livelihoods.

Understanding the coping range and vulnerability thresholds of a system is a prerequisite for the assessment of likely climate change impacts and the potential role of adaptation. Coping range and adaptive capacity of a system are certainly related, but it is important to distinguish between the two concepts when attempting to measure the ability of a system to respond to adverse consequences of climate change (Eriksen and Kelly, 2007). The concept of the coping range is a practical conceptual model because: (i) it fits the mental models that most people have with regard to risk; and (ii) it helps to link the understanding of current adaptation to the climate and adaptation needs under climate change (Jones and Boer, 2005; Jones and Mearns, 2005; Carter *et al*., 2007). In contrast, adaptive capacity defines: (i) the preconditions (including social and physical elements) that are necessary to enable adaptation; and (ii) the ability to mobilize these elements (Nelson, Adger and Brown, 2007).

2.6 Alternative Interpretations and Concepts Of vulnerability

2.6.1 The relative role of natural and Social Science

Similar to the variety of vulnerability definitions, the literature provides a vast variety of interpretations and alternative concepts of vulnerability. The concepts often originate from different academic disciplines and professional fields of practice and they often differ with regard to their unit of analysis (e.g. individual, household or region) and methods (Adger, 2006; Fussel and Klein, 2006; O'Brien *et al*., 2007; Pearson and Langridge, 2008). Different concepts and interpretations of the character and cause of vulnerability produce different types of knowledge and therefore also result in different accentuations of strategies for reducing vulnerability (Kelly and Adger, 2000; Fussel, 2007; O'Brien *et al*., 2007; Maru, Langridge and Lin, 2011).

Moreover, the broad characteristics of alternative vulnerability interpretations can be quite confusing, and even more so in the climate change area, where researchers and stakeholders with different background knowledge collaborate. Therefore, it is not only beneficial but important to identify the thinking behind specific vulnerability analyses and to highlight the major differences in alternative vulnerability interpretations (Eakin and Luers, 2006; Janssen and Ostrom, 2006).Two of the most prominent vulnerability concepts in the context of climate change are outcome and contextual vulnerability, which differ mainly owing to their interpretation of vulnerability as being the end-point or the starting point of the analysis. Outcome vulnerability(also known as the "end-point" interpretation) is a concept that considers vulnerability as the (potential) net impacts of climate change on a specific exposure unit (which can be biophysical or social) after feasible adaptations are taken into account. Thus, the outcome approach combines information on potential biophysical climate impacts

with information on the socio-economic capacity to cope and adapt (Kelly and Adger, 2000; Fussel, 2007; O'Brien *et al*., 2007)**.** Based on natural science and future climate change model scenarios, outcome vulnerability approaches typically focus on biophysical changes in closed or at least well-defined systems. The boundaries between "nature" and "society" are quite firmly drawn and vulnerability is an outcome that can be quantified and measured. The outcome vulnerability is determined by the adaptive capacity of a system. However, regarding the adaptive capacity, most emphasis is given to biophysical components and the role of socio-economic components in modifying the effects of climate change is rather marginalized. Accordingly, the most vulnerable systems are considered to be those that will undergo the most dramatic physical changes. Studies that focus on the vulnerability of agricultural yields to climate change in the future tend to follow an outcome vulnerability approach and typical technological solutions for adaptation in the agricultural sector include, for example, the use of different crop seeds, production techniques or water management (Tubiello and Rosenzweig, 2008; Challinoret *et al*., 2009; Peltonen-Sainio, 2012).

Contextual vulnerability (also known as the *"*starting point" interpretation) is a concept that considers vulnerability as the present inability of a system to cope with changing climate conditions, whereby vulnerability is seen to be influenced by changing biophysical conditions as well as dynamic social, economic, political, institutional and technological structures and processes. Thus, in the contextual approach, vulnerability is seen as a characteristic of ecological and social systems that is determined by multiple factors and processes (Adger, 2006; O'Brien *et al.,* 2007). Based on social science, contextual vulnerability approaches typically focus more on the current socio-economic determinants or drivers of vulnerability, i.e. social, economic and institutional conditions. Specific determinants that can increase or

decrease a system's vulnerability include, for example, marginalization, inequity, food and resource entitlements, presence and strength of institutions, economics and politics (Adger and Kelly, 1999; O'Brien and Leichenko, 2000; O'Brien *et al.,* 2004; Cardona *et al.,* 2012). Thus the contextual interpretation of vulnerability explicitly recognizes that vulnerability to climate change is not only a result of biophysical events alone but is also influenced by the contextual socio-economic conditions in which climate change occurs. Nature and society are usually seen as joint aspects of the same context, i.e. a strong human-environment inter-relation is assumed and the boundaries between nature and society are not firmly drawn. The current vulnerability to climatic stimuli determines the adaptive capacity of a system, and climate change modifies not only the biophysical conditions but also the context in which climate change occurs.

The contextual approach builds on the dual consideration of socio-economic and biophysical aspects that make a system vulnerable (Turner *et al*., 2003; O'Brien *et al*., 2004; Polsky, Neff and Yarnall, 2007). The general concept of socio-economic vulnerability is illustrated in Schröter *et al.* (2005) with an example on famine. Schröter *et al.,* (2005) argue that rather than focusing on the physical stress (e.g. drought) as the cause of famine, it might be more informative to focus on the social, economic and political marginalization of the individuals or groups as the cause for that famine. Likewise, the contextual approach emphasizes that the social and ecological context in which climate change occurs is likely to be as important as the climatic shock itself (Bohle, Downing and Watts, 1994; Handmer, Dovers and Downing, 1999; Turner *et al*., 2003; Ericksen, 2008).

As vulnerability is context- and purpose-specific, none of the vulnerability concepts can be considered as being better or worse than the other. As highlighted in O'Brien *et al*., (2007),

the outcome and contextual interpretations of vulnerability should be recognized as being two complementary approaches to the climate change issue. The two approaches assess vulnerability from different perspectives and they are both important to understand the relevance of climate change and respective responses (Kelly and Adger, 2000; Adger, 2006; O'Brien *et al.*, 2007). Moreover, in recognizing that any complex system commonly involves multiple variables (physical, environmental, social, cultural and economic), it seems imperative to assess the vulnerability of a system by using an integrated or multidimensional approach in order to capture and understand the complete picture of vulnerability in the context of climate change (Cardona *et al.*, 2012).

2.6.2 Climate change adaptation and smallholder farmers

Adaptation is central to many proposed strategies for reducing the negative impacts of climate change. Adaptive capacity building is increasingly embraced by governments and other institutions as a means to improve economic and ecological resilience. Policymakers draw linkages between a country's financial, human, and institutional capital and its adaptive capacity (Roberts et al., 2009). Evidence from available studies indicates that high income nations are most likely to adapt, the most vulnerable are least likely to adapt, and proactive adaptation is often government driven (Berrang-Ford et al., 2011). The task of distinguishing climate change impacts from economic ones is tremendously challenging, leading to calls for the mainstreaming of climate adaptation in development (Conway and Schipper 2011).

Smallholder farmers are targeted for adaptive capacity-building programs because of the central position of agriculture in the economies of many developing countries. In Africa, an estimated 65 percent of people are engaged in agricultural livelihoods, the vast majority of which are small scale (International Food Policy Research Institute [IFPRI] 2004). The high

dependence of farmers on non-irrigated agriculture makes them especially vulnerable to the harmful effects of climate change. Collectively, smallholder farmers are a powerful agent of land-use change; adaptive responses that yield beneficial impacts may also lead to enhanced landscape-scale resiliency. Three key features of an "adaptability and resiliency framework" developed by Fraser (2007) include agro-ecosystem robustness, availability of alternative livelihoods, and adequate institutional support. Many adaptation interventions targeted at smallholder farmers focus on developing agro-ecosystem robustness through the implementation of conservation measures and the provision of services to enhance agricultural productivity.

2.6.3 Conceptual Framework

The framework identifies the inter-relationships between shocks, vulnerabilities and adaptation strategies. The dependent variable in the empirical estimation are the choice of an adaptation option from a set of adaptation strategies while the explanatory variables for this study includes household characteristics such as education, sex, age of the household head, household size and income; institutional factors such as access to information and access to credit (DFID, 2000)

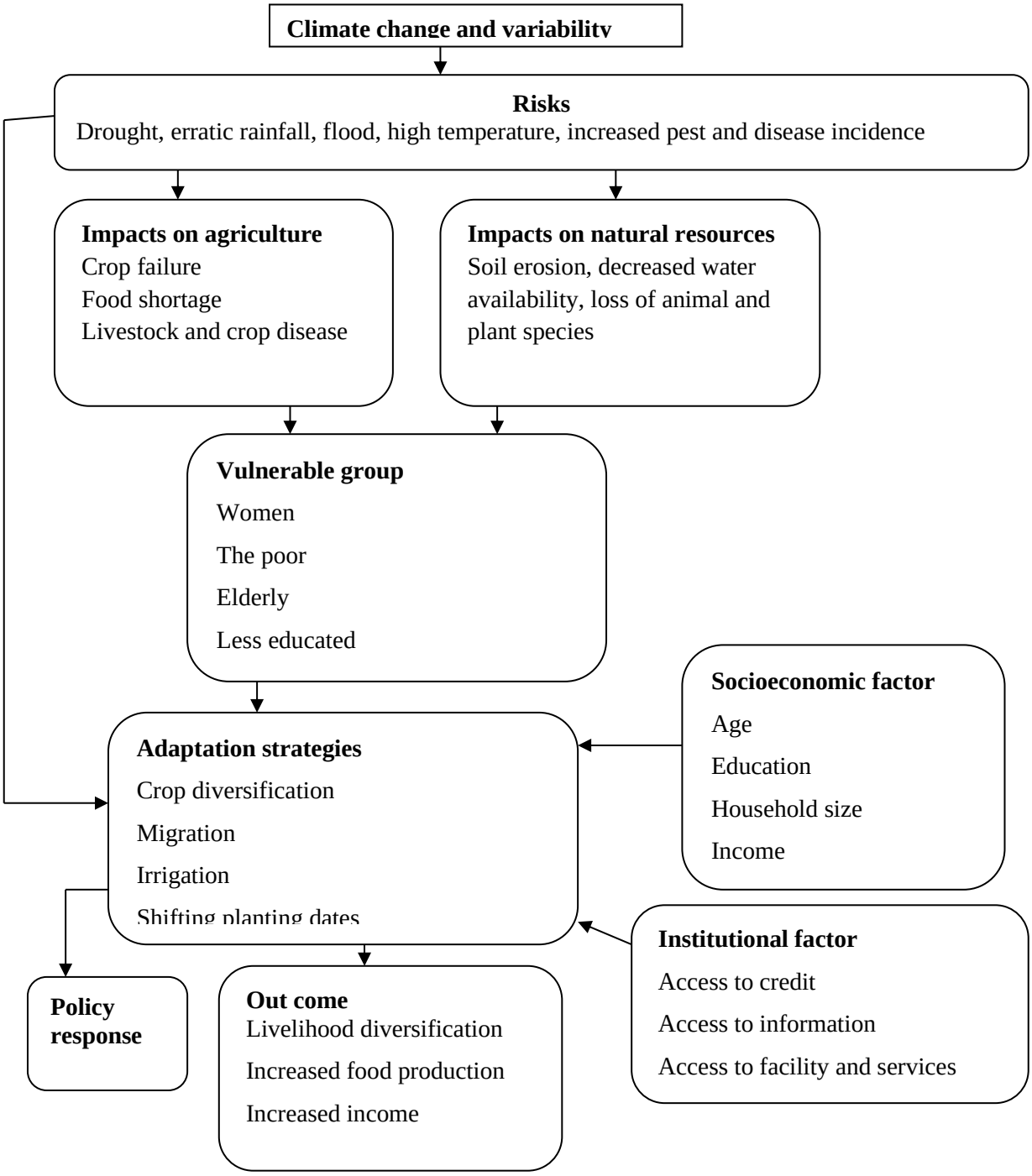

Figure 1. Conceptual framework

Chapter Three

3. Materials and Methods

3.1 Description of the Study Area

Assosa woreda is located at 642 km west of Addis Ababa, the capital of Ethiopia and it is the surrounding of Assosa town the capital of Benishangul Gumuz regional state. Its location is $9^0$50'0" to $10^0$10'0" latitude to the north and $34^0$10'0' to $34^0$50'0" longitude to the east, the altitude ranging from 600 to 1400 m above sea level and has area coverage of 2903.06 thousand hectares (ha). The area receives an average annual rain fall ranging from 860 to 1600 mm and average daily temperature from 25 to 45C^o. The agro climatic zones of the woreda are low lands that covers 75% of the area and the remaining 21% midland or 'Weynadega' and 4% highland 'Dega', About 80% of the woreda's economy depends on Agriculture and the remaining 20% is gold mining activities. The main products crops are maize and sorghum. The most dominant is maize that covers 92% of the area, topographically, the study area is gently sloping (BGBOARD, 2017).

Based on the national censes (CSA, 2007) BGRS 2016 projection year the population of Assosa woreda is 104,147, of which 52,968 are males and 51,179 females. The woreda is bordered by Mengie woreda to the East, North Sudan to the West, Komosha woreda to the North and Bambasi woreda to the South. In the woreda majority of the inhabitant is Berta ethnic group followed by Amhara and Oromo

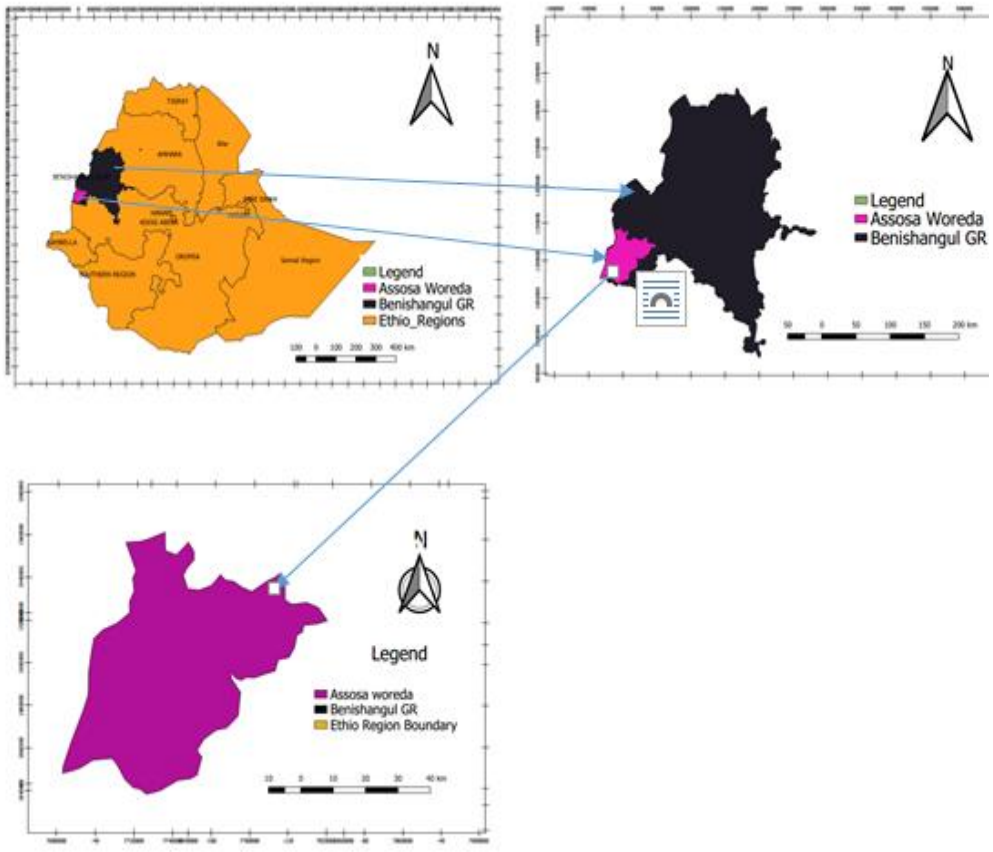

Figure 2. Map of the study area
Sources: Ethiopian mapping agency (2012)

3.2 Methods

3.2.1 Methods of Data Collections

Questionnaire: The student researcher used questionnaire to collect the primary data and that could be understood by respondents as well as obtain better information about the issues under investigation. The questionnaire included structural open ended questions to 349 households about 9% the total households in the study area were assessed.

Interview: The researcher was used to explore variables under investigation details with 20 key informants of kebele residences, woreda environmental protection, agriculture and natural

resources, health, women and youth experts in respecting offices. The focus of interview with key informants was on adaptation strategies to climate change vulnerabilities in the study area.

Focus Group Discussion: The researcher used focused group discussion in order to support the reality of the data going to gathered in house hold survey and key informant focus group discussion should be included. Therefore, for the study 4 focus group discussions involving 8 participants were arranged. To assess the adaptation strategy by clustering the kebelles in 4 clusters that each cluster having 8 members with total 32 members were participated.

3.2.2 Data Type and Source

With regard to data type and sources, the student researcher was used both primary and secondary sources. The primary sources for this study will be gathered from the household heads dwelling in the study area, from key informants of the kebelle residences, woreda environmental protection and land administration office, health office and agricultural office experts as well as from women and youth office and photographs from field observation. The secondary data were collected from different sources such as census, district manuscripts, recorded and official documents from the woreda and regional bureaus of women and youth, environmental protection and land administration and agricultural and natural resources and health bureaus, Annual Statistical Abstracts will be consulted as well as relevant literatures concerning households were reviewed. To gather data from primary sources, the researchers used structural questionnaires, interviews and field observation tools.

3.3 Sampling design

3.3.1 Selection of Study Area

Assosa woreda administration has 74 kebeles out of which the researcher has been selected 12 kebeles by random sampling techniques of total 3880 households in the selected kebeles 349 households (about 9 %) the total HHs were considered using simple random sampling techniques. In addition key informants from various institutes were selected and this include senior regional environmental protection experts, women and youth experts and agricultural experts, core processor owners, district environmental protection officers, women and youth officer, health officer), NGOs directly concerned with adaptation strategies of farmers to climate change vulnerability issues in the district.

3.3.2 Sampling techniques

In this study, both probability and non - probability sampling technique procedures were used to select the survey areas and sampling unit of households selected and interviewees. At first stage, Assosa woreda was selected randomly from the Benishangul Gumuz regional state of 20 woredas. In the second stage, 12 kebeles were selected from the total of 74 rural kebeles randomly through lottery method in order to accommodate 349 household heads.

3.3.3 Sample Size

To determine the sample size (n), sample size determination formula will be used as follows:

n= $\frac{z^2pq}{e^2}$, where, n=the sample size z= the value of the standard deviation at a given confidence level, q=1-p = denied from the target = statistical significance (acceptable error)

p = the proportion in the target.

The researcher is going to use 95% level of confidence interval with corresponding standard variate z = 1.96 as per the normal curve area table and 5% level of significance. Since the target population less 10,000, 50% is recommended to use in the target. Thus, p = 50% = 0.5 and q = 1-p = 1-0.50 = 0.5(50%). The total household of the selected 'kebeles' (N) is 3880 households. Therefore, the sample size is given by:

$n= \frac{(1.96)^2\,(0.5)(0.5)}{(0.05)^2} = \frac{3.8416\,x\,0.25}{0.0025} = \frac{0.9604}{0.0025} = 384$, then to find real sample size, i.e. $n= \frac{n}{1+\frac{n}{N}} = \frac{384}{1+\frac{384}{3880}} = \frac{\frac{384}{3880+384}}{3880} = \frac{\frac{384}{4264}}{3880} = \frac{384X3800}{4125} = \frac{1,489,920}{4264} = 349.41 \approx 349$ so that the researcher would be used the sample sizes (349) households to the study (Kothari, 2004)

Table2 .The distribution of sample sizes of household heads from each selected kebeles

No	List of kebeles	Total households	Sample households from each kebele	Methods of selection
1	Amba1	318	(349*318/3880) = 29	Simple random
	Amba 6	253	(349*253/3880) = 23	Simple random
	Amba 14	280	(349*280/3880) = 25	Simple random
2	Selga 21	274	(349*274/3880) = 25	Simple random
	Selga 24	258	(349*258/3880) = 23	Simple random
3	Megele 30	237	(349*237/3880) = 21	Simple random
	Megele 35	301	(349*301/3880) = 27	Simple random
4	Abramo	403	(349*403/3800) = 36	Simple random
	Alubo	280	(349*280/3880) = 25	Simple random
	Gambela	420	(349*420/3880) = 38	Simple random
	Afasizm	312	(349*312/3880) = 28	Simple random
	Baro	544	(349*544/3880) = 49	Simple random
12		3880	349	

Source: own construction (2020)

In addition to this the researcher would be employed purposive or judgmental Non - probability sampling technique in order to get information from office and bureau employees

and leaders because all do not have equal chance of selection to get main information from the key informants.

Table .3 Selections of key Informants from Different Offices and Bureaus for Interviews

No	Offices from where the key informants will be selected	No. of selected key informant	Methods of selection
1	Assosa woreda women and youth office	1	Purposive
2	Assosa woreda Agriculture and natural resources office	1	Purposive
3	Assosa woreda health office	1	purposive
3	Benishangul Gumuz regional state environmental protection bureau core process owner and environmental impact assessment expert	2	Purposive
4	kebele administration office	12	Purposive
5	Model kebele farmers	3	Purposive
	Total	20	Purposive

Source: own construction (2020)

3.3.4 Data Collection Procedures

The study was conducted in 12 kebeles. For this purpose 12 enumerators were used in data collection with a good command of local language (Rutana) in addition to Amharic. Before data collection enumerators would be given training on how to administer the questionnaire.

The data were collected within two month. Since the respondents are farmers, Sunday or any holydays are more comfortable to get respondents free of work at home. Each enumerator has spent time in respected kebeles and the researcher has supervise and support the enumerators.

The semi structural interview with key informants was conducted by the researcher within two month side by side to the questioners. The duration of time with the key informants was between the minimum 20 minutes and maximum 35 minutes to save their time. In the study

area illiterate (unable to read and write) respondents was selected randomly regarding to this the enumerators will be read the questioner to respondents and write the respondents consent.

3.4 Data Processing and Analysis

3.4.1 Data Processing

To reduce uncertainties, incomplete answers and other fictitious responses were discarded and make it useful in analysis, the row data would be filtered, coded, grouped, tabulated and summarized with the help of SPSS version 22 software.

3.4.2 Data Analysis

There are various methods and procedures for data analysis the application of a certain procedure and methods on several facts like the nature of the problem, the purpose of the study, the instrument used, the data collected etc. In this study, econometric model would be adopted.

3.4.3 Descriptive statistics

The descriptive statistics frequency, mean, standard deviation percentage were used, while econometric analysis also was carried out using SPSS software version 22 in analyzing the data collected through questioner and interview.

Table 4. Operational Definition and Description of variables with expected result

S/N	Variables	Operational Definition	Expected result
1	Age (age):	It is a continuous variable measured in years	In determine (+/-)
2	Marital status (marsta)	Marital status is a dummy which refers to respondent's states of being single or married. A value of '1' will be given to married '0' for single.	Negative (-)

3	Literacy level hh head (litle)	Literacy level refers to whether the respondent is literate (can read and write) or illiterate (cannot read and write). A value of '1' will be assigned for literate and '0' for illiterate.	Positive (+)
4	Family size (famsize):	It is a continuous variable, the number of family size live in the same household	In determine (+/-)
5	Early adopter neighbors	A dummy variable refers to early adopt HHs value 1 for early adopters , 0 otherwise	Positive (+)
6	Extension worker	A dummy variable value 1 for exist, 0 otherwise	Positive (+)
7	Income	It is continuous variable that determine the adaptation strategies	In determine (+/-)
8	Gender	It is variable counts in male or female and the value1for male, 0 for female	In determine (+/-)
9	Education level	It is a continuous variable measured in levels of education	In determine (+/-)
10	Access to credit	It is variable with values of a dummy variable '1' for access to credit services, '0' otherwise	Positive (+)
11	Awareness creation	Is a dummy variable with valves of a dummy variable '1' for awareness creation, '0' otherwise	Positive (+)
12	Land size	A variable with values of a dummy variable '1' for land size, '0' otherwise	In determine (+/-)

Source: own construction (2020)

3.4.3.1 Model specification

The research was used logit model; the rural households would decide to adopt the climate change strategies.

$$Yi = \begin{cases} 1 \; if \;\; small\, farmer\, adopt\, climat\, chang\, strategy \\ 0 \quad otherwises \end{cases}$$

Here the dependent variable is dichotomous, taking 0 or 1 values, there is a need of a probability model that has these two features (1) as Xi increases, Pi = E(Y = 1 | Xi) increases

but never steps outside the [0, 1] interval, and (2) the relationship between Pi and Xi is non-linear thus, one can easily use cumulative distribution function (Gujarati, 2004). Both Logistic and probit regression models satisfy the above two conditions. But, even though there is no base statistical theory for preferring one over the other, there are two practical advantages of the logit model than probit model. The first one is its simplicity: second its interpretability the inverse linear zing transformation for the logit model is directly interpretable as log-odds, while the inverse transformation for probit does not have a direct interpretation. By taking in to consideration these advantages, the researcher preferred to use binary logistic regression model to predict the effects of independents variables on the dependent variable.

Therefore, the dependent variable is dichotomous, i.e. to adapt or not to adapt climate change strategy: thus, the dependent variable Yi = 1 if the household adopt the climate change adaptation strategy, and Yi = 0 if the household do not adapt. To adapt or not to adapt in relation to independent variables can be depicted in linear probability as follow

$$Yi = \beta 0 + Xi\beta + \varepsilon i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

This is the usual linear regression model, the drawback of this model are εi only two values

If Yi =1 then εi = 1-Xiβ (with prob. Pi)

If Yi = 0 then εi = - Xiβ (with prob. 1- Xiβ)

Here, εi is not normally distributed but rather has a discrete (binary) probability distribution.

Therefore, the expectation mean of εi conditional on the exogenous variables Xi from the above.

$$E(\varepsilon i/Xi) = (1 - Xi\beta)Pi + (-Xi\beta)(1 - Pi)$$

$$E(\varepsilon i/Xi) = Pi - Xi\beta$$

Setting this mean to zero as in the classical regression analysis mean:

$$(\varepsilon i/Xi) = 0, Pi = Xi\beta \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The probability of an event is always a number between 0 and 1 (inclusive) so we can see that:

$$Pi = (prob.1/Xi) = Xi\beta \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Therefore, εi follow the binary distribution, i.e. (εi is binary distribution) leads to rise logit model. The logistic distribution function is given by:

$$prob.(\varepsilon i < Xi\beta) = \wedge(Xi\beta) = \frac{e^{Xi\beta}}{1 + e^{Xi\beta}} \ldots\ldots\ldots\ldots\ldots\ldots (**)$$

Here the response probability prob. (Yi =1) is evaluated as:

$$Pi = prob.(Yi = 1/Xi) = prob.(\varepsilon i > -Xi\beta/Xi)$$

$$= 1 - prob.(\varepsilon i < -Xi\beta/Xi)$$

$$= 1 - \wedge(-Xi\beta) = 1 - \frac{e^{-Xi\beta}}{1 + e^{-eXi\beta}}$$

$$Pi = \frac{e^{xi\beta}}{1+e^{Xi\beta}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Similarly, the non- response probability is evaluated as:

$$1\text{-Pi} = \text{prob}\,(Yi = 0/Xi) = 1 - \frac{e^{xi\beta}}{1+e^{Xi\beta}}$$

$$1\text{-Pi} = \frac{1}{1+e^{Xi\beta}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Note that the response and non- response probabilities both lie in the interval [0, 1] and hence, are interpretable. Therefore, for the logit model, the ratio is given by:

$$\frac{Pi}{1-Pi} = \frac{prob.(Yi=1/Xi)}{prob.(Yi=0/Xi)} = \frac{\frac{e^{Xi\beta}}{1+e^{Xi\beta}}}{\frac{1}{1+e^{Xi\beta}}}$$

$$\frac{Pi}{1-Pi} = e^{Xi\beta} \ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

Pi/ (1-Pi) are the odds ratio in favor of adopting the climate change i.e. the household will adopt the climate change strategy to the probability that it will not adopt the climate change strategy. Taking the natural logarithm of equation (6) one can obtain.

$$\text{Ln}\left[\frac{Pi}{1-Pi}\right] = Xi\beta = \beta 0 + X1i\beta 1 + X2i\beta 2 \ldots\ldots + Xki\beta k + \varepsilon i \ldots\ldots\ldots \quad (7)$$

Here the log of odds ratio is linear both in Xi and in the parameters. Therefore, (βo) stands for intercepts. While X_i is the hypothesized determinants of climate change adaptation and βk are the parameters to be estimated. Therefore, the model employed has the following form, with the error tem:

Where, Xi − independent variables, βo − constant,

$$\beta i - regration\ coefficients\ of\ theindependentvariable\ (slope)$$

3.4.3.2 Diagnostic Test

Before the start of complete analysis, various diagnostic tests were conducted to make the data ready for regression. Any analysis should incorporate a thorough examination of logistic regression diagnostics before reaching a final decision on model adequacy (Hosmer

et al, 2000). Model-Fit test is one of the most useful tests for truly assessing model fit for binary logistic regression models (Gujarati, 2004). Hosmer –Lemeshow test shows the overall goodness of the fitted model is indicated by insignificant chi- square (p- value >0.05) the model produce a significant difference between the observed and predicted probability so, the predicted model is fitted the data well in this study since the prob> chi2 was found to be 0.081 which is greater than 0.05 (see appendix B: section (1) for the model fit test.

To test the correlation between variables included in the model pair-wise correlation test was run. As general rule, multi-co linearity is a problem when the correlation result is above 0.80 and below -0.80 (Stock & Watson, 2007). The coefficients of all variables were found to be within the specified range and hence there is no issue of multi-co linearity as it ranges from (-0.70 to 0.076).

In standard regression, the co-efficient of determination (R^2) value gives an indication of how much variation in y is explained by the independent/ explanatory variables. This cannot be calculated the exact value for logistic regression but logistic regression gives pseudo R^2 values which try to measure something similar. (From a minimum value of 0 to a maximum of approximately 1) were tested. For this study pseudo R^2 was found 0.735 which implies that the explanatory variables explain the dependent variable by 73.5 percent.

Chapter Four

4. Results and Discussion

4.1 Data analysis and Interpretation

4.2. Introduction

This chapter presents the analysis, discussion and interpretation of the data that was collected through structured questionnaire, semi-structured interviews and focus group discussion. Descriptive statistics and econometric analyses were employed. The relationship, direction of association between dependent variable (climate change adaptation strategy) and the explanatory variables and the effect of the explanatory variables on the dependent variable are also presented. Thus, the result of the finding is presented using descriptive statistical tools such as mean, percentage and standard deviations with the help of an independent t-test and chi-square association test and logit econometric model. The researcher uses tables and descriptive statistics to present data in a way that can easily be understood by readers. A clear analytical interpretation was then made on each item presented either in tabular or graphical form.

4.3. Response Rate of the Respondents

To identify adaptation strategies of climate change vulnerability of rural households, a systematic sample of 349 households from the sample frame were taken from twelve (12) randomly selected rural kebeles in Assosa Woreda. From this total sample, 340 (97.7% household respondents were reached. The remaining 9 HH responses were not found right and dropped. Due to 5 incomplete data and 4 lack to return the questionnaire. As a result, the data

analysis was made for 340 respondents with rejecting the remaining nine. In addition, the researcher has collected the needed information by interviews from 20 key informants and 32 focused group discussion from the selected kebelles successfully.

4.4. Socio- Economic Profile and Demographic Characteristics of the Respondents

The demographic characteristics of the respondents show a great variation related with the differences in background characteristics of respondents for this study. In this study, the researcher tried to constitute different sample employees with various demographic characteristics. The description of the demographic characteristics of the target population gives some basic information about age, gender, educational level, occupation, previous experience of the respondents. The demographic characteristics of a given population have its own implication in self-employee performance in a country. Therefore, it is necessary to discuss and analyze these variables which include gender, age, marital states, and household income level respondents.

Table 4.1 Socio-Economic Profile and Demographic Characteristics of the Respondents

Variable	Category	Frequency	Percentage (%)
Gender	Male	210	61.7
	Female	130	38.3
	Total	340	100
Age	Below 20	17	5
	21-30	252	74.1
	31-40	71	20.9
	Total	340	100
Marital states	Single	32	9
	Married	306	90
	Widowed	3	0.6
	Divorced	2	0.4
	Total	340	100
	>10,000	17	5
	5000 -10000	34	10

Family income level	2000 -5000	51	15
	1000 -2000	85	25
	<1000	162	45
	Total	340	100
Occupation	Government	7	2
	Farmer	307	90.3
	NGO	14	4.1
	Others	12	3.5
	Total	340	100

Source: field survey (2020)

4.4.1. Gender of the Respondents

The above table 4.1 shows that gender of the respondents male and female almost un equivalent. The survey result indicated in table 4.1 show that, out of the total 340 respondents 210 (61.7%) were males while 130 (38.3%) were females. The respondents who took in this study were predominantly males (see table 4.1) this probability reflects the way men dominate socio economic issues in the study area but not necessary the actual male: female ratio. The under representation of in gender ratios of female vis-à-vis male does show that female are still under representation across all social sectors. The implication in relation to this study therefore, is that female involvement in adaptation of climate change strategy has not yet reached the desired threshold.

4.4.2. Age of the Respondents

As shown in the above table, 4.1 Majority, of the respondents 252(74.1%) were in the age group of 21-30 years followed by those age group 31-40 years accounting for 71(20.9%) of the respondents and 17(5%) are in the age group below 20 years. Since the majority of the respondents belong to the age group between 21- 40 this probability reflects the fact that majority of the rural population is in the youthful stage and within productive age group which is believed that most groups have great potential for economic development. Similarly the

youth groups are also active to participate in the new technology adaptation and as a result their contribution in the climate change strategy adaptation can be great.

4.4.3. Marital Status of the Respondents

306 (90 %) of the respondents are married followed by 32 (9%) were single. Only 3 (0.6%) are widowed and 2 (0.4%) are divorced. Here the married population members are large in number this may create an opportunity of climate change adaptation strategies.

4.4.4. Occupation of the Respondents Family

The sample small farmer respondents have different occupations or jobs. These include government employees, Farmers employees, NGO employees and others. As indicated in the above table, 4.1. Farmer employees account the highest percent which is 90.2% of the sample respondents whereas, 2% were the Government employees, 4.1% were NGO employees and 3.5% were other employees. Here Farmers who are having permanent job families this may help to adapt climate change strategy of smallholder farmers.

4.4.5. Family Income Level of the Respondents

The family incomes of sample farmers in general, have the direct relationship to climate change adoption strategy. As the income of households' increases, then the tendency of climate change strategy adoption increases due to their need to minimize the impacts on forest resources and ability to give money to care. As shown in the above table 4.1. The income level of the majority of the respondents is below 1000 birr per month. This amount could not initiate them and contribute some amount of money for climate change adoption strategy in the family. The other 25% of the sample respondents earn between 1000-2000 birr per month.

4. 5. Discussion on Descriptive Statistics of the Survey Result

4.5.1. Climate Change Vulnerability of Smallholder Farmers

According to the data collected from Assosa woreda Agriculture office most of the small farmers in the study area depend on agricultural economic activities with poor and traditional farming system. This traditional agricultural system highly vulnerable to climate change.

Table: 4.2 Climate change vulnerability in Assosa woreda

No	vulnerable groups	frequency	Coverage in %
1	Elder	15	4.4%
2	Children	18	5.3%
3	Female	307	90.3%
	Total	340	100%

Source: Based on filed survey (March, 2020)

According to the qualitative survey data, the most vulnerable household due to climate change are the poor, youth (especially female and children) and farmers who depend on annual crops are more vulnerable which is covered 90.3%, children 5.3% who depend on annual crops and elder accounts 4.4% are more vulnerable. Further analysis of FGD interview result reveled that seasonal drought is found to be the main sources of vulnerability which covered 6 (75%) and followed by animal diseases and soil erosion 2(25%). Farmers in the midlands did not only report drought conditions but also frequent occurrence of soil erosion. In the low lands, there was confirmed long dry spells and frost. The researcher visited several farms and confirmed, perennial crops affected by shortage of rainfall in all study sites during the visit time.

4.6. Constraints of the Climate Change Adaptation Strategy

Climate change trend continues and the change is more likely to affect agricultural activities and consequently reduce the societies copping range to the future (Temesgen *et al.,* 2009). According

Collier *et al* ., 2008, who have shown that climate change increases the heat stress on livestock and plants, decreases land suitable for agriculture and promotes shorter periods of seed formation, and consequently, lowers the yield of production. Particularly drought can be marked by precipitation deficiency that threats the livelihood resources and overall development efforts of nations and specific places through worsening Agriculture in general and farming in particular is more vulnerable to climate change.

Based on the data collected through appropriate instruments the most important reason for low adoption rate of climate change adaptation strategy in the study area are poor institutional organization, low community awareness, lack of information shortage of financial access among others. Table 4.3 below summarizes the major challenges of the climate change adoption strategy in the study area.

Table: 4.3 Major challenges of climate changes adaptation strategy

no	Problem	Frequency	Percent (%)
1	Poor institutional organization	119	34.9
2	Poor community awareness	127	37.2
3	Lack of information	24	7.0
4	Shortage of financial access	31	9.1
5	No response	39	11.8
	Total	340	100.0

Sources: Based on filed survey (March, 2020)

From the above table majority of the respondents respond that the poor community awareness 127(37.2) are the major challenge for climate change adaptation strategy in the study area, and followed by poor institutional organization, shortage of finances and lack of information 119(34.9%), 31(9.1%) and 24(7%) respectively, and these are the main problems that hinder the demand of climate change adaptation strategy. So, the existing strategy faces technical problem that hinder the technology adoption and they suggests the strategy under

implementation requires re- design to solve the existing poor quality of the strategy under implementation.

4.7. Adaptation Strategies of Climate Change for Small Farmers Household

Climate changes adoption strategies has significant and substantial effects on the livelihood development and motivation of small farmers. Climate change trend continues and the change is more likely to affect agricultural activities and consequently reduce the societies copping range to the future (Temesgen et al., 2009). Particularly drought can be marked by precipitation deficiency that threats the livelihood resources and overall development efforts of nations and specific places through worsening water shortage. Agriculture in general and farming in particular is vulnerable to climate change. Within farming activity, annual crop producers are more vulnerable to climate change than those producing some perennial trees such as Eucalyptus, banana, and mango etc. Cash crop production, reduce vulnerability means help farmers in developing resilience to external shocks and increase the overall sustainability of their livelihoods (Seyoum, 2015). Social impact of climate change is human related diseases and injuries are introduced especially in hot areas, and become highly prone to disease outbreak (e.g. Miles, 2014). However, our result indicated that there is no impact on human related disease due to intense follow of health care and implementation of full mitigation strategies package.

The following table shows the possible strategies that adapt climate changes for smallholder farmers.

Table: 4.4 Major Adaptation Strategies For Climate Changes

no	Strategies	Frequency	Percent (%)
1	Crop diversification	124	23.3
2	Irrigation	167	48.9
3	Migration	21	7.0
4	Shift planting date	28	9.1
5	No response	0	11.7
	Total	340	100.0

Sources: Based on filed survey (March, 2020)

From the above table majority of the respondents would respond that irrigation 167(48.9) are the best used adaptation strategy for climate change vulnerability in the study area, and followed by poor crop diversification, shifting cultivation and migration 124(36.3%), 28(8.2%) and 21(6.1%) respectively.

The result from FGD and interview are reported on cropping mechanisms such as seeking relief aid, spiritual solution (pray), reduce the amount of food they consume, fewer meals per day, sold livestock and seeking daily labor work to support to people to cope with difficult times in the short term. While small holder farmer were not confined to only coping measures, they also undertook adaptation strategies. Particular interest in coping mechanisms in low lands and high lands of Assosa is on crop diversification where farmers allot land for perennial crops. In those areas the variation in vulnerability was common between households; households that have perennials crop were better at coping to climatic shock than those who lack it. Implementation of adaptation strategies by small farmer households varied across the study area. However, the major adaptation strategies adopted by farmers in the study area included the irrigation, crop diversification and change in crop variety. The main reason for these adaptations may be due to presence of SLMP project and BenishangulGumuz agriculture research institute for irrigation expansion and short variety seed distribution respectively. Districts with higher small irrigation

rate are expected to have a higher capacity to adapt to climate challenges and other economic shocks.

4.8. Factors Affecting Climate Change Adaptation Strategies

4.8.1. Demographic factors

There are different demographic Factors that affecting climate change adaptation strategy by small scale farmers. But, for this study, age, marital status, literacy level and family size are explained below.

Table: 4.5 Climate Change adaptation Strategy with age and family size

variable	Adopters/non adapters	min	Max	mean	st.Dv	t-value
age	Adopter	21	60	33.6	9.1	9.14
	non-adopter	21	70	43.7	10.8	
	Total	21	70	38.1	11.2	
family size	Adopter	4	12	7.01	8.2	8.18
	non-adopter	2	5	5.1	2.37	
	Total	1	12	6.1	2.33	

Source: Own survey data,(2020)

4.8.2. Climate Chang Strategy Adaptation and Age

As it can be seen from Table 4.5, the means for adopters and non-adopters is 33.6 and 43.7, the standard deviations for adopters and non-adopters are 9.1 and 10.8, respectively. This finding reveals that there is mean variation between the climate change strategy adopters' and the non-adopters' age. The average age of adopters is less than the average age of non-adopters. In addition, this mean variation was found to be statistically significant with t-value of 9.14. This t-value suggests that there is significant difference between adaptors climate change strategy, the mean of adopters and the mean of non-adopters at ($P<0.01$) level of significance. This

implies that the younger the age, the more to adopt climate change strategy and vice versa. This may be because of older people are more conservative towards accepting new technologies and instead they prefer to continue using the technology they are habituated. This finding is in concord with the works of Conway and Schipper (2011) and Berrang- ford (2011) that found statistically significant relationship between age and climate change strategy adoption decision.

4.8.3 Climate change Adaptation Strategy and Family Size

As it can be seen from Table 4.5, the mean of non-adopters (5.1) exceeds the mean of adopters (7.01) and the standard deviation of non-adopters (1.80) exceeds the standard deviation of adopters (2.37). Though there is a mean difference in family size of both the adopters and non-adopters, the t- value 8.18 shows that there is significant difference between the family size of the adopters and non-adopters decision to adopt climate change strategy. This implies that high family size adopt climate change strategy. This may be households with more children especially male children give more value for new climate change mitigation strategy because they have more labor who can taker for climate change strategy implementation. This finding is similar with the works of Engel (2012) and Berrang et.al., (2011) that found statistically significant relationship between family size and climate change adaptation strategies.

Table: 4.6 Climate Change Strategy adaptation with marital states, lit racy level, and gender

Variable		Frequency for adaptation						
		Adopter		non adopter		Total		Chi^2
		No	Percent	No	Percent	No	Percent	p.value
Marital states	single	8	66.7	4	33.3	12	3.5	
	married	122	37.08	207	62.92	328	96.5	
	total	130	100	211	100	340	100	0.000*
literacy level	literate	98	73.13	36	26.87	134	39.3	
	illiterate	32	15.46	175	84.54	206	65.92	
	total	130	100	211	100	340	100	0.000*

Gender	female	39	88.7	5	11.3	44	12.9	
	male	91	30.6	206	69.4	296	89.1	
	total	130	100	211	100	340	100	0.000*

Source: Own survey data,(2020) NB. * indicates level of significance at 1%

4.8.4 Climate Change Strategy Adaptation and Marital Status

Table 4.6 shows that Majority (62.92%) of married women was found to be non-adopter of climate change mitigation strategy in the study area. These figures indicate that a greater proportion of single women tended to adopt climate change mitigation strategy as compared to married counterparts. In addition, the chi-square statistic showed this to be statistically significant with P-value of 0.038. Therefore, it can be conclude that there is significant relationship between marital status and climate change mitigation adoption decision at ($p<0.05$) level of significance.

From this finding one can understand that single women were more likely to adopt climate change strategy as compared to married counterpart. This may be because of single women has full power to make economic decision in the household as compared to married ones. Whereas married women were found lagged behind to adopt climate change strategy it may be because of lack of power to make economic decisions in the household, since, in masculine society, the husband is more powerful in making economic decisions. This study's finding consistent with previous studies (IPCC 2012; Eriksen and Kelly, 2007, Peltonen, 2012) that found single women (female headed households) to be more likely in adopting climate change mitigation strategy than married (male headed households).

4.8.5 Climate Change Adaptation Strategy and Literacy Level

As Table 4.6 shows, from the total of 340 respondents, 206 (60.7 %) were found illiterate 134 (39.3 %) are found literate moreover, the proportion of literate climate change mitigation strategy adopters 98(73.13 %) largely exceeds the proportion of literate non-adopters 36(26.87%) while the proportion of illiterate climate change strategy adopter 32(15.46 %) much less than the proportion of illiterate climate change strategy adopter 175(84.54 %). In addition, the chi-square statistic showed this to be statistically significant with P-value of 0.000. Therefore, it can be generalized that there is significant association between women literacy level and the probability of climate change strategy adoption decision at ($p<0.01$) significance level.

From this finding one can understand that literate women are found to be more adopt climate change strategy adopter as compared to the illiterate women. This may be because literate women are more likely to be aware of the benefits of climate change strategy as compared to uneducated. This finding is similar to the previous empirical works of (Cardona *et al*, 2012; Conway &Schipper, 2011 and Hinkel 2011) that found the higher education level of small household has a positive effect on household to adopt climate change strategy adoption compare to uneducated households

4.8.6 Climate Change Adaptation Strategy and Gender

As shown in table 4.6 out of the 340 respondents who participate in the study, 44 were female household heads while 297 were male household heads. A chi square test of independence was carried out to determine the proportion of male and female who had adopt the climate change adaptation strategy. The proportion of female who had adopted was 30.6% and the proportion

of male who had adopted was 88.7% the difference in proportion was significant at 1% level with p- value 0.000. This implies that men household head were higher than women household head in adoption of climate change mitigation strategy adoption. This result is consistent with Diz, (2011) and Hinkel, (2011) male headed household more participate than female for climate change adaptation strategies.

4.9 Economic and other Determinant factors

To assess the determinant factors of climate change adaptation strategies, economic and institutional factors that are monthly income of the respondents, availability of extension workers and early adopter neighbors are summarized as below.

Table 4.7: Climate change adaptation strategy and small farmers income,

variable	Frequency	min	max	Mean	st.Dv	t-value
income	Adopter	500	4500	1932.8	66.51	
	non-adopter	100	1700	560.94	37.87	
	Total	100	4500	1083.9	922.2	-19.3

Source: Own survey data,(2020)

4.9.1 Climate Change Adaptation Strategy and Income

Regarding average monthly income of the respondents as shown in the above table 4.7, the minimum and maximum monthly income is 100 and 4500 while the mean and standard deviation are 1083.9 and 922.2 respectively. The minimum and maximum monthly income of the adopters and non-adopters are 500 and 4500 birr and 100 and 1700, while the means for adopters and non-adopters is 1932.84 and 560.94, and the standard deviations for adopters and non-adopters are 66.51 and 37.87, respectively. This finding reveals that there is mean variation between the climate change adaptation strategy adopters and the non- adopters' monthly

income. The average income of adopters is higher than the average income of non-adopters. This infers that higher income household the more likely adopts climate change adaptation strategy. In addition, this mean variation was found to be statistically significant with t-value of -19.14. This t-value suggests that there is significant difference between the mean of climate change adoption strategy and the mean of non-adopters at ($P<0.01$) level of significance. From this finding one can understand that high income household is found to be more adopting climate change adaptation strategy as compared to low income household, and this study in concord to the previous empirical works of (Adgeret *al*, 2007; Engel, 2011; Johnston, 2012) that found the higher income household has a positive effect on household to adapt climate change strategy technologies.

4.9.2 Climate Change Adaptation Strategy and Institutional Factors

Despite climate change mitigation have multiple economic, social, environmental and health benefits the climate change mitigation program failed to capture worldwide, mainly due to political, policy and institutional barriers that contribute to low adoption rate. To examine institutional influence on rural small farmers climate change adaptation in the study area institutional variables, existence of extension workers services support are analysis as follows.

Table 4.8 Climate Change adaptation strategy and existence of extension workers

Variable		Frequency						
		Adopter		non adopter		Total		Chi^2
		No	Percent	No	percent	No	Percent	p-value
extension worker	Exist	64	55.2	52	44.8	116	34.02	
	not exist	66	29.4	159	70.6	225	65.98	
	Total	130	100	225	100	341	100	0.000*

Source: Own survey data(2020) NB. * indicates level of significance at 1%

4.9.3 Climate Change Strategy and Existences of Extension Workers

As shown in the above table 4.8 from the total of 340 respondents, 116 (34.02 %) were Saied that extension workers exist at the village level near to the farmers and create awareness about the existing climate change effects in which 64(55.2%) of them are found to be climate change adaptation strategy adopters and 52 (44.8%) of them are non-adopters. On the other side, 225 (65.98%) of the respondent are Saied the extension workers are fare from their home in which 66(29.4%) are found to be adopters and 159(70.6%) of them are non-adopters. Therefore an availability extension worker nearby area helps to provide different institutional services that support to expansion of public awareness.

This descriptive analysis result was supported by the data gained from the key informants. The key informants responded that delivering government institutions, through environmental protection experts, health extensions workers, and agriculture development agents affect directly or indirectly climate change adaptation strategy decision by providing different services such as awareness creation, training, quality control and material and technical supports. The other way of institutions organization that influences rural household climate change adaptation strategy was decentralization of services into village level. They underline that decentralization of climate change strategy to village level helps to reduces costs incurred for transportation, and it helps to familiar and increases the interest of households to adopt.

4.10. Climate Change Adaptation Strategy and Social Factors

Social factors explain social relationships and networks, there are a number of social factors that determine for climate change adaptation strategies, like influence of early adopter neighbors, members of different social associations/activities cultural informal information

exchange and attitudinal behaviors. But, for this study purpose variables of earlier adopter neighbor's membership to social associations, are discussed to examine social influence on climate change adaptation strategies.

Table: 4.9 Climate change adaptation strategy and early adopter neighbors

Variable		Frequency for adoption						
		Adopter		non adopter		Total		Chi^2
		No	Percent	No	percent	No	Percent	p-value
early adopter neighbors	Exist	123	71.93	48	28.07	171	50.15	
	not exist	7	4.2	162	95.8	169	49.85	
	Total	130	100	210	100	340	100	0.000*

Source: Own survey data,(2020) NB. * indicates level of significance at 1%

4.10.1 Climate Change and Early Adopter Neighbors

As the above table 4.9, shows, the social factor that affects climate change adaptation strategy was found to be early climate change strategy adopters neighbors from the total 340 surveyed respondents 171(50.2 %) of respondents strongly agreed that earlier adopter of climate change strategy can influence others adoption decision, Out of them 123(71.9%) were adopt the strategy and 48(28.1%) were no adopt. Similarly 170 (49.9%) of the respondents Saied no climate change mitigation strategy adopter neighbors in which only 7(4.2%) households adopt whereas 163(95.8%) were not adopters. This result supports Diffusion of Innovation Theory that emphasizes early adopters in a certain social system are able to influence attitude and behavior of others informally either to promote or hinder the acceptance of a new technology. This result is similar to the previous works of Engel (2011) and Shannon (2011) that found early adopter farmers that have positive effect on the household's likelihood of adaptation.

4.11. Econometric Analysis and Discussion

In the previous section, Determinants of urban households' credit access decision were analyzed using descriptive statistics. Further, to understand the extent to which these factors affect climate change strategy adoption decision binary logistic regression model was employed. The explanatory variables included and analyzed in the model are summarized as below.

Table: 4.10 logit regression result

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	age	-.052	.029	3.273	1	.070	.949
	edulev	.288	.122	5.551	1	.018	1.334
	famsize	.694	.477	2.115	1	.146	2.002
	gender	1.205	.466	6.683	1	.010	3.336
	erladneg	1.760	.544	10.457	1	.001	5.814
	distan	-.106	.031	11.487	1	.001	.899
	exexwork	1.060	.478	4.930	1	.026	2.887
	income	.000	.000	.796	1	.372	1.000
	lansize	.444	.358	1.532	1	.216	1.558
	accredit	1.108	.511	4.698	1	.030	3.027
	marstates	-.912	1.282	.507	1	.476	.402
	Constant	-.782	1.729	.204	1	.651	.458

a. Variable(s) entered on step 1: age, edulev, famsize, gender, erladneg, distan, exexwork, income, lansize, accredit, marstates

Source: Own formulation (2020)

4.12 Regression Result Interpretation

Variables that have significant explanatory power in determining the climate change strategy adoption decision are interpreted in this section. The coefficient and odd ratios of these powerful explanatory variables are interpreted.

Age: As indicated in the above table 4.10, as it was expected the variable age is negatively and significant at 10% level of significance. This variable has a p-value and odd ratio 0.070 and 0.949, respectively. This implies that as household age increase by one year, the probability of climate change adaptation strategy decrease (1- 0.949= 0.051) by 5.1percent keeping other covariate constant.

This implies that the younger the age, the more to adopt climate change strategies and vice versa. This may be because of older people are more conservative towards accepting new technologies and instead they prefer to continue using the technology they are habituated. This finding is in concord with the works of Berrang Ford (2011) and Conway (2011) that found statistically significant and negative relationship between age and climate change mitigation strategy adoption decision.

Gender: As indicated in the above table 4.10, as it was expected the variable gender is significant at 10% level of significance. This variable has a p-value and odd ratio 0.010 and 3.334, respectively. This implies that since, the coding gender (1) refers to male heads and the reference category gender (0) refers to female heads thus, the odd ratio is greater than two the implication is male household heads, are 3.334 times more likely higher adopt climate change strategy as compared female household heads keeping all other covariates fixed.

This implies in ordinary society men are more aware and primary responsible for decision making than women. The result of this study is consistent with empirical studies of Hinkel (2011), Cardona (2012) and Sainio (2012) that found male headed households adopt climate change adaptation strategy more quickly than women headed household.

Literacy level: As indicated in the above table 4.10: As it was expected, household level of literacy was found significant determinant factor in that affect positively small farmers household's climate change mitigation strategy adoption decision. As Table 4.10 shows household literacy level significantly affects the probability of climate change strategy adoption with p-value and odd ratio of 0.018 and 1.334, respectively. Since, coding literate (1) refers to literate household heads and the reference category illiterate (0) is illiterate household heads, the odd ratio is greater than one, the implication is literate household head are (1.334-1=0.334)33.4 percent times more likely adopt climate change adaptation strategy as compared the illiterate household keeping all other covariant constant.

Moreover, the finding of this study is similar to previous works (Conway and Schipple, 2012; Hinkel, 2012; and Cardona, 2012) that found educated household heads are more aware about the benefit of climate change strategy and the effect of using climate change so; literacy level is a significant positive factor in determining a climate change adoption decision strategy.

Early adopter neighbors: As it was expected the existences of early adopter neighbors were a positive significant factor that determines a small households' climate change adaptation strategy. This variable has p-value and odd ratio 0.001 and 3.336 respectively. The odd ratio is greater than two, the implication is that household who have early adopter neighbors are 3.336 times more likely adopt as compared to household don't have early adopter neighbors keeping other covariant fixed.

This finding confirms household technology defusing theory which asserts that early adopters create quake connection of the new technology with others and this theory illustrates that how face to face communication is more influential to create a network among the small households.

The result of the study also similar to the work of Nelson *al.,* (2010), Lin *et al.,* (2011), Sainio (2012) and Hinkel (2012) that found early adopter neighbor as one factor that positively determines the climate change strategy adoption decision.

Distance from extension services: As table 4.10 above shows that the distance from household home to climate change mitigation center has a negative effect on the adoption of climate change adoption strategy of small households at statistically significance level of 1% with p-value of 0.001 and odd ratio0.899 respectively. This implies that as household distance from climate change services center increase by one kilometer, the probability of climate change adoption strategy decrease(1- 0.899= 0.101) by 10.1 percent keeping other covariate constant.

This study is similar to previous works of Nelson *et al*., (2010); Inayat, (2011); Wandel, (2006); Cardona, (2012) that found centralization of climate change strategy at the center has significant negative effect on small farmers households' climate change adoption strategy. This study also came up with similar findings of Wandel (2006), Sainio (2012), Hinkel (2012) and Smitet al., (2000) found that if the climate change mitigation strategy extension services far from the household resident, accessibility of climate change adaptation information are not easy and take more time to adopt so, the probability of climate change strategy adoption decrease as distance from center increase.

Awareness creation: As Table 4.10 shows, as it was expected household having awareness was found positive significant determinant factor that affects credit use decision with p-value of 0.026 and odd ratio 2.887 which is significant at 5% level of significance. Since, coding aware (1) refers to aware household heads and the reference category aware (0) is not aware

household heads, the odd ratio is greater than two, the implication is aware household head are 2.887 times more likely use climate change strategy as compared not aware household keeping all other covariant constant. As it was discussed in the descriptive analysis part, when awareness of the household increases they know the benefit of climate change strategy and start to take risk of climate change adaptation strategy and start new mitigation practice and minimize the climate change vulnerability. The finding of this study is similar to previous works Conway and Schipple, (2011); Hinkel, (2012), and Lin, (2011) found that household awareness has significant positive effect on a household's climate change adoption strategy as compared to their counterpart.

Access to Credit: As it was expected credit availability to small households was a positive significant factor that determines a households' climate change adoption decision. This variable has p-value and odd ratio 0.030 and 3.027 respectively. coding (1) refers to credit access household heads and the reference category (0) is not access to credit household heads, the odd ratio is greater than two, the implication is easy access credit household head are 3.027 times more likely use climate change strategy as compared not credit access household holding all other covariant constant. This study came up with similar findings of Nelson *et al.,* (2010), Adger., (2000) and Sainio (2012) that found credit access with smooth payment modality as one determinant factor that affects climate change adaptation strategy adoption decision. The result of the study also similar to the work of Hinkel (2012), Nelson *et al.,* (2010) and Cardona (2012) that found access credit to small farmer households helps to solve the financial problems and helps to aware about the benefit of climate change strategy and the effect of using climate change so; access to credit is a significant positive factor in determining a climate change adoption decision strategy.

Chapter Five

5. Conclusions and Recommendations

5.1 Conclusions

This study investigates adaptation strategies of small holder farmers' to climate change vulnerability in Assosa woreda Benishangul Gumuz Regional State where more than 98 percent of the rural population depends on inefficient traditional agricultural economy. The key objectives of the study were to investigate adaptation strategies of climate change vulnerability in the study area. To achieve the objectives at hand the student research used both primary and secondary data source. Moreover data gathered were analyzed using descriptive and econometric methods.

The finding reveals that majority of small farmers households are the most vulnerable to climate change are the poor, youth (especially female and children) and elder farmers which is covered 94.7%, 4.4% respectively. Further analysis of FGD interview result reveled that seasonal drought is found the main sources of vulnerability which covered 6 (75%) and followed by animal diseases and soil erosion fire wood 2(25%). Farmers in the midlands did not only report drought conditions but also frequent occurrence of soil erosion. In the low lands, there was confirmed long dry spells and fire wood. All those are the reasons to small farmers' climate change vulnerability in the study area and may aggravate, famine and hanger which in turn environmental degradation, human health problem and farm land productivity reduction.

According the respondents climate change vulnerability mitigated and adapted through the strategies of alternatives irrigation, crop diversification, sifting cultivation and migration is

vital. However, still application of that irrigation 167(48.9) are the best mitigation strategy for climate change vulnerability followed by poor crop diversification, shifting cultivation and migration 124(36.3%), 28(8.2%) and 21(6.1%) respectively, are the main strategies that mitigate climate in the study area. The result from FGD and interview are reported on cropping mechanisms such as seeking relief aid, spiritual solution (pray), reduce the amount of food they consume, fewer meals per day, sold livestock and seeking daily labor work to support to people to cope with difficult times in the short term. This slow or poor rate of adaptation of such climate change coping mechanism varying in different social, economic, cultural, and institutional factors, contributes to this slow adaptation. Furthermore, survey result shows that only 38.1% of the households adopt climate change strategies and advantages in terms of high production and better life as compared to non-adopters.

Furthermore, the findings of the study revealed that variations in adaptation of the climate change strategy among small farmer households were assessed based on demographic, socio-economic and other factors. Among the demographic determinants age and gender of the household head is found to be negative and positively significant to affect adoption. In the case of socio- economic variables household education level, early adopter neighbors, awareness and access to credit were found that positive and significant effect to the adaptation of climate change. Moreover, factors such as distances to extension services are found to be negatively and significant determinant factor to climate change adoption strategy.

5.2. Recommendations and Policy Implications

Majority of the small farmers do not have access information on alternative technologies like irrigation, crop diversification, saving. To fill these knowledge gaps different strategies should

be planned to introduce and disseminate the alternative technologies, or at least public awareness creation effort should be strengthen about the benefits of climate change adaptation strategy and technologies via religious places, meeting places, market places, experience share with early adopters, posters, and radio and TV advertisements is vital to increase the awareness of the community for improvements of their agricultural productions.

Women and children are the most vulnerable group in the study area. As a result, give due consideration to women (gender) and other vulnerable groups in the context of climate change strategy development have a 'multiplier effect' since empower and educate women have over all positive effect in the household. So, motivate women to use climate change adaptation strategy for their livelihood and to be came active participant in different social and development associations to self-help improved is vital.

The village people have life cycle which they follow very culturally. Any intervention without understanding their habits, behavioral pattern and psychology will not lead to success of any intervention. It's very difficult to ask them to change their habits so any intervention should fit into their life cycle and users need to be involved in the early stage in order to ensure compatibility with local practices. So, technical faults during and post implementation needs to be taken care of. Another technical barrier is the lack of tools and methods, to monitor and quantify climate change impacts. The mitigation technology improvement should consider the work culture and the user behavior.

Climate change adaptation strategy is a cross cutting issues so, it needs sect oral coordination from Regional to kebele level. Extension agents, woreda and regional experts and producers should improve their level of participation in joint activities, and they should also consider

improving the number of visits to understand small farmers' conditions better. Finally, more research on climate change adaptation technology should be carried out and the results implemented for the betterment of the society and conservation of the environment. The smallholder farmers identified lack of funds, shortage of water for irrigation, poor planning, and shortage of the seeds recommended by agricultural experts as the main constraints in undertaking adaptation. Furthermore, on the basis of the results revealed in this study on key drivers of specific adaptation methods, the government can play a significant role by promoting adaptation methods appropriate for particular circumstances ecological zones. The results also contribute guidance for targeting farmers' recruitment into initiatives aimed at enhancing adaptation to climate change using particular methods. In order to increase adaptive capacity of farmers, the responsible bodies should create better work opportunity for farmers outside agriculture and minimize negative impacts and maximize any benefits from change in the climate.

5.3. Implication for Future Research

The study recommends that further studies should be carried out on challenges and its impact of climate change in Agricultural products are the future research area.

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Appendix

Anex1. Quantitative household survey questions.

This research's aim is to determine the adaptation strategies of small holder farmers to climate change vulnerability in Assosa woreda.

Your response will be treated as private and will be used for research purpose. Below are my questions to you.

1. **General information's**

A. Name of house hold head---------- E. Date of interview ----------

B. Name of woreda ---------- F. Starting time ----------

C. Name of kebelle ---------- G. Ending time ----------

D. Name of village ---------- H. Name of enumerator ----------

Part 1. Household character tics (Answer should be thick like X)

1. What is the sex of the house hold head? Male ----------: Female ----------

2. Marital status: Married ----------; Single ----------; divorced ----------; Widow ------

3. What is or more occupation? Farmer----------; farmer and off farm activity. ---------- Government----------,

Part 2. Demographic and social characteristics'

2.1 **Family size**: How many people live in your house including the household head?

Male ----------; Female ----------;Total ----------;

2.2. **Status** (Answer should be thick like **X**).

2.2.1. Wealth: Poor --------; Medium ----------; Rich ---------- use secondary data.

2.2.2 How well-off is your house hold today compared with the situation 5 year ago?

a. Less well-off ----------; b. about the same ----------; c. better off now ----------

2.2.3 Health situation in your family (Answer should be thick like **X**)

2.2.4 Current incidence of malaria: Very high -------; High------; Medium ------; Low-----

2.5.2 Access to health service at community health center /health station: Very poor ----- Poor--------; Good ---------; Very good ---------

Part 3.1 livelihood system

3.1.1 What are the main sources of your livelihood in order of priority?(Answer should be in **rank**)

- Annual crop ----------; Off farm activity ----------;
- livestock ----------; Remittance----------;
- perennial crop such as fruit crop ----------; Gift in kind ----------;
- forest product ----------; Safety net ----------;
- Trade ----------; Other specify ----------;

3.1.2 **Income**: what is your average monthly income from different sources in Ethiopian birr?

(1). <1,000 4). 15,000-35,000

(2). 1,000-10,000 (5). 35,000- 45,000

(3). 10,000-15,000

Did you have access to any of the following in the last year?

(Answer should be **Yes or No**)

- Schools or adult education classes : Yes ----------; No ----------;
- Training or workshops : Yes ----------; No ----------
- Other specify ----------;

3.2.3 **Financial capital**

Do you use of any of the following in the last year? Answer should be **Yes or No**)

Savings ---------; Investment ---------; Credit/formal, informal) --------; remittance----------

Pensions ----------; wage ----------;

3.2.4 **Social capital** (Answer should be **Yes or No**)

3.2.4.1 Can you get help from other people in the village (community) if you are in need, for example if you need extra money because someone in your family is sick?

No --------; Can sometimes get help, But not always ----------; Yes ----------;

3.2.4.2 Have you participated in group activities like Debo or other arrangements in the past 12 months to support a family in the village? No ----------; yes ----------;

3.2.5 **Physical capital** (Answer should be **Yes or No**)

Tools or equipment

- Family drip irrigation ----------; Tractor ----------;
- Irrigation pump ----------;

Part 4. Vulnerability to climate risk

4.1 Have you observed any change in the following climate change related events in recent times (past ten years? (Answer should be **Yes or No**)

- Level of temperature ----------; Length of the rain season ----------;
- Amount of rainfall ----------; The time for onset and end of wet season --------;
- Frequency of forest occurrence ----------; other specify ----------;

4.2 If yes to the above questions, how do you describe the type of change for each climate change related events? Answer should be **increase or decrease**)

- Level of temperature ---------- --; Length of the rain season ----------;
- Amount of rainfall ---------- ;The time for onset and end of wet season ----------;
- Frequency of forest occurrence ----------; other specify ----------;

4.3 Have you used /received any of the following resources /support in under taking the above measures to overcome or avoid the negative impacts of climate change related events?(Answer should be **Yes or No**) .

- Credit from CBO/NGO/GO, micro finance institution ----------;
- Material input from the CBO/NGO/GO ----------; Income generated from other livelihood activities ----------;
- labor support from community members ----------;
- Financial labor material /labor support from relatives /neighbors ----------;
- Technical advice /support on technology /marketing from CBO/NGO/GO----------;
- Other specify ----------;

4.4 Have you failed to take adaptation measures due to some constraints? Answer should be **Yes or No**).

4.9 If yes to question 4.4 can you indicate the most important constraint that you have faced? ----------;

Part 5. Agricultural input and production input

5.1 Did you use the water resources for irrigation? Yes----------; No----------

5.2 Tillage method: Manual with hoe ----------; Animal traction ----------; Tractor---;

5.3 Status of your cultivated land fertility; high fertile ----------; fertile ----------; Not fertile-----

5.4 Which agricultural input use in the past year? Manure ----------; Compost ----------; Urea ----------; DAP ---------; Bio fertilizer ----------;

Other specify ----------;

5.5 Have you purchased the following input in the last year? Answer should be Yes **or No**

Seed --------; fertilizer ----------; Animal feed ----------; other specify ----------

Part 6. Adaptation strategies

6.1 What adjustment in your farming have you made to climate change adaptation?

6.2 What are the major constraints faced for your implementation of agricultural adaptations to climate change in your farm practices?

6.3 What action do you take in the face of variability rainfall patterns?(Answers should be thick like **X**)

- Less rainfall: use fertilizer ----------; terracing ----------; cattle manure ---------; quick repining variability seeds ----------; irrigation ----------; flood control -------; pond ----------; a forestation ----------; other specify ----------;
- No rainfall/drought: use fertilizer ---------; cattle manure---------; irrigation ---------pond ----------; terracing ----------; quick ripening variability seeds ----------; flood control ----------; a forestation ----------; other specify ----------;
- Erratic rain: use fertilizer ----------; cattle manure ----------; irrigation ----------; pond ----------; terracing ----------; quick ripening variability seeds ------;flood control ---------; a forestation ---------; other specify ----------

6.4 Did you use input supply services in the last 5year? Yes ----------; No ----------;

6.5 Did you use market information services in the last 5 year? Yes ----------; No ------;

6.6. Did you use extension services in the last 5 year? Yes ----------; No ----------

Part 7. Institutions and markets

7.1 Do you use for information services?(Answer should be **Yes or No**)

- Radio : yes ------; No ---------Television: yes -------- No --------; Newspaper: yes --- No ----------; other specify ----------;

7.2 Do you try to get loan /credit last year? (Answer should be Yes or No).

Yes ----------; No ----------;

7.3 If yes, from which sources: government ----------; micro finance ----------;

other specify ----------

7.4 If not, why? high interest rate ----------; lack of experience and information ---------; lack of deposit ----------; other specify ----------

Anex.2 Qualitative questions for key informants interviewing in kebele level (climate change, vulnerability and adaptation questions)

1. Do you believe there is climate change in your kebele ?
2. I f yes, What are the manifestations climate change in your kebele ?
3. What are the solutions to climate change in relation to agriculture?
4. Which groups of people are more vulnerable? Why?
5. What are subsistence farmers doing to adapt to climate change?
6. What are the challenges and constraints to adapt to climate change?
7. How does the government /NGOs support subsistence farmers in relation to climate change?
8. Is there anything you want to add about climate change?

Anex.3 Open end questions interviews for the regional bureaus (climate change, vulnerability and adaptation questions)

1. Do you think there is climate change in your zone?
2. If you yes, how do you describe the problem?
3. Do you asses vulnerability to climate change? If so, how do you determine vulnerability of locations and peoples?
4. What is the role of your organization in relation to climate change?
5. Does your organization has plans to agricultural adaptation to climate change? If yes, can you explain?
6. What are the challenges and constraint to adapt to climate change?
7. Have you perceived any changes in climate change in your area in the past 10 years?
8. If yes to the above, what are those changes? And which of these changes are more important in terms of their impact on your livelihood?
9. What aspects of the livelihood (This may refer to livelihood activities (e.g. agriculture, assets, such as livestock, human capital e.g. health, social capital e.g. capacity to work together among the community, livelihood out comes e.g. income from different sources, etc.) of the local community are more affected by those climate change?

10. Compared to other community around your areas (This may refer to adjacent woredas /kebeles in the same or different agro ecology etc), Do you think your community is more or less vulnerable to climate change?

11 .When you concedes different groups in or community, Do you there are same groups who are more vulnerable to climate change? If yes, who are those groups? and why those groups more vulnerable ? What the reasons for this difference in vulnerability?

12. Refering to each of the livelihood aspects that were significantly affected by climate change (question 3 above), how do you tried to adapt to these climate changes? What do you do to agricultural adaptation to climate change? and What constraints faced to adapt to climate change ?

13. Is there a change in incidence of diseases in your area as a result of climate change? If yes what are those diseases (you can also ask the same about livestock and plant disease or pests)

14. How do you get modern (scientific information about climate change?(for example, Do you listen radio about weather ?)

15. Can you explain about support by government agencies or NGOs regarding problem caused by climate change?

16. Is there anything you want to add about climate change?

Those are the questions I have. Thank you for participating in this survey.