



**ADDIS ABABA UNIVERSITY**

**SCHOOL OF GRADUATE STUDIES**

**INSTITUTE OF REGIONAL AND LOCAL DEVELOPMENT STUDIES**

**CLIMATE CHANGE IMPACTS ON RURAL LIVELIHOOD AND  
HOUSEHOLD-LEVEL RESPONSES: A CASE STUDY OF ARBA MINCH  
ZURIA WOREDA GAMO GOFA ZONE SOUTHERN REGION**

**BY:**

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**A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF  
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**MAY, 2011**

**ADDIS ABABA, ETHIOPIA**



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**MAY, 2011**

**ADDIS ABABA, ETHIOPIA**

**DEDICATION**

*This thesis is dedicated with lots of love to*

*Amannuel Alemayehu (**Big brother**)*

*My family (especially **Abo** and **Abaye**), and*

*My wife (**Momi**).*

## STATEMENT OF THE AUTHOR

First of all, I declare that this thesis is my genuine work and that all the source of material used for this thesis has been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for MA Degree at Addis Ababa University and is deposited at the University library.

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15/06/2011



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## ACRONYMS

DA	Development Agent
CSA	Central Statistical Authority
DAP	Di-Ammonium Phosphate
E.C	Ethiopian Calendar
FSP	Food Security Programme
PSNP	Productive Safety Net Programme
IPPC	Intergovernmental Panel on Climate Change
MoFED	Ministry of Finance and Economic Development
MoRDA	Ministry of Rural Development and Agriculture
NAPA	National Adaptation Plan of Action of Ethiopia
NMA	National Metrological Agency
OMCSI	Omo Micro Credit and Saving Institution
PANE	Poverty Action Network of Civil Society Organizations in Ethiopia
WMCSI	Wisdom Micro Credit and Saving Institution

## ABSTRACT

*The main objectives of the study was to examine the major impacts of climate variability and change on rural livelihood and identify household level responses under the existing socio-economic and institutional environment. A study was conducted in three purposively selected rural kebeles of Arba Minch Zuria Woreda of Gamo Gofa Zone, Southern Region. A total of 60 sample household (20 from each kebele) were selected from three kebeles. The necessary data were generated from both primary and secondary sources. Household survey, key-informant interviews and personal observation were the main source of primary data. Examination and review of both published and unpublished reports were the major sources of secondary data. Descriptive statistics (such as means, percentages, minimum, and maximum), explanation of observation and narration of interview results were used to analyze the collected data.*

*The findings of this study showed that most farmers and interviewee respondents in the study area are aware of and perceived that local climate is changing, in terms of increase in local temperature, increase in the frequency and severity of extreme weather events like drought and floods, and above all, unpredictable and highly fluctuating precipitation patterns in their locality. In terms of impacts on rural livelihood, climate induced changes and related extremes were identified to cause severe loss and damage on household assets, decline farm production, increased indebtedness, outmigration, heavy dependency on food aid and vulnerability and reduced households' resilience against external shocks. The findings also indicated that for perceived change in climate elements and extreme events, households adopted different response mechanisms including change in the timing of farm operations, improved soil and water conservation practices, integrated watershed and rangeland management measures, social network and capital, traditional/modern micro credit and saving institutions, intensification of fertilizer and pesticides application and income diversification. However, these responses were constrained by many factors and unable to cope with increased vulnerability to future climate changes. Furthermore, poor socio-economic facilities and lack of policy-institutional support undermined these efforts.*

*Therefore, strengthening recent efforts of soil conservation, watershed and rangeland management, investment on intensification of small-scale irrigation and other water harvesting technologies, improving and expanding smallholder farmer's access to agricultural credit and finance, market information, agricultural inputs and social services and capacity building on disaster risk reduction and improving early warning systems and communications strategies are highly recommended.*

**Key Words:** Climate Change, Temperature, Rainfall, Adaptation, Livelihood, Livelihood strategies, Livelihood diversification.

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# CHAPTER ONE

## INTRODUCTION

### 1.1 Background of the Study

Impacts of climate change are wide ranging. Increased incidence and severity of extreme weather events (like drought and flooding) threaten the lives of millions of people across the world. Climate change and variability is widely agreed to be already a reality, and impacting populations, livelihoods and Ecosystems in Ethiopia. Exacerbating poverty and leading to infrastructural breakdown and social insecurity, it threatens to set back development efforts by decades, profoundly affecting all of us (Alebachew, 2009). Climate change will further reduce access to drinking water, negatively affect the health of poor people, and will pose a real threat to food security in many countries in Africa, Asia and Latin America (IPPC, 2007). In other words, climate change is a development issue, affecting all walks of life and placing increased pressure on limited capacity to meet the needs and aspirations of human society and improve basic livelihoods. The problem has received more global attention than any other environmental issue. As established by IPCC and other studies, climate change will continue to increase variability in weather patterns and make them more extreme.

Throughout human history various forms of climate change have been observed. However, the change in the remote past was essentially natural, with little or no human influence. According to IPCC (2001), since recently, the human factor has been added to the climate change equation, which is mainly due to the increased concentration of anthropogenic gases, such as CO<sub>2</sub>, methane (CH<sub>4</sub>), nitrous Oxide (N<sub>2</sub>O) and halocarbon compounds.

These gases form a layer in the atmosphere which traps a significant proportion of radiant energy from the earth. As a result, global surface temperatures gradually rise, thus resulting in a change in other climatic variables such as precipitation, humidity, wind speed and others.

It is widely believed that the change will have considerable adverse effects on economic, social, and environmental systems. Climate change is impacting efforts aimed at reducing poverty, inequality and food insecurity. Extreme weather events (hurricanes, storms, flooding, drought, heat waves) caused by climate change are likely to become more common, widespread spatially, and increased severity which will add pressure on human misery. Flood risks and other forms of weather events are expected to become more frequent, threatening food supplies and may reduce water supply. Crop and livestock production patterns and productivity will be impacted by changing climate and expected changes in pests and diseases (IPPC, 2001). One of the IPPC's conclusions was that warming caused by human activities could lead to "abrupt or irreversible" impacts.

Although all regions of the world will eventually experience the impact of climate change, the impact will disproportionately affect developing countries. According to IPPC (2001), even though developing countries in general and least developing countries in particular have been assumed to contribute almost nothing to anthropogenic climate change, they are more vulnerable to the impacts of climate variability and change, because they are least capable and least prepared to adapt to the potential effects of climate change. They have limited capacity compared to developed countries because of financial, skill and technology constraints, and high levels of poverty (Mendelshon and Dinar, 1999).

Africa is particularly vulnerable to such effects. According to World Bank (2003) climate change in Africa is predicted to be exacerbated by existing developmental challenges such as endemic poverty, poor governance system, and relatively low institutional thickness,

limited access to capital including markets, infrastructure and technology; ecosystem degradation; and complex disasters and conflicts. These in turn have contributed to Africa's weak adaptive capacity; increase the continent's vulnerability to projected climate change. Environmental problems including land degradation, soil erosion, deforestation, loss of biodiversity, recurrent drought, flood and water and air pollution would also be expected to exacerbate the challenges (IPPC, 2007).

Ethiopia is one of the countries in African continent which is under pressure from climate stresses and is highly vulnerable to the impacts of climate change. Ethiopia is extremely vulnerable to the impacts of climate change because of its geographic exposure, low income, greater reliance on climate sensitive socio-economic sectors such as rainfed agriculture and pastoralism, under-development of water resources, low health service coverage, high population growth rate, low adaptive capacity, inadequate road infrastructure in drought prone areas, weak institutions, lack of awareness, etc. The livelihoods of many millions of people in the country are critically dependent on subsistence rainfed agriculture (Alebachew, 2009; Aklilu and Alebachew, 2009; NMA, 2007).

NMA (2007) and PANE (2009) indicated that climate variability currently is imposing a significant challenge to Ethiopia by affecting food security, water and energy supply, poverty reduction and sustainable development efforts, as well as by causing natural resource degradation and natural disaster. Vulnerability assessment based on existing information and rapid assessment carried out under NAPA in NMA (2007) has indicated that the most vulnerable sectors to climate variability and change are Agriculture, Water and Human health. In terms of livelihood approach smallholder rain-fed farmers and pastoralists are found to be most vulnerable. The arid, semiarid and the dry sub-humid parts of the country are affected most by drought.

Deressa (2007) and others further argued that in Ethiopia, agricultural improvement was constrained mainly because of climatic factors and soil and land degradation. This were triggered and exacerbated by improper land use such as cultivation of steep slopes, over cultivation and overgrazing, and more socio-economic constraints such as inappropriate policies, subsistence farming and declining farm size mainly due to population growth. Additionally, tenure insecurity, weak agricultural research and extension services, lack of agricultural marketing, inadequate transport network and use of agricultural inputs such as low use of fertilizers, improved seeds and pesticides, poor nutrition of livestock, low level of veterinary care, and livestock diseases are other constraints.

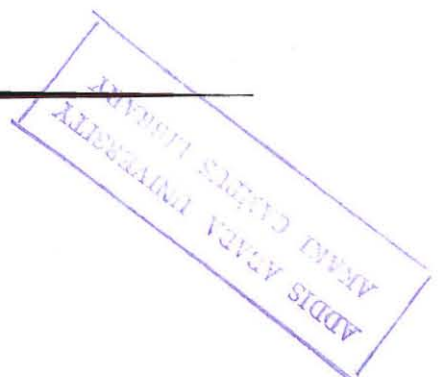
Human societies have a long record of adapting to the impacts of weather and climate change through a range of practices that include crop diversification, livelihood diversification, migration, irrigation, water management, disaster risk management, and insurance (IPPC, 2001; Maddison, 2007). Local adaptation strategies in Ethiopia include traditional practices in the areas of soil and water conservation, changes in cropping and planting practices, indigenous agro-forestry, diversification of income and livelihood sources through petty commodity production and trading, inter-household transfers and loans, mortgaging of land, food appeal/aid; disaster and risk management, early warning system, and insurance (Aklilu and Alebachew, 2009; Deressa, 2010, NMA, 2007). In the lowlands, pastoral households also employed diverse portfolio of strategies to cope and adapt with climate related adversity including seasonal mobility, herd diversification and splitting, rotational grazing, collection of wild foods and rangeland differentiation into wet and dry grazing reserves. Opportunistic farming, livestock marketing, petty trade, seasonal migration and consumption adjustments were served as additional economic adaptation strategies (Aklilu and Alebachew, 2009; NMA, 2007).

## 1.2 Statement of the Problem

Ethiopia is undertaking massive development efforts to reduce poverty, ensure food and water security and achieve MDGs, however, climate change and the resulting hazards caused a serious threat on it (PANE, 2009). According to Aklilu and Alebachew (2009) climate change in Ethiopia poses particular risks to farmers and pastoralists whose livelihoods are climate sensitive given their limited capacities to adapt to the impacts of changing climate.

Arba Minch Zuria Woreda is characterized by chronic poverty and food insecurity. According to survey made by Gamo Gofa Zone Agriculture Department (2000 E.C) high population density, acute land shortage, declining soil fertility, declining/complete failure of rainfall are the underlying causes of chronic food shortage in the Woreda. This survey also reported that droughts and flooding in the woreda increase the stress on social institutions, and increase the vulnerability of households through loss of assets, impaired health, and potential effects in animal disease and with potential risk for humans. Deficit in food production and potential increase in extreme weather events, decline in precipitation, increased resources degradation and soil moisture will be an added burden in the woreda.

Drought destroyed farmlands and pastures, contribute to land degradation, cause crops to fail and livestock to perish. Flooding in turn causes significant damage to settlements and infrastructure, livestock and animal health, and the water-logging of productive land undermines agriculture by delaying planting, reducing yields, and compromising the quality of crops, especially if the rains occur around harvest time. These direct impacts are often compounded by the rising cost of food and loss of environmental assets (Gamo Gofa Zone Agriculture Department, 2000 E.C).



Though the impact of climate change in Ethiopia is severe empirical studies evidenced the phenomenon are very few and most of them are focused on specific issues and sectors of the economy. Even though different scholars have been tried to assess the impacts of climate change most of them are based on aggregate information and limited only on the impacts of climate change. But climate change impacts by its nature are location-specific phenomenon and adaptation responses also need to reflect the vulnerability conditions of that particular area. Therefore, the argument for this study is that the local perspective is essential because it is the local impacts which have significance of individuals and communities, and where measurements must be obtained in order to properly describe climate change, predict its future likelihood and devise intervention measures.

Understanding weather farmer's observed and perceived change and variability of climate variables (precipitation and temperature) in their locality, investigating the impacts of observed change on rural household livelihood and adaptation responses developed and used at household level is very essential for targeting interventions to reduce the adverse impacts of climate change, help to devise appropriate adaptation strategies and mainstreaming climate change into local development agenda. Based on the aforementioned argument this study was done in Arba Minch Zuria Woreda of Gamo Gofa Zone Southern Ethiopia.

### **1.3 Objectives of the Study**

This study was done mainly to investigate and assess the impacts of climate change on rural households' livelihood and examine household level adaptation responses in Arba Minch Zuria Woreda of Gamo Gofa Zone Southern Ethiopia.

Specifically, this paper tried to:

- ✓ Assess the trends of local climatic elements (Rainfall or Precipitation and Temperature) over the past 20 years (1988 – 2008) and investigate the perceptions of farmer's towards climate variability and change in the study area;
- ✓ Examine the major impacts of changing climate and climate-induced extremes on agricultural production and
- ✓ Identify household level responses/strategies under the existing local institutional and policy environment.

## **1.4 Research Questions**

This study seeks to answer the following four fundamental questions to achieve the aforementioned research objectives:

- I. What are the local trends of climatic elements (precipitation and temperature) over the past 20 years (1988 – 2008)?
- II. Did the rural households' perceive change and variability of those climate variables to have occurred already in their locality?
- III. What are the major impacts of climate change and climate induced extremes and how does they affect rural households' livelihood? and
- IV. What kinds of adaptation measures have the rural households' been using to reduce the impacts of the changing climate and climate induced extremes on their livelihood?

## **1.5 Significance of the Study**

Agriculture, which is the single most important sector of the Ethiopian economy, is mainly dependent on rainfed farming. Recurrent climate induced hazards impacting subsistence farmers severely in Ethiopia and climate change is expected to adversely affect agricultural

production in the country. A better understanding of farmers' perceptions of climate change, its impacts on the rural households' livelihood and ongoing household adaptation response measures is important to inform policies aimed at promoting successful adaptation strategies for the agricultural sector.

Different stakeholders (government and non-governmental organization (NGOs)) involved in rural development activities are highly concerned with impacts of climate variability and change and have been taking measure to increase and improve households' adaptive capacity and resilience through different measures. Thus, researchers, NGOs, policy makers and extension agents need to understand the farming system of smallholders under the prevailing socio-economic environment and specific impacts of climate change on the livelihoods of rural household and their responses to cope with the impacts.

The outcome of the study will generate information for policy makers, governmental and NGOs to design and develop effective adaptation strategies and measures to support smallholder farmer's livelihood strategies. Moreover, the methodology developed in this study and the result to be found can serve as a departing point to undertake similar research in similar setting.

## **1.6 Scope and Limitation of the Study**

This study was carried out in Southern Nation, Nationalities and Peoples' Region (SNNPR) at Gamo Gofa Zone of Arba Minch Zuria Woreda. Due to constraints arising from shortage of financial resources, time, accessibility problems, and other logistics problems, it was found necessary to consider only three selected kebeles of the Woreda namely: Zigity Meriche, Kolla Shelle and Chano Dorga. It was focused on farmer's perception on local climate change, impacts of climate change on households' livelihood (mainly crop-

livestock production) and household level adaptation responses in the study area. Although farm productivity is subject to multi-dimensional factors, only climate change was considered in this study among other.

In addition, the quality of the information gathered through structured survey questionnaire depends on the willingness, recalling capacity (climate change perception) and knowledge of the respondents. This can also be taken as a limitation of this study.

### **1.7 Organization of the Thesis**

This thesis is organized in to five major parts. Part one constituted the introduction, which focuses mainly on the background, statements of the problem, objectives, research questions, significance and scope of the study. Part two deals with reviews of different literatures and the different empirical evidence concept and definition about climate change, livelihood and adaptation. Part three contains short description of the study area, method of data collection, data sources and collection method, sampling technique and units of analysis and methods of data analysis. Part four contains discussion of the results. And part five contains summary, conclusion and recommendation (policy implication).

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 Overview of Ethiopian Agriculture and Climate**

##### **2.1.1 Ethiopian Agriculture**

Small scale, subsistence and mixed rain-fed farming dominated Ethiopian agriculture which is the source of livelihood to an overwhelming majority of the population and is the basis of the national economy. It is the main source of livelihood for 85% of the population, 90% of the export earnings and contributed 40 -50% to the GDP. It also supplied more than half of the raw material requirement of agro-based domestic industries and is the major source of food for the population and hence the prime contributing sector to food security (NMA, 2001; Meseret Molla, 2009).

Based on agro-ecological setting farming system in Ethiopia is categorized under different systems. These are the highland mixed farming system, the lowland mixed agriculture, the pastoral system, shifting cultivation, and commercial agriculture (NMA, 2001). Under these diverse farming systems, different varieties of crops and species of livestock are produced. Ethiopia has the largest livestock population which is an integral part of the farming systems in the country. It is the source of many social and economic values such as food, drought power, fuel, cash income, security and investment in both the highlands and the lowlands/pastoral farming systems. In terms of their contribution, crop production is estimated to contribute on average about 60 percent of the total agricultural value, while

livestock accounts for about 27 percent and forestry and other subsectors account for about 13 percent (MoFED, 2006).

Though the country is endowed with huge agricultural potential, the country has remained unable to feed its people for many years due to a number of socioeconomic and environmental constraints including application of traditional farm technologies, use of ox-drawn wooden ploughs with steel pikes and other time-honored farm equipments, minimal application of fertilizers and pesticides due to high input prices in the presence of credit constraints and weak extension services, and low use of improved seeds are common. (Meseret Molla, 2009). Inadequate feed and nutrition, low level of veterinary care, occurrence of diseases, poor genetic structure, inadequate budget allocation, limited infrastructure, and limited research on livestock was also found to be a bottleneck for livestock sub-sector development in Ethiopia.

Climatic factors such as drought and flooding and environmental degradations are the major factors among others to affect agricultural production and its improvement negatively. Thus, the amount and temporal distribution of rainfall and other climatic factors during the growing season is critical for agricultural production which can induce food shortages and famine (Befekadu and Berhanu, 2000).

The impact of these variables are further triggered and exacerbated by the major socioeconomic constraints including inappropriate policies, land fragmentation and subsistence farming due to population growth, land degradation due to inappropriate use of land, such as cultivation of steep slopes; and over cultivation and overgrazing. Additionally, tenure insecurity, weak agricultural research and extension services, lack of agricultural marketing, inadequate transport networks, inadequate use of agricultural inputs, and the use of backward technologies are other constraints (Deressa, 2010; Devereux and Guenther, 2007). Yesuf et al (2008) indicated that the source of poor

production in the livestock subsector include Ethiopian agriculture is heavily dependent on natural rainfall, frequent floods, and pest incidence.

### **2.1.2 Climate of Ethiopia**

Climatic elements are affected by altitude and geographical location. Ethiopia enjoys extremely varied climatic conditions with an extensive altitude range which are suitable for different agricultural production systems. According to NMA (2007) and Deressa (2010), the climate of Ethiopia ranges from semi-dry desert in the lowlands, inhabited by pastoralists, to warm and humid in the south-western part of the country. Mean annual rainfall ranges from about 2000 mm over some pocket areas in the Southwest to about less than 250 mm over the Afar lowlands in the Northeast and Ogaden in the Southeast. Rainfall decreases northwards and eastwards from the high rainfall pocket areas in the Southwest. Rainfall in Ethiopia occurs in different seasons during the year. In Ethiopia there are four known seasons, namely, *Tseday* (September – November), harvest time, *Bega* (December - February), a dry season; *Belg* (March - May), a short rain season, and *kiremt* (June - August), a long rain season.

Temperatures are very much modified by the varied altitude of the country. Taking the two extreme altitudes, temperature range from the mean annual of 34.5<sup>0</sup>C in the Danakil Depression, while minimum temperatures fall below zero, with a mean of less than 0<sup>0</sup>C, in the upper reaches of Mount Ras Degen (4620m), where light snowfalls are recorded in most years. Between these extremes are vast areas of plateau and marginal slopes where mean annual temperatures are between 10<sup>0</sup>C and 20<sup>0</sup>C (Meseret Molla, 2009; NMA, 2007; Deressa et al, 2009). Daily maximum temperature varies from more than 37<sup>0</sup>C over the lowlands of Northeast (Afar Triangle) and Southeast (Ogaden) to about 15<sup>0</sup>C over the

highlands of Central and northern Ethiopia. The months of March through May are the hottest during the year.

The rainfall is correlated with altitude. The middle and higher altitudes (above 1500m) receive considerably greater rainfalls than do the lowlands, except the lowlands in the west, where rainfall is high (2000 mm). In the lowlands (below 1500m) rainfall is erratic and averages below 600mm. The Afar and Ogaden lowlands receive less than 250 mm. There is strong inter-annual variability of rainfall all over the country. Despite variable rainfall, which makes agricultural planning difficult, a substantial proportion of the country gets enough rain for rainfed crop production (Ibid).

### **2.1.3 Climate Trends in Ethiopia**

Historical data from 1951-2006 shows a warming trend of approximately  $0.37^{\circ}\text{C}$  every ten year. Whilst the trend analysis of annual rainfall variability shows that in Ethiopia rainfall remained more or less constant when averaged over the whole country (NMA, 2007). According to Mc Sweeney et al, (2008), in Ethiopia the mean annual temperature has increased by  $1.3^{\circ}\text{C}$  between the year 1960 and 2006. It was reported that the average number of hot days per year has increased by 73 (an additional 20% of days) and the number of hot nights has increased by 137 (an additional 37.5% of nights) between 1960 and 2006. Over the same period, the average number of cold days and nights decreased by 21 (5.8% of days) and 41 (11.2% of nights), respectively. These reductions have mainly occurred in the months of September to November (NMA, 2007).

However, if one looks at how rainfall is distributed across the country, there is marked difference. There is a tendency for less rain to fall in the northern part of the country where there is already massive environmental degradation. The same trend can be observed in the

south-east and north-east of the country which are both often affected by drought. However, in the central Ethiopia where most of the population and the country's livestock are, and where soil is severely depleted and degraded, more rain is falling. The western and north-western parts of the country have also received more rain (McSweeney et al, 2008; Daniel Kassahun, 2006).

#### **2.1.4 Climate Projections for Ethiopia**

One cannot predict the future climate change adequately without a sound understanding of the future expectations of the emission and concentration of green house gases in the atmosphere, which will depend on socio-economic trends including population and economic growth, technological changes, energy demand, fuel mix, etc (NMA, 2007; PANE, 2009).

Climate projections generated by UNDP (cited in DFID, 2009) highlight the likelihood of mean temperature increases of 1°C in 2020s and up to 3.9°C to 2080s. Rainfall predictions indicate an increase of 30mm in the interior for the 2020s. In the 2080s, the average conditions are likely to become much wetter, especially in central and south-west Ethiopia, with the possibility of 100mm more rain in the south-west of the country. This will mainly result from a significantly wetter October-December rainy season, with less rain in the main rainfall season (June-September). NAPA predictions project similar temperature increases and also refer to increased rainfall, with most significant predicted increases (between 20-40%) in northern Ethiopia.

#### **2.1.5 Vulnerability of Ethiopia to Climate Change Impacts**

Climate variability is already imposing a significant challenge to Ethiopia by affecting food security, water and energy supply, poverty reduction and sustainable development efforts,

as well as by causing natural resource degradation and natural disasters. In Ethiopia recurrent drought and frequent floods which covered a wide geographic area caused severe loss of life and property (NMA, 2007).

The IPCC (2007), defined a regions vulnerability based on three aspects, firstly its adaptive capacity (ability to respond, proactively change in response to actual or expected impacts of climate change), sensitivity (the degree to which any system is affected), and exposure to changing climatic patterns.

According to NMA (2007) the most vulnerable sectors to climate variability and change in Ethiopia are Agriculture, Water and Human health and in terms of livelihood approach smallholder rain-fed farmers and pastoralists are found to be the most vulnerable. The arid, semiarid and the dry sub-humid parts of the country are affected most by drought. The country's heavy dependence on rain-fed and subsistence agriculture increase its vulnerability to adverse effects of these changes. In general, the level of vulnerability of different social groups is determined by both socioeconomic and environmental factors. The poor rural people who do not have access to different livelihood options; infrastructure, and heavily dependent on degraded natural capital are known to be the most vulnerable (Deressa, 2010; World Bank, 2003).

Deressa et al (2007) and Yesuf et al (2008) stated that the vulnerability of Ethiopian agriculture to climate change is mostly attributed to its heavy dependence on rainfall, application of outdated farming technologies and implements, low level of rural service provision and infrastructure development, low investment in services and infrastructure, inadequate policies and institutions as well as social and gender inequalities and environmental degradations.

Rainfed agriculture, which supports the livelihoods of the majority of the population, is highly sensitive to climatic conditions characterized by highly erratic rainfall, frequent droughts that often cause famines and flooding caused by heavy rainfall. Given the dependence of the economy on agriculture and the dependence of the agricultural sector on climatic conditions, especially rainfall, the macroeconomic performance of the country follows rainfall patterns, in years where there is good rainfall, the economy performs well and in years of bad rainfall the economy performs very badly (Dercon, 2004; Dercon et al, 2005; Alebachew and Aklilu, 2009).

### **2.1.6 Impacts of Climate Change on Ethiopian Agriculture**

Climate change is likely to increase the risk of crop failure and destruction of the livelihoods which depends on them. Climate change is likely to hinder the quality and quantity of pasture, which in turn will have an impact on livestock productivity, and the distribution and incidence of animal and plant disease. Given its inherent link to natural resource, agricultural production is extremely at the mercy of uncertainties driven by climate variation, including extreme events such as flooding and drought (Kurukulasuriya and Rosenthal, 2003).

NMA (2007) stated that repeated drought, already endemic to Ethiopia, has increased in the past several decades, leading to widespread food insecurity and malnutrition. Its impact is very much damaging to Ethiopia because of low adaptive capacity. Alebachew and Aklilu (2009) indicated that the past recurrent droughts in Ethiopia resulted in huge loss of life and property as well as migration of people. Above all these climate perils brings Ethiopia to be heavily dependent on food aid.

The other notable climate related hazard which affected Ethiopia most frequently is flash and seasonal river flood. In recent times flooding has increased in frequency,

predominantly due to deforestation and soil degradation. Flash floods occurred in most part of the country, where as large scale flooding is limited to the lowland areas of the country (Deressa et al, 2009; World Bank, 2003). Extreme flooding can be a factor in disease outbreaks, and increased in the number and severity of flood events will likely also increase the incidence of water-borne disease such as cholera, dysentery and typhoid in the lowland pastoral areas of the country (Kidanu et al, 2009).

According to Daniel Kassahun (2006), in addition, warmer weather provides better growing conditions for pests and other diseases that attack crops and destroy the farmers' harvest and herding sizes. Million Getnet et al. (2010) also reported that in Ethiopia an increase in temperature, leading to changing agro-ecological characteristics, resulted in drying and disappearance of fodder species.

Yesuf et al. (2008) have confirmed that in most pastoral and agro-pastoral communities of Ethiopia, change in water availability, in terms of timing and amount, and the increases in temperature, has impacted rangeland and livestock watering points which in return along with other risks, have resulted in a decline in the herd size per household in all livestock types and a change in herd composition. This is mainly due to lack of fodder and livestock water availability and increasing incidence of livestock diseases (Alebachew and Aklilu, 2009; Million Getnet et al, 2010).

### **2.1.7 Adaptations to Climate Change**

Adaptations to climate change impacts in general and to the agriculture sector in particular are not a new phenomenon. Natural and socio-economic systems have continuously been adapting autonomously, or in accordance with a plan, to a changing environment throughout history. As significant number of studies highlight, the right mix of adaptations

have the potential to significantly reduce (or enhance) the magnitude of potential adverse (or beneficial) impacts on agricultural productivity. Research has shown that the agriculture sector is especially adaptable given that technologies, resources, and management changes have been undertaken relatively quickly (Mendelsohn and Dinar, 1999).

With impacts on the agricultural sector manifesting from both climate variability and long-run climate change, the type of adaptation option that is implemented is clearly crucial. Throughout human history, societies have adapted to natural climatic variability by altering settlement and agricultural patterns and other facets of their economies and lifestyles. Adapting with climate has not always been easy or successful as the records of collapsed societies reveal and there are still limits to adaptations. There are a long record of adapting to impacts of weather and climate change through changes in behavior, choices of technology and infrastructure, use of market instruments and public policies (Kurukulasuriya and Rosenthal, 2003; NAPA, 2007).

In theory, the literature discusses two types of likely responses to address climate impacts, namely, those that are reactive or, alternatively, anticipatory adaptations (ex-ante). These include measures taken in anticipation of a coming change in climate elements and require that decision makers be able to predict what is coming. Reactive (or autonomous) adaptations consist of coping strategies that agents and institutions are likely to make in response to climate impacts after the fact (ex-post). These strategies merely require that the decision maker to be aware of changes that have occurred (Mendelsohn and Dinar, 1999).

Literatures also examined several micro level adaptations. These include farm production adjustments such as diversification and intensification of crop and livestock production; changing land use and irrigation; and altering the timing of operations. Other market responses indicated includes development of crop and flood relief/insurance schemes, innovative investment opportunities in crop shares and futures, credit schemes, and income

diversification opportunities. Technological developments in the form of the development and promotion of new crop varieties and hybrids and advances in water management techniques like irrigation, conservation tillage repeatedly explained as an alternative in recent studies of adaptation (David Maddison, 2007; Kurukulasuriya and Rosenthal, 2003).

Decisions on the type of adaptation are often made by individuals, groups within society, and organizations and governments on behalf of society. Some adaptation measures may be taken at individual level. Others like rainwater harvesting and investments, building dams, releasing new cultivars that are more drought resistance require collective actions. According to David Maddison (2007) these time societies have inherent capacities to adapt to climate change and have developed different adaptation and mitigation strategies to combat climate change. They have developed knowledge, skills, technology, institutional arrangements and strategies that are important foundations for adapting to long-term climate change.

Based on type of economic activities and social networks societies can access local coping strategies against shocks. These highly differ among households and communities. Communities have always adapted to climate variations by making preparations based on their resources and knowledge accumulated through experience of past weather pattern. The adaptive measures that households use when faced with climate change could also differ in terms of their ease of implementation, equity effects, lag between implementation and effect, their cost of implications, compatibility with other programs and agencies implementing measures (Admassie, 2008).

The capacity to adapt to climate change also varies across countries, social groups and regions over time. These capacities will depend to a large extent on the availability of natural resources, their level of development, their resource base, technological knowhow and level of information about climate change, and their scientific and technical capacity.

Greater economic resource availability increases adaptive capacity while the lack of it limits adaptation options. Technological options limit range of potential adaptation choices. Hence, adaptation measures are very much related to socio-economic conditions of the country and community given basic forms of adaptations including micro-level adaptations such as diversification and intensification of crop and livestock production, changing land use, irrigation and altering the timing of operations, market responses, institutional changes and technological developments (Kurukulasuriya and Rosenthal, 2003).

## **2.2 Conceptual Framework for Livelihood Analysis**

The concept of a livelihood is widely used in contemporary writings on poverty and rural development, but its meaning can often appear elusive, either due to vagueness or too different definitions being encountered in different sources. Livelihood analysis entails an examination of the assets (resources) that are available to people and how they are able to transform those assets through various livelihood strategies into sustainable livelihood outcomes such as reduced poverty and well-being (Scoones, 1998). The following section discusses important issues and concepts of livelihood analysis.

### **2.2.1 Livelihood**

While a livelihood in its simplest definition could be described as a 'means of living', the most well-known and popular definition is that provided by Chambers and Conway (1992) where in:

*"A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation (while not undermining the*

*natural resource base) and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term”*

This definition, with minor modifications, has been utilized by several researchers adopting rural livelihoods approach (Scoones, 1998; Carney, 1998).

*“A livelihood comprises the capabilities assets (including both material and social resources), activities required for a means of living and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household”*

The important feature of this livelihood definition is to direct attention to the links between assets and the options people possess in practice to pursue alternative activities that can generate the income level required for survival. Central to both these definitions is the idea of livelihood assets. Assets in the Chambers and Conway livelihood definition contain a number of components, some of which belong to recognized economic categories of different types of capital, and some of which don't, namely, claims and access. In this thesis the words resources, assets and capitals are used interchangeably.

Many of the livelihood approaches are based on the premise that the asset status of the poor is fundamental to understanding the options open to them, the strategies they adopt to attain livelihoods, the outcomes they aspire to, and the vulnerability context under which they operate (Ellis, 1999). For him, assets (or capitals) are both the resources people use in building livelihoods, and the assets that give people the capabilities 'to be and to act'.

Followers of the Chambers and Conway line of thinking about livelihoods (for example Ellis, 1999) have tended to identify five main categories of capital as contributing to assets in the livelihood definition, and these are natural capital, physical capital, human capital, financial capital, and social capital.

Income comprises both cash and in-kind contributions to the material welfare of the individual or household deriving from the set of livelihood activities in which household members are engaged. The cash earnings component of income includes items like crop and livestock sales, wages, rents, and remittances. The in-kind component of income refers to consumption of own-farm produce, payments in kind, and transfers or exchanges of consumption items that occur between households within rural communities, or between urban and rural households.

### **2.2.2 Livelihood Strategies**

According to DFID (1999) the term livelihood strategies are defined *as* the range and combination of activities and choices that people make in order to achieve their livelihood goals, including productive activities, investment strategies, reproductive choices, etc. Livelihood strategies are composed of activities that generate the means of household survival and are the planned activities that men and women undertake to build their livelihoods (Ellis, 1999).

Both economic and other set of factors constitute critical decision parameters that shape activity choices of households. Assets, skills, incomes or generally, endowments are as important as social class and caste, opportunities, family networks, ethnicity, institutional and political regimes governing access to opportunities, social capital, and household's perception of risk in determining which activities households participate in (Dercon and Krishnan, 2000). In addition to these, seasonality, labor market differences, risk availability, liquidity constraints owing to imperfection in the market for credit, insurance, land and labor etc. have also been found to be relevant (Ellis, 1998).

### **2.2.3 Livelihood Outcomes**

Livelihood outcomes are the achievements of livelihood strategies, such as more income (e.g. cash), increased well-being (e.g. non material goods, like self-esteem, health status, access to services, sense of inclusion), and reduced vulnerability (e.g. better resilience through increase in asset status), improved food security (e.g. increase in financial capital in order to buy food) and a more sustainable use of natural resources (e.g. appropriate property rights) (Scoones, 1998).

### **2.2.4 Rural Livelihood Diversification**

The concept of livelihood diversification is emerging as a survival strategy of rural households in developing countries (Ellis and Freeman, 2005). According to Ellis (1999) the rural people are looking for diverse opportunities to increase and stabilize their incomes, which are determined by their portfolio of assets-social, human, financial, natural and physical capital. Rural livelihood diversification is defined as the process by which rural households construct an increasingly diverse portfolio of activities and assets in order to survive and to improve their standard of living.

Diversification is not only driven by constraints or “the unrelenting struggle for survival of the poor”, it can also be determined by incentives. While some diversify because they have little choice, better off households may diversify because they have a lot of choices (Barrett et al, 2000). Hence diversification could be involuntary or voluntary. Motives for diversification are therefore, different across households with different stock of endowment and access to resources and in practice, difficult to isolate and also, different across communities with different sets of natural endowments such as fertile arable land. Since a host of heterogeneous, interacting factors actually contribute in shaping household diversification strategies, Barrett et al (2000) suggest the use of much disaggregated analysis to better understand factors shaping livelihood strategies in specific communities.

## CHAPTER THREE

### RESEARCH METHODOLOGY

This chapter has two major sections. The first section presents the description of the study area. Biophysical and socio-economic conditions of the area are included in this section. The second section contains methodology adopted in the study. It describes data type and sources, sampling procedures, data collection techniques and methods of data analysis.

#### 3.1 Description of the Study Area

Arba Minch Zuria Woreda is found in Gamo Gofa Zone of Southern Region bordering Dirashe Special Woreda in the south, Bonke Woreda in the west, Chenchu Woreda in the north, Mirab Abaya Woreda in the east, and Boreda Woreda in the southeast. The total area of the Woreda is 1,681.72 Km<sup>2</sup>. The altitude varies between 1200 – 3050 meters above sea level. The Woreda has 45.4% of its land in the *Dega zone (highland)*, 41.6% in the *Woina Dega zone (mid-highland)* and 11% in the *Kolla zone (lowland)*. The mean annual rainfall in the Woreda ranges between 1100mm – 1600mm whereas the average temperature is 23<sup>0</sup>C, varying between 20<sup>0</sup>C - 25<sup>0</sup>C. Meteorological records reveal that the rainfall pattern in Arba Minch Zuria is bimodal which is characterized by two production seasons, traditionally known as *Belg* and *Meher/Kiremt*. The Belg rains usually occur within the months of February/March–May, whereas *Meher* takes place from June to August/September (Woreda Annual Agricultural Report, 2002 E.C; Gamo Gofa Zone Socio-economic Abstracts, 2002 E.C).

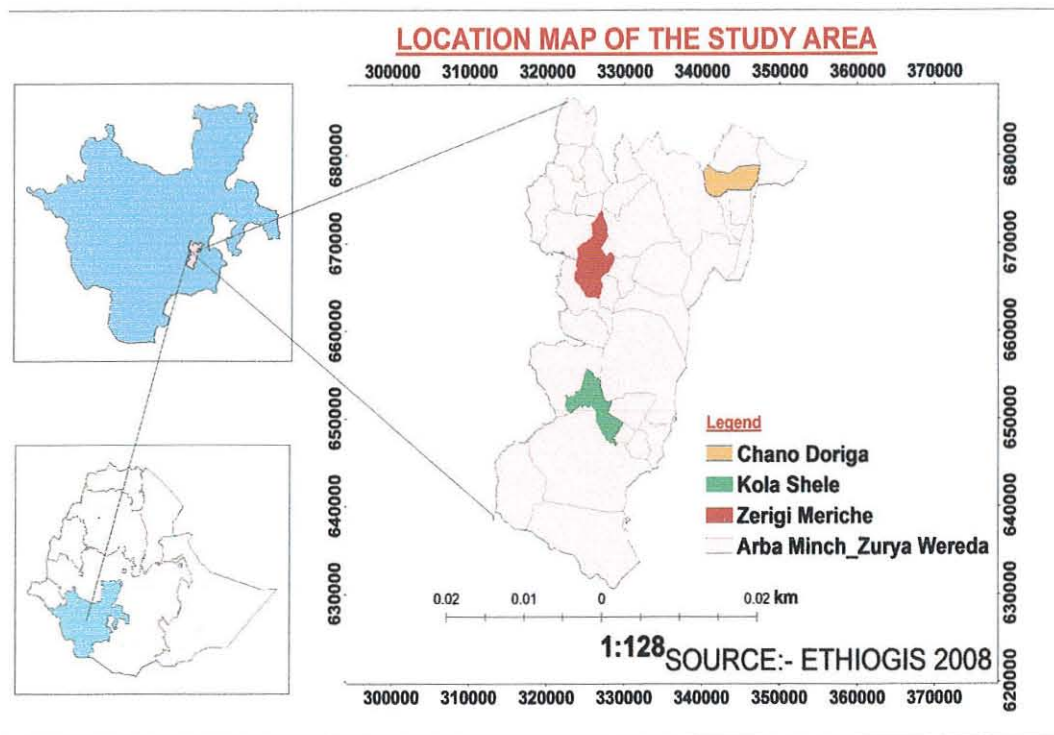


Figure 3.1: Location Map of Arba Minch Zuria Woreda

According to the information obtained from Woreda Department of Agriculture, 20% of the topography is flat whereas 35% is steep to gentle slope. Mountainous areas and gorges represent 35% & 10% respectively. The overall feature of the terrain is higher at the center and the altitude decreases towards northeast & southwest (Woreda Annual Agricultural Report, 2002 E.C).

Administratively, the Woreda has 29 rural kebeles with a total population of 165,680, of which 82,751 (49.95) are men and 82,929 (50.05%) are women (CSA, 2008). From these kebeles in the woreda 4, 15 and 10 kebeles are located in the highland, mid-highland and lowland altitude, respectively. The Woreda has an estimated population density of 98 people per Km<sup>2</sup>.

Agriculture is the mainstay of the economy and livelihood system of the woreda. According to Woreda Investment Expansion Main Process Report (2002 E.C), agriculture in the woreda is a source of employment and subsistence for about 97 percent of the total population. The climates of the woreda are most favorable for the cultivation of a wide variety of crops. In the woreda, maize, teff, wheat, barley, sorghum, pepper, bean, haricot bean, finger millet, pea, vegetable and fruit are the major crops grown by the majority of farmers. In Ethiopia, Arba Minch Zuria is well known for banana production and it is produced as cash crop.

Livestock keeping is the other component of farming system in the Woreda. According to Woreda Agriculture Department report, as to the livestock holdings, there are 88,741 cattle, 818 equine, 20,960 sheep, and 14,423 goats, 53,671 chicken and 12,500 beehives in the woreda. The current livestock density is 113.5 per square kilometer (Woreda Annual Agricultural Report, 2002 E.C).

Land is the main natural resource base on which the livelihood is directly depending on. Beside land, there are about six river streams and two rift valley lakes which are found adjacent to the woreda (parts of Lake Abaya and Chamo). The land use data shows that about 73.24, 6.71, 6.79, 9.95, 5.59 and 7.27 percent are cultivated (both annual and perennials), grazing, forest, cultivable, uncultivable and land allocated for village, market area, communal social purposes, respectively (Woreda Annual Agricultural Report, 2002 E.C).

The reconnaissance survey report made by Woreda Agriculture and Rural Development Department revealed that in the Woreda there are 6 rivers with irrigation potential of 3,870 hectares. These include Sule, Elene, Hare, Kulufo, Baso and Wozeqa. Some of them share between neighboring woredas because of their location at boundary lines.

Data from the Zonal Department of Agriculture (2002 E.C) further revealed that there are 6,758 hectares of natural forest and 3000 hectares of man-made forest in the woreda which together account for 6.79% of the total area. Bush land and Shrub land are the dominant vegetation cover in the lowland areas. Due to rapid population growth accompanied by increasing demand for arable land, agriculture, and fuel wood consumption, the forest cover of the woreda is dwindling. The depletion of forests cover contributed to rapid erosion of the topsoil of the woreda. Soil erosion is intense forming gullies in sloppy areas. In addition to agricultural resources, there are construction minerals such as stones and sands. However, the potential mineral deposits are not well investigated and exploited.

In the Woreda, the existing infrastructural facilities and social services are relatively weak. As to the water supply of the woreda about 108,836 (45.7%) of the have access to potable water. The hydroelectric power supply service in the woreda is good potential and the woreda is a center for redistribution to other woredas in Gamo Gofa Zone. However, high reliance on the fuel wood in the woreda would lead to deforestation and have negative impact on the environment. According to a 2002 E.C report, Arba Minch Zuria has 31 kilometers of asphalt roads, 69 kilometers of all-weather roads and 51 kilometers of dry-weather roads, for an average road density of 90 kilometers per 1000 square kilometers. Compared to the land area of the Woreda it can be said that the road network is insignificant. Most farmers in the Woreda communicate and exchange goods and services at the local markets and transport their produce using either pack animal, carrying on head or on the back over the long distance.

In terms of communication, the majority of the people have access to digital telephone services and recently mobile telephone usage increased dramatically. From the total population within the Woreda 37.4% of the population has access to digital telephone service. However, telecommunication facilities are underdeveloped in most remote parts of

the woreda although recently digital telephone lines are extended and expected to become operational soon (Gamo Gofa Zone Socio-economic Abstracts, 2002 E.C).

Regarding education sector, the total numbers of schools prevailing in the Woreda in 2002 E.C reached 29 in number. However, there are only 2 high school whereas no pre-college (preparatory) school and college/university within the Woreda. Shortage of textbooks and other educational materials and shortage of qualified teachers are some of the major constraints in the education sector (Ibid).

There are 8 health centers, four health posts, 13 rural drug vendors and six clinics currently serving the population of the woreda and those in the vicinity. However, there is no hospital in the Woreda. Most of the residents of the Woreda are forced to travel long distance for treatment and visit in the cases of serious illness, especially Arba Minch town. The main problem of the sector is inadequate health facility, poor health coverage level, lack of transport services and accessibility, shortage of financial budget and shortage of qualified manpower.

### **3.1.1 Zigity Meriche Kebele**

Zigity Meriche kebele is located at a distance of 31 kilometers from the center (Arba Minch town). The old and abandoned road to Bonke Woreda crosses the kebele. The total population is 7,494, of which 4,140 are male and 3,354 are female. The total area of the kebele is 2,020 hectares. The major land use of the kebele is farming/cultivated land, while area demarcated for forest protection is also significant (Zigity Meriche Kebele Administration Office, 2002 E.C).

Like other highland kebeles in the Woreda the major crops grown in the kebele includes barely, pea, beans, haricot-beans, potato, wheat, lentil, and enset are also grown. In this kebele most farmers had grown food grains, largely barley, pea and beans. The cultivation of perennial cash crops is quite limited. A very high population density, acute land shortage

and declining soil fertility are the underlining challenges of crop production. Livestock production also constitutes part of the mixed farming system, providing draft power, producing meat and milk and serving as a source of cash income. The major livestock in this kebele are oxen, cow, donkey, sheep and goat (Ibid).

The kebele's natural resources, apart from agricultural land, are river sand and quarry stone, which are providing income source for significant number of the kebele's population. Clay soil is also available and is used as raw material by women for pottery production (Ibid).

As regards basic service infrastructure, the kebele has one primary school (grade 1-8), one health post, one motorized bore-hole for water supply and one Farmer Training center (FTC). On the other hand, electricity and land-line telephone are available, but the distribution is limited due to topography and settlement (populations are sparsely settled). Wireless and mobile telephone service are also available (Ibid).

### **3.1.2 Kolla Shelle Kebele**

Kolla Shelle kebele is located at a distance 27 kilometers from Arba Minch town (center of the Woreda). The total population is 8,570, of which 4,780 are male and 3,790 are female. The total area of the kebele is 1,490 hectares. Like other kebeles in the Woreda, the major land use in this kebele is cultivated land, while newly developed plantation forest is also significant (Kolla Shelle Kebele Administration Office, 2002 E.C).

Like other lowland kebeles in the Woreda the major crops grown in this kebele are maize, teff, sorghum, cotton, chat, banana, mango, avocado, and beans are grown. The major food grains include maize and teff whereas cash crop dominated by banana and chat production. Livestock production also constituted the farming system in this kebele where sheep, goat, cow, chicken and donkey are dominant (Ibid).



Kolla Shelle kebele is endowed with substantial resources of river sand which provides income generating opportunities for significant number of the inhabitants. This kebele is crossed by two rivers in the Woreda, namely Wozeqa and Sule River, providing a potential for irrigation and livestock watering (Ibid).

With regards to basic service infrastructure, Kolla Shelle has one primary school (grade 1-8), one Kindergarten school, one health post, a motorized bore-hole for water supply, and a Farmer Training Center (FTC). Electricity coverage in this kebele reached 40% of households and wireless and mobile telephone services also exist (Ibid).

### **3.1.3 Chano Dorga Kebele**

The kebele is located 17 kilometers far from Arba Minch town (center of the Woreda). The kebele has a total area of 1,256 hectare; total population of 2,767 and 421 households. Out of the total population are 1569 male and 1,198 are female. Most land is cultivated; there is no natural forest and very limited communal grazing land (Chano Dorga Kebele Administration Office, 2002 E.C).

Like other kebeles of the Woreda in this kebele the agriculture system is mixed farming. This kebele is located in the lowland agro-ecology and most households grow banana and mango largely and small amounts of maize and teff, carrots and cabbage in some pocket areas. Maize and beans are intercropped, while sweet potatoes and teff are grown in single stands. Cattle, sheep, donkeys and chicken are reared in this kebele, but due to lack of grazing land (zero-grazing system), household's use 'cut and carry' system for feeding their livestock (Ibid).

This kebele is crossed by Perennial River of Hare that flow in a southeasterly direction, but no irrigation is practiced in the kebele using this river due to topography. Farming is totally

dependent on rainfall and subsistence. Flooding due to heavy rainfall is the major concern in the kebele (Ibid).

In terms of basic infrastructural and social services, in this kebele there are one primary (1-8 grades), one health posts and a motorized bore-hole for water supply. There is no farmer training center in the kebele. The kebele is connected with the center of the Woreda and other nearby kebeles with dry weather roads, but most of the inhabitants used pack animals to transport farm products. The kebele received 24 hour electricity power and the telephone coverage also reached 46% with recent existence of wireless and mobile telephone (Ibid).

### **3.2 Methods of Data Collection and Analysis**

Here procedures and principles of data collection for this study are discussed. Selection of household survey respondents and interviewing procedures are also parts of the main concerns for this part. As a natural follow up of data collection is analysis and interpretation of the collected data using appropriate statistical tools.

#### **3.2.1 Data Type and Sources**

Quantitative and qualitative data were collected from both primary and secondary sources. Primary data were collected from 60 sample households and 20 key informants selected from three kebeles and different governmental and NGOs at the woreda level. Personal observation was also done.

Primary data collected from sample households include information on: household demographic characteristics (education, age, family size, sex, marital status), household assets, household income, livestock holdings, land characteristics (land size, land use, soil fertility), institutional factors (credit, training, accessibility of farm inputs, extension service, social services), perception of climate change, impacts of climate change and



related climate induced extremes on households livelihood (crop-livestock production) and adaptation responses at household level.

Secondary data about population, farming systems, infrastructure situation, meteorological data (annual rainfall and average temperature), etc were collected from both published and unpublished sources.

### **3.2.2 Sampling Procedure**

A two-stage sampling technique was employed to draw sample household heads. In the first stage, out of the total twenty nine kebeles in the woreda three kebeles were selected based on preliminary survey and interview with officers and experts of Woreda Agriculture Department on the degree of susceptibility of the kebeles to climate change and related extremes, severity of the impacts of local climate change and related extreme events. Of these three one kebele was from the highland (*Dega*) and two were from lowland (*Kolla*) agro-ecologies. At second stage, a total of 60 household heads (20 from each kebele) were selected randomly from the respective lists of farmers at the kebele administration level. The relative homogeneity of households in terms of socio-economic characteristics, financial constraints, and use of other data collection techniques, particularly key informant interviews are the major justification for determining this sample size.

*Table 3.1: Sample kebeles, Number of households and Sample size*

S/N	Name of Sample Kebele in the Woreda	Total Number of Households in the Kebele	Total Number of Sample Household Heads selected for survey	
			Number	%
1	Zigity Meriche	774	20	2.58
2	Kolla Shelle	871	20	2.3
3	Chano Dorga	643	20	3.11
Total		2,288	90	3.93

Source: Arba Minch Zuria Woreda Administration Office (2010)

### **3.2.3 Methods of Data Collection**

A structured household survey questionnaire was used to collect primary data. Detailed information on household demographic characteristics, household assets, livelihood sources, perception on local climate, impacts of climate change on household livelihood and household level adaptation responses were collected by household survey questionnaire from sample household heads. Before the formal survey, informal survey was conducted to select sample kebeles and to collect general information about the study area and farming system. Pre-test was done by asking 6 household respondents at 3 kebeles to develop and modify the structured questionnaire.

Moreover, key-informant interview was made with some experts, farmers and residents in order to collect qualitative primary data collection and triangulate data collected through other techniques. For this key informants interviews, semi-structured open ended questions was raised and administered by the researcher. For these interview respondents were selected from various governmental departments, experts from community based

organizations, NGOs and communities who were known to be experienced with climate change and related extreme events in their locality was selected and contacted. Altogether twenty key informants was contacted and interviewed.

Personal observation were also done through transect walk in selected kebeles for this study in order to understand the realities on the ground with a particular focus on local climate change and variability, climate change impacts on rural livelihoods (crop-livestock production), and household level adaptation responses. This were helped the researcher in supplementing and triangulating data collected using other techniques.

Four enumerators were recruited and trained for one day on the contents of questionnaire and method of data collection. The researcher conducted the training and supervised the enumerators during data collection. Following the training, data collectors exercised data collection on the field for a half day before actual data collection was started. Then discussion was made to make the questionnaire more clear and actual household survey were started and completed. Data at household level were collected by visiting each and every one of the sample respondents to enable the enumerators to help each other and allow the researcher to conduct close monitoring and supervision during survey.

### **3.2.4 Methods of Data Analysis**

Since both qualitative and quantitative data was generated, qualitative and quantitative data analysis techniques were employed. Qualitative data which was generated using household survey were analyzed using Statistical Package for Social Sciences (SPSS/ version 17.0 for windows) and Microsoft Excel 2007. Descriptive statistics such as mean, frequencies, percentages and standard deviation were computed using this software program and results were also being presented in tables and figures. Similarly, qualitative data obtained from key informants interview and direct personal observation were analyzed and narrated/explained. Various archival and policy documents have been reviewed to substantiate the primary data.

## CHAPTER FOUR

### RESULTS AND DISCUSSION

This chapter presents the results and discussion about local climate trend and farm household perception about the change in local climate, livelihood impacts (particularly on crop-livestock production) of climate change and household level adaptation responses. It presented the findings using descriptive statistics, narration of key informant interview and explanation of personal observation.

#### ***4.1 Trends of Climatic Element (Rainfall and Temperature)***

The existing annual metrological record of precipitation and temperature for Arba Minch Zuria Woreda between the year 1988 and 2008 is presented on the following graphs. (see Figure 4.1, 4.2a, b and 4.3). The precipitation trend for the Woreda has shown a normal variability throughout the years under consideration (i.e. there was no significant observed change in the amount of rainfall in the study area).

In terms of seasonal distribution of rainfall over the years under consideration, the study area got the highest amount of rainfall during *Belg* season and the lowest amount during *Bega* season. Recorded metrological data has also shown that the pattern of rainfall over the two rainy seasons (kiremt and belg) was normal and no particular change was observed.

Figure 4.1: Trends of Annual Rainfall (mm) over the year (1988 – 2008)

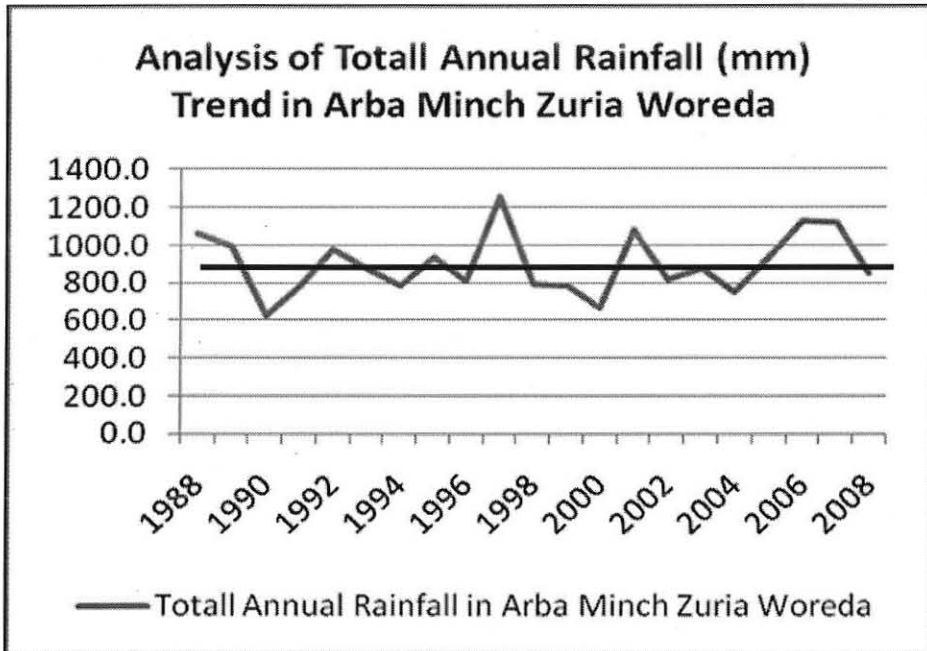
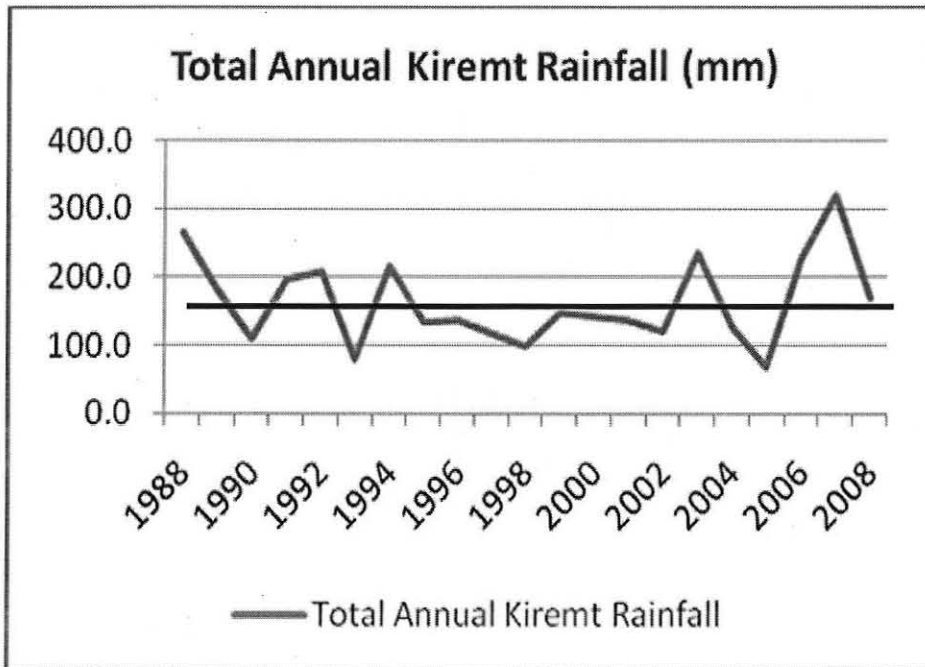
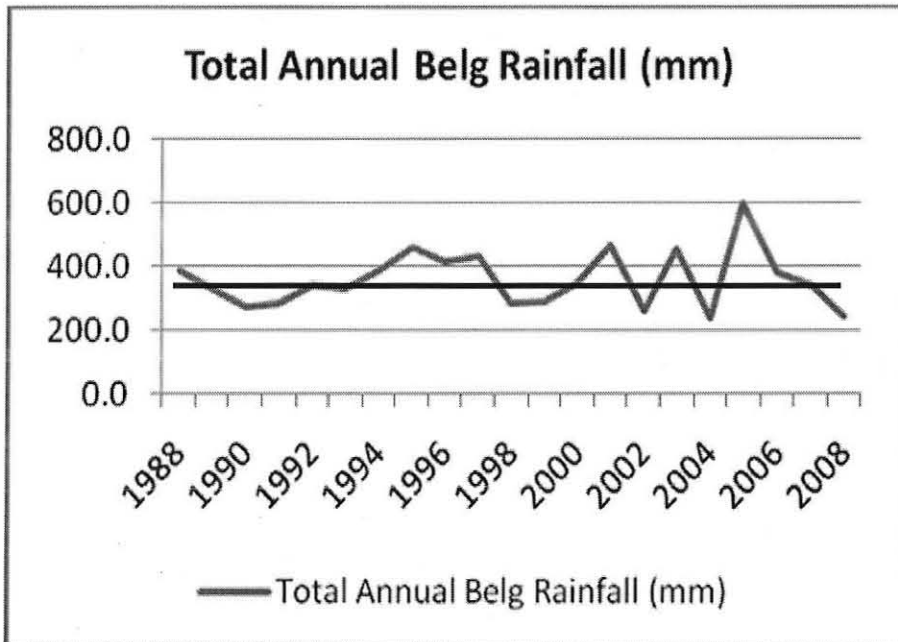


Figure 4.2: Trends of seasonal rainfall distributions over the year (1988-2008)

(a)

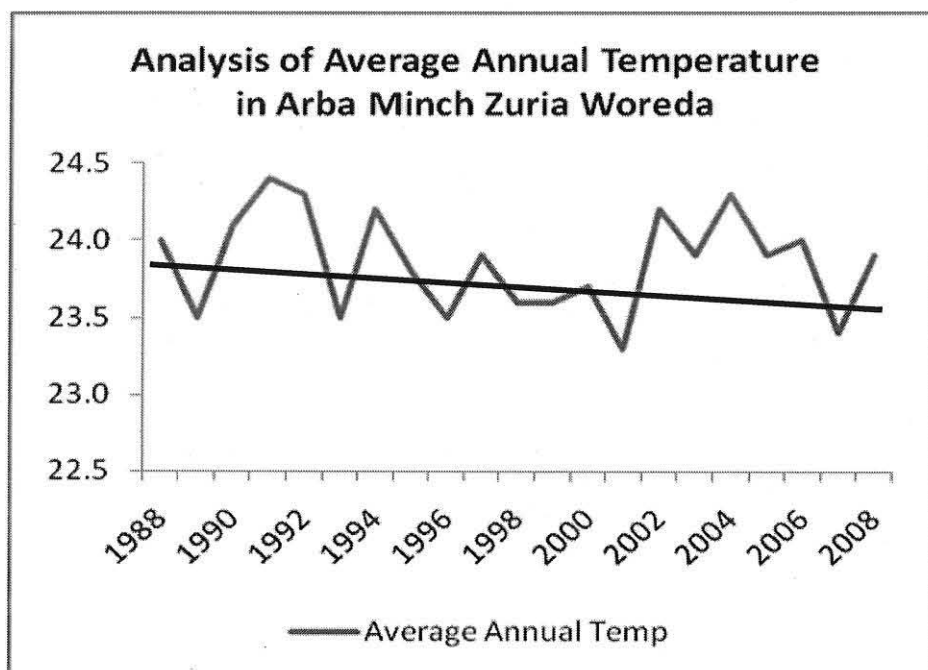


(b)



Data on temperature from 1988 – 2008 has shown a declining trend with the minimum temperature ( $23.3^{\circ}\text{c}$ ) recorded in 2001 and maximum temperature ( $24.4^{\circ}\text{c}$ ) recorded in 1991 (see Figure 4.3). The mean value of temperature and its standard deviation over the period are  $23.9^{\circ}\text{c}$  and  $0.32^{\circ}\text{c}$ , respectively.

Figure 4.3: Trends of Average Annual Temperature ( $^{\circ}$ c) over the year (1988 – 2008)



## 4.2 Demographic and Socio-Economic Characteristics of the Respondents

### 4.2.1 Marital Status, Sex and Age of the Respondents

Out of the total respondent farmers (farm household head) 92% were married, 4% were divorce and the remaining 4% were widow. The distributions of sample household heads by sex constitute 94.5% and 5.5% for male and female, respectively. The mean age of the household heads was found to be 47.25 with standard deviation of 10.74. The maximum age observed was 68 and the minimum 28 years.

### 4.2.2 Family Size

The total family sizes of sample household were found to be 178, 176 and 156 in Zigity Meriche, Kolla Shelle and Chano Dorga kebele, respectively. The average family size of the respondents was 8.9, 8.8 and 7.8 in Zigity Meriche, Kolla Shelle and Chano Dorga kebele, respectively. The maximum and minimum household size of the sample respondents was found 15 and 4, respectively with an average size of 8.5 members (see table 4.1).

Table 4.1: Distribution of sample household by family size

Family size	Zigity Meriche Kebele		Kolla Shelle Kebele		Chano Dorga Kebele		Total Household	
	Household size	%	Household size	%	Household size	%	Household size	%
3-5	3	15	2	10	3	15	8	13.3
6-10	11	55	13	65	15	75	39	65
□ 10	6	30	5	25	2	10	13	21.7
Mean	8.9		8.8		7.8		8.5	

Source: Own survey result, 2011

### 4.2.3 Educational Status

As the level of household head education increases, it is believed that the transfer of information and knowledge about climate change and its adaptation strategies to increase significantly. For the sample household heads it was found that 41.7% are able to read and write through informal and formal education below grade 4<sup>th</sup>, 10% had formal education above 4<sup>th</sup> grade and the remaining 48.3% had never been to school or were illiterate (see table 4.2).

Table 4.2: Distribution of household head by education status

Kebele	Read and write		Literate above 4 <sup>th</sup> grade		Illiterate	
	No	%	No	%	No	%
Zigity Meriche	7	35	1	5	12	60
Kolla Shelle	9	45	3	15	8	40
Chano Dorga	9	45	2	10	9	45
Total	25	41.67	6	10	29	48.33

Source: Own survey results, 2011

About 37.3 of the family members in all surveyed kebeles were attending formal education or attend school in the past, out of which, 47.4% of those literate are females (Table 4.3). Despite the fact that agricultural activity is labor-intensive, especially during the peak period (weeding, harvesting and sowing) most farmers hesitate to send their children to school.

Table 4.3: Distribution of household number by education status

Kebelle	Total family number	Family member which have got formal education		Family members attending or attended school in the past			
				Male		Female	
		Number households	%	Number households	%	Number households	%
Zigity Meriche	178	54	30.34	31	57.4	23	42.59
Kolla Shelle	176	64	36.36	27	42.19	37	57.81
Chano Dorga	156	72	46.15	42	58.33	30	41.67
Total	510	190	37.3	100	52.63	90	47.37

Source: Own survey result, 2011

#### ***4.2.4 Income Sources and Livelihood Strategies***

From the survey, if we compare income share by broad livelihood activities, the share of agriculture accounts for about 64.1%, nonfarm for 22.8% and off-farm accounts 13.1% in decreasing order. Farm income in the study area is obtained mainly from crop and livestock production. The mean farm income for sample household 3630.9 Birr per year with standard deviation of 1191.97 Birr. The survey result revealed that the mean off-farm income of household respondents was 231.67 Birr.

Furthermore, observation of the data revealed that off-farm activities (agricultural wage, land rent, and environmental gathering) are survival mechanisms pursued mainly by the poor and less poor groups but not viewed as an opportunity that farmers engage in as a choice. Nonfarm activities, such as rural craft is also mainly choice of the poor than the counterparts. Thus, off-farming activities seem more of a coping mechanism for the rural population than a way to accumulate wealth and reduce poverty. The poor tend to concentrate on off farm activities with low entry constraints (gathering, such as charcoal making and fire wood collection and wage).

#### ***4.2.5 Market Distance***

Farmers buy household consumption goods and other farm inputs from markets in addition to selling farm surplus, if any. Markets are mostly located in open rural villages and nearby towns, especially Arba Minch town. For each respondent from all kebeles there are two major markets which are located in their village/kebele (small in size) and Arba Minch town. Most of the rural markets (village market) operate once a week except the major once in nearby towns (Arba Minch, Merab Abaya, Konso). The local markets are characterized by inadequate marketing facilities and services, such as good sanitation, product protection, shelter, storage, package, price and other market information and so

forth. The maximum and minimum time from the market was 180 minute and 10 minutes, respectively. About 48% of the respondents walk more than 1 hour to reach the nearest market.

#### ***4.2.6 Land Holding Size***

From survey result, the land holding size per household varies between 0.5 and 1 hectare. On average land holding size of respondents in Zigity Meriche, Kolla Shelle and Chano Dorga kebele was 0.5, 1 and 0.5 ha, respectively. For the whole survey respondents average farm size was found to be app. 0.67 hectare per household (8.5 heads). As a result fallow lands are scarce and there are also shortages of grazing land. Out of the sample respondents about 7%, 2% and 4% in Zigity Meriche, Kolla Shelle and Chano Dorga kebele, respectively are landless and managed to work on sharecropped and rented plot.

#### ***4.2.7 Labor Inputs/ Availability***

Labor force as determined by the size, age and gender composition of a family is one of the productive resources available for rural household in addition to land and capital in agricultural activities. In addition to the household head, other members of a family also work both on the farm and off-farm. Usually husband, wife, son/daughters share farm activities. In all kebeles women's are actively engaged in cropping activities during peak seasons, particularly in times of planting/sowing, weeding and harvesting. On the other hand, adult men are responsible for almost all farm operations although their participation in the household activity is limited. Youths and children under the age of fifteen also have responsibilities in farm activities including keeping animal herds and caring for small children in the house after their return from school. In addition to the available family labor, labor force for farming also depends on the number of working days per month and

time (hours spent on the farm per working days). Under normal conditions, farmers work on their farm for about 8-9 hours and 6 days on average per week.

Most of the sample household head reported that there are no labor shortages even at the peak period due to small size of cultivated land. However, large farm holders used daily labor, Baso/Debo (traditional labor sharing mechanism based on mutual aid particularly in the past) and casual laborers in weeding and harvesting period. Interviewee also indicated that farmers working hour in their farm decreased over the past few years due to increased local temperature.

#### ***4.2.8 Institutional factors***

Institutional support like credit facilities, market accessibility, extension services, timely input supply, and availabilities of agricultural technologies, irrigation scheme, and other rural infrastructure development are central to rural development and improved farm production. The following section discusses these aspects in terms of household survey and interview respondents from the study area.

##### ***I. Agricultural Extension***

Agricultural extension is of a paramount importance to introduce better agricultural practices and improved technologies to smallholder farmers in a country like Ethiopia where traditional farming practices are dominant. In this study, like other rural parts of the country in general and kebeles of the woreda in particular, the Office of Agriculture and Rural Development through its technical experts and DAs at kebele level provided agricultural extension services. Extension service is provided by extension workers and to some extent by non-governmental organizations such as Vita and World Vision. Two to three development agents were also assigned at each kebele to give frequent and

continuous technical support and advice. According to officer at the woreda level, agricultural extension service in the study area mainly focused on providing basic agricultural education, teaching and demonstration about the use of agricultural inputs, forestry development, soil conservation, livestock production and other aspects. Almost all sample household respondents responded that, development agents have been assigned in their kebele, but most of them complained that they do not get sufficient agricultural extension services.

The agricultural desk under the department of Agricultural and Rural Development was the main government institution mainly responsible for the implementation, monitoring and evaluation of the agricultural extension services at zonal level. It has a technical expert (SMS) both at the zonal and woreda level to provide technical assistance and training for DAs and supervisors. Development agents are responsible for the actual implementation at the extension program at grass root level.

## ***II. Disaster Prevention and Preparedness Committee***

Disaster Prevention and Preparedness Committee operates at woreda level with the main objective of assessing the drought situation, screening the needy people, organizing the distribution of relief aid and executing the food for work program. In principle, the Early Warning Team, the technical arm of the Committee ought to undertake periodic assessments about the situation of crop production and livestock health and submit reports to the committee regularly. Although assessment reports are sent to upper hierarchies more or less regularly, the Committee and the team rarely meet unless disaster occurs.

### ***III. Food Security Programme (FSP)***

Food security programme was aimed at protection and promotion of household assets in order to address problems of farm production shortfalls, smallholder farmers' vulnerability to the decline in income and consequent falls in household consumption level. The Ministry of Agriculture and Rural Development is mainly responsible for its effectiveness. This programme firmly believed to address chronic and transitory households' vulnerability to food insecurity and hunger via the provision of *Household Package and Credit Schemes* which was assumed to help this farmers create household assets. Together with it government also undertook *Voluntary Resettlement Programme* which was mainly focused moving those chronically food insecure households from highly degraded and infertile to fertile and potentially underutilized areas within the region.

According to Deputy Administrator of Woreda Agriculture and Rural Development, the contribution of food security programme in the woreda is indispensable, because this programme helped a lot in addressing smallholder farmers vulnerability to food shortage by undertaking several measures like conservation of natural resources, provision of farm credit for relatively food-insecure households to purchase improved farm inputs, providing training and technical assistance to develop alternative income sources and diversification of their household livelihood, participating vulnerable farmers in collective community works to build up societies capital and improve their resilience and others. He said that this program is also important to cope up with the increased risk of flash flood and other natural calamities like land slide in the woreda through emergency food aid and relief services. In the past much of the support for the chronically food insecure was meet through emergency food assistance but it was insufficient, unpredictable and failed to address underlying causes of food insecurity.

According to Woreda Administration Head, with the help of this programme they are able to resettle 2,300; 1,680 and 4, 540 people since 2007, 2008 and 2009, respectively who were severely affected and their residents are assumed to be flood and land slide prone to potentially fertile and underutilized areas within the woreda on voluntary basis. Beneficiaries of household package and credit scheme also reported during the interview that this programme helped them to restart their lifelong livelihood (crop-livestock production) again after crisis and to some extent to build and create household asset, etc.

Though there are debates over its effectiveness *Productive Safety Net Programme (PSNP)* which was launched since 2005 as a key element of FSP at the national level marked a shift from relief and crisis management towards long term asset building and strengthening chronically food insecure household resilience to any form of shock and stress in their community. This program provided with food and/or cash for those households involved on developmental activities, such as soil and water conservation, rural water supply development or road construction and direct transfers for those households who are unable to take part in public work due to labor shortage.

According to Deputy Administrator of Woreda Agriculture and Rural Development Office, there are around 350-400 households who were assumed to be model beneficiaries of PSNP in the woreda and graduated over the past two years, whereas the total PSNP beneficiaries in the woreda reached around 46,360 households since 2002 E.C. The study identified it as being effective in building local capacity and in filling the gap where it doesn't exist. For instance, the construction of check dams and afforestation has reduced the exposure of lowland areas to floods. Soil and water conservation programmes have increased the percolation rate of water, thereby enhancing the asset base (i.e. increased soil moisture content). The food for labor scheme under food insecure households receive 15 Kg grains/month, has reduced labor migration. Access to credit schemes has allowed



villagers to invest in their assets and enable them to engage in petty trading, livestock fattening, and diary production.

However, respondents also outlined that budget delays and budget cuts by donors have been a problem. Others indicated that nepotism and corruption in targeting the beneficiaries, capacity issue relating to techniques of timely follow up and monitoring beneficiaries progress and application of improved agricultural technologies (human capital problem), lack of coordination and overlap on the responsibility (due to lack of clarity) between process unit are among others. Respondents explained that most of the activities are carried out at times peak agricultural seasons (e.g. sowing), thus disrupting agricultural productivity.

However, relative to the past the current performance is more predictable, helps to protect and build households assets, while at the same time strengthening the productive base of food insecure areas and helped to reduce chronic food insecurity.

#### ***IV. Access to Agricultural Credit and Input Supply***

Credit availability has also a paramount importance to improve the ability of the rural households at critical times of year to buy inputs and meet household consumption needs during the times of crop failure (emergency). Availability of credit and modern farm inputs is an integral parts of extension system which is required to improve agricultural production through the use of modern and improved agricultural technologies like fertilizer, improved seeds, farm implements, etc.

Credit in the form of cash or kind was provided to sample households. There are different sources of credit. Among all, institutions like micro finance and office of agriculture and rural development take the leading role in providing credit in cash or in kind to farmers. As reported from the survey result, about 45.4% of sample households got credit either in the

form of cash or in kind from government, informal local institutions, and private money lenders and from friends and relatives for different purposes.

Government actual credit provision was undertaken through multi-purpose cooperatives and Omo and Wisdom Micro Credit and Saving Institutions (OMCSI and WMCSI, respectively). The regional Cooperative Promotion Bureau is responsible to provide supervision and technical assistance to multipurpose service cooperatives for its success. Credit was disbursed to farmers in the form of regular and revolving fund. The regular loan is mainly used to purchase fertilizer (Urea and DAP) and improved seed with a repayment period of one year. Whereas, revolving credit/fund is provided for animal fattening, rearing and to purchase post harvest technologies. The repayment period was extending to one year from animal fattening to more than one for animal rearing and purchase of post harvest technologies.

Most of the respondent farmer used inorganic fertilizer for improved seed, particularly for maize. DAP and Urea is the only inorganic fertilizer widely used by farmer to increase or maintain agricultural production. Of which most farmers use DAP more than Urea because the impact of DAP were observed in the seed of crop whereas the impact of Urea was observed on the leaves of crop. Improved seed and fertilizers were also provided by NGOs, particularly Vita on credit basis.

From the total of household respondents received credit and who were asked whether they received credit for agricultural purpose or not, about 48.8% reported that they had got access to credit for agricultural activities, particularly to purchase fertilizer and improved seed. However, many farmers are reluctant to use credit for fertilizer, as it is very expensive and have bad perception (in Zigity Meriche kebele) that leads them to indebtedness.

## *V. Infrastructure*

Development of infrastructure is an engine for economic development and growth. All-weather roads, potable water supply, well organized and equipped markets, communication (telecommunication, postal service, and internet), electricity/energy, banks and credit facilities, school and training centers, hospital and health centers, information centers, stores, etc are the main ones.

According to household respondents, currently in their village they are connected with other kebeles through feeder roads mainly constructed by community members under PSNP and main asphalt road stretched from Addis Ababa to Jinka also connected them with major nearby towns, especially to transport farm products. Respondents from Kolla Shelle and Zigity Meriche reported that, most of them use pack animals or their own backs to transport their products to the nearby market. The majority of respondents explained that repeated destruction of both feeder and main roads by flash floods and river overflow in recent year caused increased cost of transportation and damage over their produce together reduced household income.

Survey result revealed that 37% of household respondents have access to telephone lines. Reports from interviewee indicated that mobile usage by the farmers increased in recent years. The use of telephone as a means of accessing market information (price) was increased and helped most respondent households to charge fair price and obtain increased farm income. But most farmers in the study area complained over the problem of network failure and expensiveness of its usage.

According to Arba Minch Zuria Woreda Administration Report (2002 E.C), currently there is no hospital in the woreda, which is serving the entire population in cases of serious illness. But most residents in the woreda used the nearby hospital in Arba Minch town. In the woreda there are a total of 8 health stations and the existing health coverage is 54%.

From the total household respondents 58% of them reported that they had access to health services. But the majority of them complained over the quality and adequacy of the service relative to increasing health demands in their village. Some respondents also indicated that health service during the times of emergency, especially during flooding most of them did not have timely support from these institutions. Due to absence of hospital which is near to their residents and problems of transport, most of them are forced to incur additional costs which in return increased household expenses, given low level of household income. According to interviewee from all kebeles there is increased participation of private investors in this sector except complaining over price and quality.

With respect to educational facilities, elementary schools are fair in number. Almost each kebele in the woreda have elementary school and some have junior secondary schools. However, there is no secondary school. There are only 2 secondary school located within the woreda and Arba Minch Town to host students from different elementary schools in the woreda. According to some respondents in the study area students in their village have difficulty in going to school because of absence and increased cost of transport, increased cost of living in nearby towns where secondary schools are located and decreased household income over the past few years. Interviewee indicated that in recent years the rate of student dropout after elementary school is high due to increased responsibilities of children to support household farm activities against decline in their income under the current climate stress. Survey result revealed that 40% of household respondents reported that they had access to formal education. The participation of private and NGOs in this sector was reported to be very low despite recent initiatives to start up KG and primary level program in selected kebeles of the woreda.

Almost all kebeles in the woreda are reported to have 24 hours-a-day electric power supply from Arba Minch station (Woreda Administration Report, 2002 E.C). From the survey 56% of household respondents reported that they have access to electricity. Most

respondents in the study area reported that repeated power break as the major problem relating to electricity.

## ***VI. Social Capital/Traditional Community Organizations***

Other than the formal organizations run by the local government, there are indigenous community organizations that have played a considerable role in the social as well as economic lives of farmers in the woreda. Being a member in one of these organizations is crucial to any household not only because of the sense of belongingness to the community but also because of the benefits derived from the social network. These organizations provide their members with labor, cash as well as material support, especially during the times of emergency and peak seasons. *Baso* (local name for labor sharing mechanism), *Idir*, and *Iqqub* are the three major non-religious community organizations that every member of the community in the study area is assumed to engaged in. *Baso* is an arrangement whereby individual households pool their labor resources in order to mitigate labor shortage in times of peak/emergency. *Idir* is a social organization where members help with each other during times of grief, weddings, as well as other social occasions. *Iqqub* can be considered as a source of revolving fund from which every member will benefit in turns. These social organizations strengthen community ties by building cohesive social networks.

From among the sample households, 83.3% said that they are members of these organizations. According to the respondents, *Baso* is the main coping strategy used to alleviate the problem of labor shortage especially during harvesting, weeding, and threshing. *Idir* is the dominant organization that the majority of the sample households participate in. Respondents ranked *Idir* as the most essential community organization that provides material support.

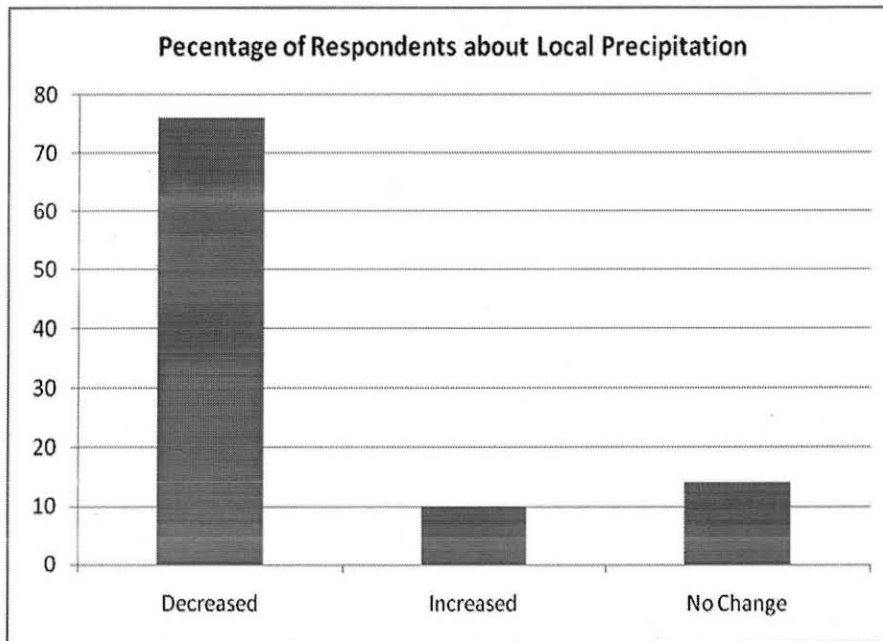
### ***4.3 Households' Perception about Local Climate Change***

The findings indicated that local households' perceptions of climate change and variability are based on assessment of mainly temperature and rainfall events as they experience them within their locality.

From those who have noticed some change in the local climate, 86% of the respondents pointed out that rainfall patterns have become highly erratic and varied in the last few years to the effect that they perceived the time of onset of seasonal rainfall fluctuate, the duration tends to be very short relative to the previous conditions and the prevalence of mid-season dry spells had increased (see figure 4.4). A considerable number of respondents have also observed that, in addition to the erratic nature of precipitation, below normal rainfall years are becoming more frequent exacerbating food insecurity in the Woreda.

Under normal weather conditions in the past, this woreda experienced two rainy seasons per year, the rainy seasons are known as *belg* and *kiremt*. *Belg* is a short rainy season extending from March to May and the main season (*Kiremt*) falling between June and August. However, elderly respondents (interviewee) from the study area (all kebeles) reported that the pattern of rainfall in terms of amount and distribution over the past few years has become highly fluctuating and sometimes erratic. According to them, when the rain occurs, it is usually heavy and often causes severe floods, with hailstorms. Respondents from the lowland kebeles (Kolla Shelle and Chano Dorga kebele) also indicated that in recent times frequent and complete failure of *belg* season rainfall is a normal phenomenon and most of the months under the main rainy seasons become dry.

Figure 4.4: Analysis of Household Survey Respondents Perception of Local Precipitation



What was more confusing to the farmers in recent times was that the area could simultaneously experience frequent drought and excessive precipitation during the same season, especially during belg season. The trend in precipitation, as observed by elderly farmers, was that their area was getting drier. A higher frequency of seasonal droughts or mid-season dry spells and late onset and early ending of the rain season evidenced increased aridity of their village. Most farmers indicated that the main rainy season used to begin in late May or early June and end as late as mid September, but the late 1990s onwards the trend was that the main rainy season would started as late as mid June and end as early as mid August. Often extended rainfall during *Tseday* season caused heavy loss and damage of crops, because this season was considered as harvesting time and exacerbated food shortage and consequent falls in household income.

With respect to local temperature, farmers observed that local temperature was on an increasing trend, as evidenced by the high rate at which surface water sources such as streams dry up and the wilting of crops after the occurrence of a precipitation event. About 78%, 8% and 14% perceived mean temperature as increasing, decreasing and remaining the same over the past 10 to 20 years. Interviewee also indicated that the number of hot and dry days increased with a long duration of sunlight as opposed to cold and wet nights. According to them, in the past farmers in their village on average work in their farm for about 8-9 hours, whereas in recent years they are forced to stay and work on their farm for about 4-5 hours due to increased temperature and duration of sunlight. Hence, the predominant households' perceptions in the study area are increased temperature and declining precipitations.

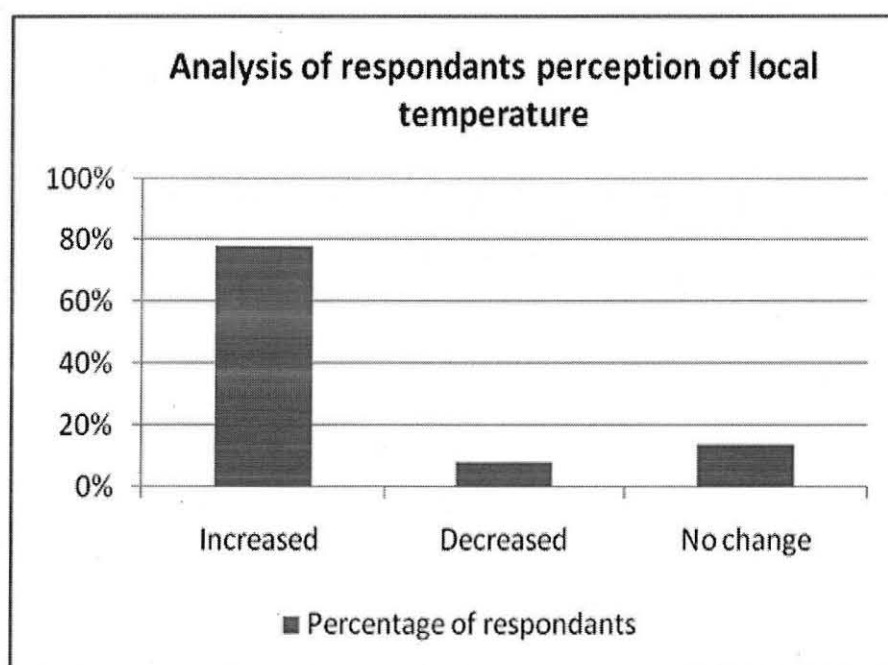


Figure 4.5: Analysis of household survey respondents about local temperature

#### ***4.4 Impacts of Climate Change on Households' Livelihood***

A significant number of empirical literature and studies found that climate change has been frequently imposing challenge on rural household livelihood and resulting in disruption of society's socio-economic activity. Study respondents also reported that delay on the onset of rainfall and/or complete failure of rain (particularly belg season) and heavy and unseasonal rain was identified to result in reduced farm production/crop failure due to drought, emergence of weeds, increased opportunity for crop pests, and flooding which breaks up irrigation canals, destroy basic social infrastructures including schools and road networks. These climate variables also contributed to decline in pasture/forage and grass regeneration and increased outbreak and vulnerability of livestock diseases and death of many people and livestock. Increased local temperature and heat stress also identified to cause forage deficit, water shortage used both for irrigation and livestock watering, physical deterioration of livestock and herders due to long distance travel for water and pasture.

##### ***4.4.1 Climate Change-related Events and their Impact on Crop and Livestock***

###### ***Production***

Through the interview and household survey carried out in this study, smallholder farmers explained how the current weather patterns were affecting their farming systems and subsequently their livelihoods. They cited mainly precipitation and temperature-related weather events, as the ones that are a real cause for concern in relation to their agricultural activities. The high frequency of excessive rainfall and drought since the late 1980s and onwards has been the major challenge eroding the farmers' assets, displacing them from their homestead and leaving them more vulnerable to the vagaries of these climatic events. The high frequency of these events gives farmers no time to recover from previous impacts

through either asset accumulation or acquiring the skills and knowledge necessary for adapting to future climate changes. Consequently, farmers are subjected to continuous hunger and deeper cycles of poverty and vulnerability. The unpredictability of precipitation presented more challenges to the farmers than any other climate change elements. One elderly farmer in the Dorga kebele stated that what they are witnessing today is a new and worrying phenomenon.

*"We are increasingly experiencing a high frequency of drought and excessive rainfall or both during the same year. Due to these events, food shortages have also become much critical and we are selling household assets to buy food and finance household consumption needs. During drought our livestock die and we remain just only by the will of God (Tossa)."*

Other interview respondent in Kolla Shelle kebele confirmed the same challenges they are faced with over the past few years:

*"... In our village no one rely on their own production to feed their families, because their yields are insufficient because our agriculture heavily reliant on rainfall which was unpredictable and insufficient for crop production. Most households didn't get any harvest during the past three years due to rain shortages and subsequent crop failure. If this was a case what will be our future? No one can tell you what will happen in the future..."*

### ***a) Impacts of Heavy and/or Excessive Rainfall***

Survey respondents indicated prolonged and excessive rainfall conditions during the crop growing season leads to flooding, water logging, erosion, and excessive leaching - all of which lead to crop failure, depending on the intensity of the condition. Weeding, fertilizer and pests and diseases chemicals application becomes more difficult. Farming costs increase as more fertilizers and other chemicals are required, leading to losses to insect pests and diseases of field crops, as well as those that are stored on the farm. If these conditions are experienced during harvesting and post-harvesting periods, heavy crop damage and loss are incurred as crops rot in the fields, as well as on open spaces since most farmers do not have water or moisture proof storage facilities (Interview with Woreda extension officer and DAs). The lowland kebeles (particularly Chano Dorga and Kolla Shelle) of the woreda are prone to the risks of flooding whereas the highland kebeles (particularly Zigity Meriche) are prone to landslides and soil erosion caused by heavy precipitation. Loss of vegetation cover and poor farming practices in the highlands exacerbate and makes flooding hazards worst in the lowland kebeles in recent years.

From the survey carried out 54%, 36% and 10% of the respondents reported that flooding is more frequent (severe), frequent and less frequent, respectively. According to them, flooding was caused due to heavy and unpredictable precipitation and overflow of nearby rivers flowing from the highland areas. Excessive deforestation coupled with expansion of farm lands towards the marginal areas due to decline in crop production and population pressure exacerbated the problem. Unplanned settlement and construction of rural road network also noted as the factor contributed for increased flooding in their village (Dorga kebele). Woreda officers indicated that poor and unplanned construction of irrigation canals and drainage system also contributed heavily for flooding caused by river overflow in all kebeles of the woreda.

Flash floods and overflow from Hare and Wozeqa River has caused widespread destruction of life and basic household assets. In recent years flooding becomes frequent, devastating and sometimes sudden to the farmers and their household resources. According to Woreda Early warning and Disaster management process report (2007 and 2008) in Kolla Shelle overflow of Wozeqa River due to heavy and prolonged rainfall during the belg season since 2007 and 2008 has caused death of over 22 people, about 265 livestock, displacement of over 650 people, and left 2,141 people vulnerable to drought due to loss of crops in the farm and damage over stored crops. It has also caused destruction of over 300 houses, loss of different household properties (estimated to be over 117, 9,687 birr), school properties (estimated to be 10, 1,005 birr), agricultural crops including maize, teff, cotton, sorghum, and other vegetables and fruits such as tomato, banana, enset (estimated to be over 760, 5,234.5 birr). Fatal diseases such as diarrhea, cholera, fever and malaria are the major health related threats during the event. It has also caused further challenges on these farmers in preparing their land for the next cropping season due to siltation by stones and often residues of heavy trees.



*Figure 4.6: Damage caused by heavy and prolonged rainfall on maize (Dorga kebele) and banana (Kolla Shelle kebele) production Source: WEWDPP (2007 & 2008)*

The impact of this climate event on crop marketing is also quite devastating for the farmers. The rain-damaged crops will be of poor quality and, therefore, fetch low prices on the market. Sometimes the prolonged excessive rain leads to deterioration of already poor rural roads and bridges making the roads that traverse the area impassable (this is a particular case in Kolla Shelle and Dorga kebele). This affects the timely transportation of both agricultural inputs and outputs to and from the markets further affecting agricultural productivity and household incomes in subsequent years. Some of the road infrastructure remains in the state of disrepair for years leading to deepening poverty among farmers whose household income mainly comes from farming. For example, overflow of River Hare and Sile River and flash floods from the highlands caused repeated and severe destruction of the main road stretching from Addis Abba to Jinka and other rural roads each year over the past 5 years, particularly during belg season. The farmers were, however, quick to point out that prolonged and excessive rainfall that damage crops were uncommon but when they occur, they will be quite intensive and devastating for them.

In the highland kebele (Zigity Meriche) heavy precipitation with landslide has caused massive destruction of household properties, loss of fertile soils, destruction of irrigation canals and public utilities. According to interview respondent (community leader) in this kebele, landslide which was considered as a peculiar feature of the kebele each year after the main rainy season and costs innumerable amounts of household assets, livestock, human life and other social services including school, roads, etc. From the Woreda Early warning and Disaster prevention process report (2006/07) in 2006 and 2007 landslide and flooding occurred after the heavy rainfall during the belg rainy season caused death of 246 livestock and 36 people, complete destruction of household assets estimated to be 272, 340,243 birr, school properties (estimated to be 256, 736 birr) and irrigation canal (both traditional and modern) which was 12 km (costs 4, 350, 277.76 birr).

In recent years, increased and excessive precipitation were experienced in the woreda during the 2005-2006 and the 2008 onwards seasons and led to serious household food insecurity among about (50-60)% of the smallholder farmers in the woreda (Interview with Woreda Rural development officer and NGOs official).

### ***b) Impacts of Increased Temperature and Drought***

Drought is not a new phenomenon in the lowland kebeles of the woreda. It is more of cyclical; the period changed in recent years and has become more frequent, occurring every 2-3 years (interview with community leaders in Kolla Shelle and Chano Dorga Kebele). Respondents in both kebeles indicated that during the rainy season, the rains were not only insufficient but also extremely unpredictable. The damage caused by this weather condition depends on the part of the crop growing season it would having temperature occurred. If such conditions are experienced during the early stages of the rain season, it mainly affects the farmers' ability to meet the planting deadlines and cause poor crop germination. Mid-season, prolonged dry spells, stress crops through wilting and may promote the occurrence of insect pests, such as armyworms (interview with extension and NGOs officers).

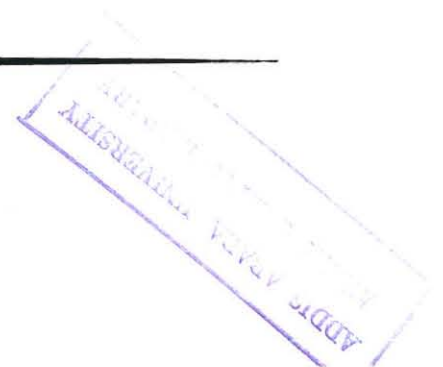
Data collected from household survey confirmed that 72%, 23% and 5% of the respondents indicated drought in their village were more frequent/ severe, frequent and less frequent, respectively over the past 10 years. According to Woreda Early warning and Disaster management process report (2010), more than 68% of the woreda populations are prone to drought caused by insufficient rainfall and complete failure of belg season rainfall. Resident in the lowland kebele (Kolla Shelle kebele) said that:

*"...in recent 5 years the rainfall were highly variable and fragile. It doesn't come on time and if it was occurred it was insufficient to grow cereals and*

*sometimes completely fail. We are forced to wait for main rainy season to grow crops which was also unpredictable. Coupled with increased temperature, water streams and surface run-offs sharply declined to cause water shortage not only for irrigation but also for watering our livestock. As a result, we are unable to feed our households sufficiently. To survive with the change and meet the needs we are engaged in different activities like collecting fuel wood, charcoal, manual labors, petty trading (mostly household wife's and children), temporarily migrating to the nearby towns in search for work, traveling long distance in search for water and pasture..."*

The lowland is already a drought-prone area but the farmers indicated that dry spells have become more frequent and devastating in recent years. Overall, agricultural productivity hinges on whether there has not been a prolonged dry condition in the area during the crop growing season, since farming is mainly rainfed. The fall in crop production leads to household food insecurity which was associated with a sharp rise in food prices until the next good harvests caused additional stress on household livelihood. This happens at a time that most households would have failed to raise household incomes through selling agricultural products and poverty levels increase dramatically.

The dominant food crops include wheat, teff, enset, sorghum and maize and the dominant cash crops include vegetables and teff and/or maize. According to respondents, climate change has potentially contributed to a change in the pattern of crop production. A shift from highland crops like wheat to lowland crops like sorghum is reported, as well as a shift to more drought-resistant and early maturing crops like sweet potato. Also, a shift towards



single cropping as compared to double cropping is observed. According to them, these caused reduced farm income and increased households' vulnerability.

As respondents indicated that the short and irregular rains negatively affect grazing pastures. A poor rainfall season resulted in very poor pastures during the dry season, affected the condition of their livestock, particularly cattle. With less pasture, livestock herd size and productivity diminish. The change in water availability, in terms of timing and amount, and increase in temperature, has impacted on the rangeland and on livestock watering points. These changes, along with other risks, have resulted in a decline in the herd size per household in all livestock types and a change in herd composition. Water shortage forced families to travel longer distance to get water for their livestock by spending more time which can be used for other farm activities. The main impact was the existence of very weak animals at the onset of the rain season. The overall livelihood impacts of extreme weather conditions on local smallholder farmers, therefore, include sale of assets, indebtedness, outmigration, and dependency on food relief/aid.

In very recent years (2007 onwards) drought becomes a serious phenomenon. One respondent in the lowland kebele (Dorga kebele) said that:

*"...our village looks like semi-arid and arid. In recent years, particularly in 2000E.C onwards we are faced with chronic shortage of rain during rainy (belg and kiremt) seasons. This resulted in water stress/shortage. The volume of Hare River and other nearby streams declined sharply which also resulted in a big challenge for irrigating our farms and watering our livestock. Our farm income declined dramatically (because of declined in crop-livestock production) while the demand peaked (increase in prices of consumable items contributed for). We are pushed to live at sub-human*

*conditions. As a strategy few household members traveled to the nearby towns in search for labor works, but the return were not satisfactory as payment was low as compared to increased living costs in recent years. I think there was something gone wrong (sin). Everyone needs to pray for almighty God. That is all what we can do. Nothing and nobody could change the situation, because I feel hopeless and scared about our future..."*

#### ***4.5 Household Level Adaptation Responses/Strategies***

Human societies are increasingly attempted, with varying degree of success, to cope and adopt with climate related events. As a response mechanism for perceived long-term change in climate variables and climate related extreme events such as drought and flood in the study area, farm households adopted a number of strategies which includes changes in timing of farm operations (changing planting/growing/harvest seasons), diversification of crop and livestock varieties (high yield variety seeds/HYVs, drought resistant crops, improved animal breeds, etc), soil and water conservation practices (water harvesting, rangeland and watershed management, restoring degraded areas, changing land topography through land contouring and terracing and construction of diversions/recharge areas etc), use of small-scale irrigation (both traditional and modern), rotating or shifting production between crop and livestock, application of fertilizer, pesticides and integrated pest and disease control, social capital network and income diversification (engaging in off-farm activities) are the dominant ones.

*Table 4.4: Household-level climate change adaptation response mechanisms*

<i>Adaptation Strategies</i>	<i>Percentage of Household Survey respondents (from those respondents adopted a strategy)</i>
Changes in timing of farm operations	74%
Social capital resources	64%
Soil and water conservation practices	62%
Formal and/or Informal saving and loan institutions	56%
Income diversification/Off-farm employment	46%
Diversification of crop and livestock varieties	36%
Application of fertilizer, pesticides and integrated pest and disease control	37%
Rotating/shifting production b/n crop and livestock	34%
Use of small-scale irrigation	21%
Others	18%

From the table above one can simply understand that the majority (above 90%) of these adaptation responses employed at household level were meant to improve farm productivity whereas the remaining less than 10% are related to non-yield strategies (particularly shifting from agriculture to other sectors).

Changing/altering the timing of farm operations (74%), particularly planting, growing and harvesting seasons help farm households to ensure that critical crop growth stages don't coincide with harsh climatic conditions in the season, such as mid-season droughts. This strategy was the means for escaping sensitive growth stage through crop management

practices. This strategy was a particular response especially in the lowland kebeles because of slight change in on set of and early ending of rainfall.

Community members also indicated that they often rely on social capital resources (64%) as a response mechanism in the times of emergency and/crisis that have traditionally existed in every kebeles of the study area. Established social support mechanisms include baso (traditional labor sharing mechanism), iqqub and idir, informal savings and loan associations, membership into which helped guarantee support in the form of labor, money or cattle in times of need. However, during times of extended and extreme hardships, the community turns to the local government for support and expects that adaptation measures such as irrigation will be implemented in their areas by the local government. These institutions are also considered as the means to reduce household vulnerability and spreading mechanisms of risks relating to climate change (farm level risk management strategy). These institutions were less dependable especially during severe crisis because almost all members are faced with the challenge at the same time and supports are beyond institutions capacity.

Soil and water conservation practices (62%), such as water harvesting activities, rangeland and watershed rehabilitation and management practices, improved use of surface and ground water, restoring degraded areas, changing land topography through land contouring and terracing, construction of diversions, reservoirs and recharge areas to reduce vulnerability by reducing runoff and erosion and promoting nutrient restocking in soils was also common in the study area. These conservation and management techniques helped farmers in the study area to maintain and improve soil structure and fertility of their farm. For example, maintaining crop residues from previous harvests on the soil surfaces are likely to help maintain soil quality and provide protection against wind erosion.

A considerable number of respondents from Dorga kebele also reported that with the support of Arba Minch University, development agents and extension workers in their kebele, they are undertaking improved water resource and soil management practices especially around the nearby highland areas. These collective watershed and rangeland management and rehabilitation which was covered roughly around 1500-2000 hectare helped them to restore those degraded areas. Other techniques such as digging collective wells, diffusion of appropriate technology to enhance greater water use through community advocacy work including reduced water use in land preparation as well as loss (through seepage and percolation) during the crop growth period, use of drip irrigation (Arba Minch University) method and so on were crucial. Interview with Woreda Rural Development Officers indicated that these practices were also replicated in other kebeles of the woreda and the improvement was relatively promising. At the woreda level there are about five model watershed and rangeland rehabilitation and management kebeles which was assumed to be areas of adopting and transferring best agricultural practices.

According to interview at the woreda level, farmers and/or communities participation in this activities was highly intensified as Agricultural Extension Officers and NGOs experts (from Vita and World Vision) wake out to promote and give timely support for them. These institutions are enthusiastic about promoting these practices because they are building on farmers' indigenous knowledge, skills, and experience acquired over the years, as farmers were battling to survive the harsh climatic conditions that prevail in the area. If these practices are properly promoted and adopted by the farmers, they promise to address some of the climate change challenges among smallholder farmers considering their poor resources and marginal location which makes conventional irrigation impossible particularly in steep slope highland and degraded lowlands. With the help of environmental organizations residents intensified their efforts to protect the remaining woodlands and encouraged to adopt agro-forestry practices such as planting multi-purpose trees. Furthermore, during rainy seasons, residents also dig shallow ponds to collect rainwater

and during drier seasons they keep deep wells to overcome water shortages (this is very particular in the lowland kebeles).

Credit access from both formal and informal saving and loan institutions (56%) contributed for improvement of farm productivity by enabling the rural households to purchase and use improved inputs such as fertilizer, pesticides, improved animal breeds and the like technology. According to the respondents these institutions are very essential to help them to overcome capital and credit constraints that otherwise persist. It also helped poor households in terms of investment made on human or physical capital to enhance future household production and reduce vulnerability to shocks induced by climate events. One interview respondent from Zigity Meriche kebele said that:

*"In the past all farm households in our village were in very serious trouble...during this climate-related extreme events most of we are trying to cope with but unable to do so...it is only by the will of God that we are survived...households owning land for farming may asked loan to finance costs implied by climate related shocks and obliged to share what they have with others..."*

From the survey results we can understand that livelihood/income diversification (46%) has increasingly become an important adaptation strategy in the woreda. It was reported that there are more climate change related migrations to the nearest towns and to other distant towns in the country. According to these respondents migrants undertake off-farm or non-farm activities for part of the year (remittances supplement and diversify) household income) and return during the harvest time which helps the households to ensure the security in livelihood during periods of food shortage and enhance social resilience of

households through temporary diversification of sources of livelihood. Other activities, such as collecting and selling fuel wood and charcoal, fishing, fruit gathering and selling, providing local transport using animals like horse, involving in construction and other seasonal works, are also on the increase. The sustainability of these sources of income is quite questionable since some of them are considered as illegal and environmentally degrading.

According to respondents from all kebele reported that crop diversification (36%) improves household food security since different crops are affected differently by the same climatic conditions. Also, given the high frequency of mid-season dry spells and shortening of the rain season, farmers grow short season and drought-resistant crop varieties, such as sorghum and finger millet and vegetables including Enset and Boye (local name). For a staple crop, such as maize, instead of planting local varieties, farmers have opted for hybrid maize (accessed from Vita and others) that takes a shorter period to mature and yield more than traditional varieties in good years. This appears quite logical and sustainable if seed producers continue to improve on these varieties. However, indigenous land races that were more adapted to the conditions in the area are being lost as farmers prefer high yielding hybrid varieties. Most farmers reported that they prefer to select and use their own genetic pool by selecting and storing the best seeds from each year harvest otherwise from the neighboring farms or others.

Switching crop varieties can be expensive, making crop diversification typically less profitable than specialization. For example, in Zigity Meriche and Dorga Kebeles some respondents reported that most of the farmers in recent years used improved early maturing and drought resistant crop varieties. However, the applications of these crop varieties are constrained by their price (affordability) and payment mechanisms. Moreover, respondents indicated that traditions can often be difficult to overcome and dictate local practices. For example, in the woreda there has a long and rich tradition of a particular crop variety such

as enset, maize, sorghum, millet and others, but recent transitions to newer and more suitable varieties were difficult (Interviewee from Vita).

Farmers in study area explained that in order to improve the productivity of their farm they also alter the intensity of fertilizer and pesticides application (37%). Most of the respondents believed that agricultural intensification (increased the use of farm inputs such as fertilizer, pesticides, capital, labor, land others) helped them to reduce risks from climate change. But most of the respondents complain over its effectiveness since most farm inputs in the study area are very scarce in their supply and if available nobody can afford the price unless otherwise government and other NGOs working in their community subsidize them. For example, application of more fertilizers such as Urea and DAP as an adaptation strategy has its own challenges.

Chemical fertilizers are scarce and exorbitantly priced in the woreda and most smallholder farmers cannot afford them. If they apply they remain indebted given that shortage of rainfall/water, poor fertility of the farm and other. Despite the fact that, there are also positive initiatives to promote the preparation and application of natural fertilizers like compost using local resources in a wider context particularly in the highland areas. Other strategies applied under this category were integrated pest and disease control and weed management. Most of these strategies were meant by collective actions of farmers and other local and international projects (particularly by *Southern Tsetse Eradication Project (STEP)*).

Other respondents also prefer to rotate or shift crop production with livestock (34%) but most often mixed type. They reported that, in the past their principal source of livelihood was only from crop production. But during the last few years decline in farm production and/or complete crop failure caused by climate shocks most of them are forced to seek other agricultural sources of income mostly livestock rearing. This days farm households

are totally undertaking both crop and livestock rearing and as an adaptation strategy the majority prefer to rotate within these farm source of livelihood following local weather patterns. However, shift from high valued crops like teff (lowland) and wheat (highland) to low valued crops enset and maize and vegetables production reduced farmers' income to a great extent. According to Woreda Rural Development Officer, most smallholder household in the lowland kebele to cope with the decline in livestock, people are turning to beekeeping, changing to drought tolerant livestock breeds (with the help of NGOs), collecting and purchasing feeds and using hay as well as crop residues (which can be used as a natural fertilizer/source of energy for household consumption) and temporarily migrating to the nearby highland areas where feed and water are available.

Irrigation was introduced in Arba Minch Zuria Woreda during the Imperial regime. However, it was at a very small scale and as a result there were small number of beneficiaries. According to information from the community members, food crops including maize and teff, cash crops particularly cotton, vegetables and fruits like banana, mango, enset and others was produced on many irrigated plots. Reduced volume of river flow and other streams used for small irrigation posed a serious challenge, but recent works on watershed rehabilitation and conservation measures contributed to some extent (interviewee from lowland kebeles).

According to the deputy administrator of Woreda Agriculture and Rural Development Department, there are 10-15 households under modern scheme and 250-300 under the traditional scheme. However, in recent year's production using irrigation was highly challenged by the decline in the water banks of Main River due to prolonged drought and often overflow caused by heavy rainfall. From the total household respondents 21% of them reported that they have used small-scale irrigation using Wozeqa, Suyle and Hare Rivers. Most of them also reported that the amount of water flow in this river bank is not sufficient considering the existing number of users and shortage of rainfall in their village.

Population pressure and low moisture retaining capacity of the soils were other problems mentioned by most of the interviewee.

Given traditional farming system in this study area, access to irrigation is the function of distance and suitability of farm topography often for Hare River (Chano Dorga Kebele), because most of the respondents from this kebele reported that they have a much lesser probability of getting access to the existing scheme as they are in the lower streams of the river and destruction of vegetation cover in the highland areas also contributed for the decline in the volume of this river flows and frequent flooding due to overflow during heavy rainfall.

Other adaptation strategies include growing legumes (such as beans) towards the end of the rain season when cereals fail, mainly due to excessive rainfall, and application of more fertilizers when nutrients are heavily leached from the soils. Legumes mature fast and provide nutritious relish. They also fetch good prices on the market.

NMA offered seasonal climate forecast data on a daily basis. The forecast in Ethiopia is issued through various media channels, such as the radio and television on a daily basis. Almost all of the farmers interviewed professed ignorance of the seasonal climate forecast information and they did not use this information to make efficient use of their limited resources through informed on-farm practices and investment decisions to adapt those impacts related to flooding, droughts and other extremes. Most of the respondents also reported that traditional sources of weather forecast dominated their decision making process intensity and duration of sunlight and cloudiness among others.

Respondents also reported various adaptation and/or coping strategies which were helped them to deal with climate induced shocks such as flood and drought. These strategies include food for work, food aid, safety net program by the government and other

emergency relief programs. Even though the debate is still on the table about their effectiveness, beneficiaries of productive safety net program are relatively less vulnerable than those of others (interview with Woreda Productive Safety Net Program Officer). Other emergency based responses helped farmers to survive and recover from catastrophic events.

The adaptation strategies that were pointed out by the farmers are based on lessons learnt from previous climatic stresses (indigenous knowledge systems), shared knowledge with other distant farmers through farmer field days and trips, and advice from both Agricultural Extension Officers and NGOs that are involved in various food security activities in the woreda. Lessons learnt from previous climatic stresses provide important entry points for social learning and enhanced adaptive capacity to both wetter and drier periods now and in the future.

## **CHAPTER FIVE**

### **SUMMARY, CONCLUSION AND RECOMMENDATIONS**

#### **5.1 Summary**

This research was designed with the objectives of assessing the impacts of climate change on rural livelihood, examining farmer's perception of local climate change and variability and identifying household adaptation responses and recommending solution to strengthen farmer's effort in the study area. The study area is located in southern part of the country, SNNPR at a distance of 505 Km from Addis Ababa and 275 Km from the region capital, Hawassa. Crop and livestock production is the dominant farming systems which is predominantly rainfed and subsistence.

To achieve the objectives of the study, a total of 60 sample household heads were selected randomly from three purposively selected kebeles and primary data was collected using structured and semi-structured questionnaire, key-informant interview and physical observation. Secondary data was also collected from both published and unpublished sources.

Descriptive statistics such as mean, percentages, minimum, maximum and others has been employed and presented using graph, tables and verbal description. Narration and explanation of information and/or data obtained using key-informants interview and physical observation were put into place.

In the Woreda studied most farmers reported less rainfall, declining rainfall days and when it comes, it does with great intensity which leads to flooding without recharging ground water resources. The majority of people interviewed and respondents are worried because they are totally dependent on the rains. However, metrological data gathered from the local weather stations for this study site doesn't show what farmers are experiencing. It shows a normal variability of annual rainfall over the year under consideration (1988-2008). In terms of local temperature most of them perceived that mean annual temperature increased, particularly over the past few years as they experienced an increased number of hot days. Contrary to these, metrological report indicated that the local temperature has shown a declining trend.

The lack of congruence between local metrological data and people's perceptions is understandable. Farmers, for example, assess rainfall in relation to their needs at particular times; small changes in the quality, onset, and cessation of rain over days or even hours can make a big difference, whereas meteorological data is more likely to be measuring totals and larger changes. At the same time, people's perceptions of climate change and variability are affected by local environmental, social, economic, and psychological factors. When combined with deforestation (which can increase local temperatures), soil erosion, population growth, economic development (or lack thereof), and illness, it can feel like the climate is getting worse because even small changes can have terrible impacts.

Small-scale farmers reported that delay on the onset of rainfall or complete failure of rain (particularly belg rain), early cessation of kiremt rainfall, heavy and unseasonal rain has negatively impacted crop production and food insecurity and livestock rearing. Heavy rainfall is devastating for agricultural production- beating down crops and sluicing away soils and silts up riverbeds, leading to further floods. Flooding also reported to cause massive destruction of basic infrastructural facilities and put greater pressure on social services. Furthermore, increased local temperature was also identified as the major

challenges to result in reduced farm production, emergency of weeds, increased opportunity of pests, decline in pasture/forage and grass regeneration, increased outbreak and vulnerability of livestock disease, water shortage and others.

The overall livelihood impacts of extreme weather and climate induced events on smallholder rural household in the study area, therefore, includes sale and loss of household assets, increased indebtedness, outmigration, and heavy dependency on food relief, increased vulnerability towards external shocks and extreme events, and lowering households' adaptive capacity and resilience.

With some assistance from both governmental and non-governmental organizations, small-scale farmers in the study area are adopting a variety of context-specific adaptation responses. In the farming areas, farmers change the timing of farm operations, shift to more drought tolerant crops and varieties, improve forest conservation and management practices, use small scale irrigation and water conservation measures, intensification of fertilizer and pesticides application and integrated pest and disease control, use of social capital network, formal and informal credit and saving institutions, and seek alternative means of income from off-farm activities. Others institutional and policy support measures including credit services, awareness raising on saving and use of modern farm technologies, providing safety net and food and emergency aid.

In the Woreda studied, people have few assets and even fewer opportunities to make a swift adjustment for the better. Small holdings, limited access to health and education services, poor credit and finance, and lack of access to information, markets and productive technologies all hinder poor farmers, from exercising options that would increase their adaptive capacity. These opportunities and constraints are shaped beyond the farm and the household by the policy and institutional arrangements fashioned by the state, markets,

donors, and international development agencies. In other words, these are all man-made and as such can be changed.

In short, the followings are a short summary of the major findings of this study:

- ✦ In every study kebeles, farmers perceived climate variations, especially in reference to the two important climate variables: precipitation and temperature, whereas metrological data gathered from the local weather station doesn't show what farmers are experiencing;
- ✦ In terms of impacts, climate induced extremes and hazards has negatively impacted crop and livestock production, food security, water and health in particular and rural household livelihoods in general through sale of household assets, increased indebtedness, impaired health, dependency syndrome on food aid;
- ✦ With some assistance from non-governmental organizations and the government, small-scale farmers are adopting a variety of context-specific adaptation responses and/or strategies. However, these response mechanisms were found to be insufficient; and
- ✦ Limited resources (such as land and livestock), lack of alternative sources of income and livelihoods options, lack of knowledge and expertise, limited access to health, education, transport and communication services, poor credit and finance, and lack of access to information, markets, and productive technologies all were found to hinder poor farmers from exercising options that would increase their resiliency.

## 5.2 Conclusions

The impacts of climate change will increase the challenge of ongoing poverty alleviation efforts in Ethiopia. It will hit hardest those whose livelihoods are more intimately tied to local resource bases and therefore more climate-sensitive. Survey findings has shown that farmers perceived that local climate is changing, though there was divergence with metrological data, and its impact on their livelihood, particularly on crop and livestock production is exacerbating. The frequent rain delay, erratic precipitation, drought, heavy rainfall and unseasonal rainfall are a grave concerns for all farmers. Farmers used various response mechanisms which include altering the timing of farm operations, shift to more drought tolerant crops and varieties, improve forest conservation and management practices, use of small scale irrigation and water conservation measures, intensification of fertilizer and pesticides application and integrated pest and disease control, use of social interconnectedness, formal and informal credit and saving institutions, and seek alternative means of income from off-farm activities. Others institutional and policy support measures including credit services, awareness raising on saving and use of modern farm technologies, providing safety net and food and emergency aid.

## 5.3 Recommendations

- ✦ Strengthening recent efforts such as improved soil conservation practices, integrated watershed and rangeland management based on the sharing of best practices through community participation, civil society engagement, and the participation of academic and research institutions, with regular monitoring to identify promising practices for scaling up is urgent.
- ✦ With the ever increasing rainfall unreliability, greater dependence on rainfed crop production and continued water deficit (especially in the lowland), investment on

intensification of small-scale irrigation and other water harvesting technologies are highly recommended;

- ✦ Improving smallholder farmer's access to agricultural credit and finance, market information, agricultural inputs, and social services including transport, health, and education is very essential for livelihood diversification as well as increased household resilience to external shocks.
- ✦ Build on what smallholder farmers and rural communities are already doing to adapt to climate variability and change. Investigate these practices further for their sustainability and potential for replication or enhancement through information sharing and extension contacts.
- ✦ Capacity building on disaster risk reduction, as well as improving early warning and communications system called special attention.

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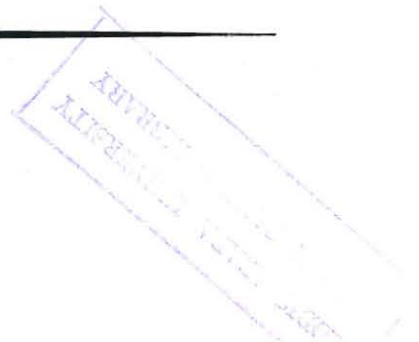
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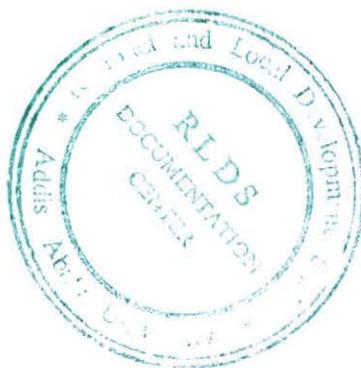
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## ANNEX A: DEFINITIONS OF KEY TERMS

**Adaptive capacity** is defined as “the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPPC, 2007).

**Climate change adaptation** is defined by IPCC (2007) as “adjustment in natural or human system in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

**Climate change** is any long-term significant change in the “average weather” that a given region experiences. The climate of a place or region is changed if over an extended period (typically decades or longer) there is a statistically significant change in measurements of either the mean state or variability of the climate for that place or region (ISDR).

**Climate impacts** refer to the consequences of climate change on natural and human systems (IPPC, 2001). Potential and residual impacts are distinguished based on adaptation.

**Climate** is commonly thought of as the average weather conditions at a given location over time, but it also includes more complicated statistics.

**Climate variability:** Variations in the mean state and other statistics of the climate on all temporal and spatial scales beyond that of the individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability) (IPCC, 2007).

**Climate vulnerability:** According to the IPCC Fourth Assessment Report, vulnerability to climate change refers to “the degree to which a system is susceptible or unable to cope with, adverse effects of climate change, including climate variability and extremes.

**Farm income** refers to income generated from own-account farming, whether on owner-occupied land, or on land accessed through cash or share tenancy. It is, broadly defined,

includes livestock as well as crop income, and comprises both consumption-in kind of own-farm output as well as the cash income obtained from output sold. In all cases, reference is to income net of the costs of production (Carney, 1998).

**Financial capital** refers to stocks of cash that can be accessed in order to purchase either production or consumption goods (whether savings, supplies of credit or regular remittances or pensions) and provide them with different livelihood options (Ibid).

**Human capital** refers to the skills, knowledge, ability of labor, and good health important to the ability to pursue different livelihood strategies (Ibid).

**Livelihood** comprises of the capabilities, assets (stores, resources, claims and access) and activities required for a means of living (Chambers and Conway, 1992).

**Livelihood Diversification** involves developing a wide income earning portfolio to cover all types of shocks or stress jointly or the strategy may involve focusing on developing responses to handle a particular type of shock or stress through well-developed coping mechanisms (Ellis, 1999).

**Livelihood strategies** are activities composed of that generate the means of household survival (Ellis, 1999).

**Natural capital** refers to the natural resource base or stocks from which resource flows useful for livelihood are derived (e.g. land, water, biodiversity, environmental resources) (Carney, 1998).

**Non-farm income** refers to non-agricultural income sources. Several secondary categories of non-farm income are commonly identified. These are: (1) non-farm rural wage or salary employment; (2) non-farm rural self employment, sometimes called business income; (3) rental income obtained from leasing land or property; (4) urban-to-rural remittances arising from within national boundaries; (5) other urban transfers to rural households, for example, pension payments to retirees; (6) international remittances arising from cross border and overseas migration (Scoones, 1998).

**Off-farm income** refers to wage or exchange labor on other farms (i.e. within agriculture). It includes labor payments in kind, such as the harvest share systems and other non-wage labor contracts that remain prevalent in many parts of the developing world. It may also include income obtained from local environmental resources such as firewood, charcoal, house building materials, wild plants, and so on, where these can be measured and a value attached to them (Scoones, 1998).

**Physical capital** refers to the basic infrastructure (transport, shelter, water, energy, irrigation canals, terraces and communication) and economic production equipment and means which enable people to pursue their livelihoods (Carney, 1998).

**Resilience:** The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures (ISDR).

**Rural livelihood** refers to activities and/or the work on which rural communities based for their living and often heavily reliant on the natural resource base (Ellis, 1999).

**Social capital** refers to the social networks and associations (networks, membership to groups, relationships of trust, access to wider institutions of society) in which people participate and from which they can derive support that contributes to their livelihoods (Carney, 1998).

**Weather** refers to hour to hour or day to day changes in temperature, cloudiness, precipitation, and other metrological conditions (ISDR).

**ANNEX - B**

**SURVEY QUESTIONNAIRE**

**Addis Ababa University**

**College of Development Studies**

**Institute of Regional and Local Development Studies**

**Climate Change Impacts on Rural Livelihood and Household-level Responses: (A case study of Arba Minch Zuria Woreda)**

**Household Survey Questionnaire**

**Questionnaire Number:** \_\_\_\_\_

**General information**

Date (dd/mm/yr): \_\_\_\_ / \_\_\_\_ / \_\_\_\_

Name of enumerator: \_\_\_\_\_

Signature \_\_\_\_\_

Date entered (dd/mm/yr): \_\_\_\_ / \_\_\_\_ / \_\_\_\_

Date checked (dd/mm/yr): \_\_\_\_ / \_\_\_\_ / \_\_\_\_

Entered by: \_\_\_\_\_

Checked by: \_\_\_\_\_

Name of Household head: \_\_\_\_\_ Age: \_\_\_\_ Ethnicity: \_\_\_\_\_ Religion: \_\_\_\_\_

Location: Region: \_\_\_\_\_ Zone: \_\_\_\_\_ Woreda: \_\_\_\_\_ Kebele: \_\_\_\_\_

Name of respondent (if it is other than the household head): \_\_\_\_\_ Age: \_\_\_\_\_

---

**Part I: Household Characteristics**

**1.1 Demographic characteristics**

No	Name	Sex	Age (yrs)	Relation to head	Marital status	Education level
1	(Household head)					
2						
3						
4						
5						
Code		1 Male 2 Female		1 Wife 2 Son/daughter 3 Mother 4 Father 5 Brother 6 Sister 7 Relatives (specify) 8 Others (specify)	1 Single 2 Married 3 Widowed 4 Divorced/separated 5 Other (specify)	1 Illiterate 2 Literate 3 Primary level 4 Secondary level 5 Tertiary (college and university level) 6 If any, (specify)

**Part II: Household livelihood sources**

**2.1 Income sources**

1. What are the three major sources of income for your household? (Rank them according to their importance)

Occupation	Approximate monthly income (in Birr)
i. _____	_____
ii. _____	_____
iii. _____	_____

2. Did your household generate/get enough monthly income from farm activities relative to household monthly expenditure?

1. Yes      2. No

3. What are the principal expenses of your household?

1. Food grain      2. Schooling      3. Agricultural inputs      4. Health cost      5. If any, please specify

**2.2 Off-farm sources of income**

1. Did anyone of your household member engaged in off-farm activities?      1. Yes      2. No

2. If yes, which of the following is the three main source of off-farm income?

1. Self-employed (specify)      2. Wage labor      3. Remittances/gifts/transfers      4. If any, please specify

3. Is there any change/shift in off-farm activities during the last few years? If yes, please explain?

**2.3 Household Asset Holdings (Endowments)**

No	Question	Response code		
		Type of household asset	Number owned	
1	Which assets do your household own?	1	House (grass roofed/corrugated)	
		2	Radio	
		3	Television	
		4	Desk/chair	
		5	Land (specify)	
		6	Other, please specify	
2	Which farm implements/tools did your household own?	1	Tractor	6    Oxen
		2	Generator/water pipe	7    Shovels
		3	Plough	8    Hoe
		4	Cultivator	9    Harrow
		5	Seed planter	10    If any, please specify
3	Do your household own land for farm activities?	1	Yes	What if the size?
		2	No	
4	Is your land size increase/decrease/remain unchanged during the last 5 years years?	1	Increase	
		2	Decrease	
		3	Remain unchanged	
5	How do you see the fertility of yours household farm?	1	Fertile	
		2	Less fertile	
		3	Infertile	

6	Did your household own pasture/grazing land?	1	Yes	What is the size? _____
		2	No	
7	Did your pasture/grazing land changed during the last 5 years?	1	Increased	
		2	Decreased	
		3	Remain unchanged	

## 2.4 Crop Production Status

1. What crops does your household grow?

Crop type		Type of farming			
		1. Subsistence	2. Commercial cash crops	3. Irrigated	4. Rainfed
1	Teff				
2	Maize				
3	Wheat				
4	Sorghum				
5	Fruits (specify)				
6	Vegetables (specify)				
7	If any, please specify				

2. How did you observe crop production during the last few years?

1. Increased      2. Decreased      3. Remain unchanged      4. If any (specify)

3. If it was increased/decreased, what do you think the reason behind it?

4. What are the major challenges of crop production for your household? 1. Lack of agricultural inputs    2. Climate-induced extremes (specify)  
3. Environmental degradation (specify)    4. Shortage of extension support    5. Market-related shortages    6. If any, please specify

## 2.5 Livestock production status (Ownership)

1. What is your household livestock production status?

Type of livestock		Number owned now	Benefit gained/obtained from
1	Cow		
2	Oxen		
2	Sheep		
4	Goat		
5	Donkey		
6	Chicken		
7	If any please specify		

2. How did you observe your household livestock production during the last few years?
  1. Increased
  2. Decreased
  3. Remain unchanged
  4. If any (specify)
3. If yours household livestock production was increased/decreased, what do you think the reason behind it?
4. What are the major problems related to your household animal husbandry/livestock production activity (rank them according to their severity)?
  1. Shortage of grazing/pasture land
  2. Shortage of veterinary care
  3. Shortage of water
  4. Lack of extension services
  5. Market-related shortages
  6. Climate-induced extremes (specify)
  7. If any, please specify

**Part III: Climate change, its impact on rural livelihood (crop and livestock production) and local adaptation/coping mechanisms**

No	Question	Response Code	Last year	Last 5 year s	Before 5 years
1	How did you perceived rainfall pattern over the following years in your village?	1	Important change		
		2	Little change		
		3	Unchanged		
2	If there is important change, can you explain the change in terms of period, amount and duration of rainfall over the following period please?				
3	If there is any observed change in the quantity, period and duration or patterns of rainfall in your village, which type of crop is affected most?	Type of crop		If it was affected , explain the impacts of change in rainfall on each	
		1			
		2			
		3			
		4			
		5			
4	If the change affected your crop production, how did you cope with it? (list the first 5 mostly used strategies)				
5	If there is any observed change in the quantity, period and duration or patterns of rainfall in your village, which type of livestock is affected most?	Type of livestock		If it was affected , explain the impacts of change in rainfall on each	
		1			
		2			
		3			
		4			
		5			

6	If your livestock is affected by the change, which adaptation/coping mechanisms did your household apply? (list the first 5 mostly used strategies)					
7	How did these change affected yours household living and/or livelihood?					
8	In your opinion, how would rainfall occur in the future in your village?					
9	What do you recommend to be done to cope with this change in the future?					
10	How did you perceived the temperature of your village?			Last year	Last 5 years	Before 5 years
		1	Hot			
		2	Constant (medium)			
		3	Cold			
11	Did you observed change in temperature in your village?	1	Yes			
		2	No			
12	If yes, what do you think about change in temperature over the following periods?	1	Increased			
		2	Decreased			
13	Which type of crop is affected mostly by the change in temperature?	Type of crop		If it was affected, explain the impacts of change in temperature on each		
		1				
		2				
		3				
		4				
		5				
14	If the change affected your crop production, how did you r household cope with it? (list the first 5 most used strategies)					
15	Which type of livestock is affected mostly by the change in temperature?	Type of livestock		If it was affected, explain the impacts of change in temperature on each		
		1				
		2				
		3				
		4				
		5				

16	If your livestock is affected by the change, which adaptation/coping mechanisms did your household apply? (list the first 5 most used strategies)				
17	How did this change affected yours household living and/or livelihood?				
18	In your opinion, how would temperature occur in the future in your village?				
19	What do you recommend to be done to cope with this change in the future?				
20	How did you perceived flood in your village?		Last year	After 5 years	Before 5 years
		1	More Frequent		
		2	Frequent		
		3	Less frequent		
		4	Not at all		
21	Which type of crop is affected mostly by flood?	Type of crop		If it was affected , explain the impacts of flood on each	
		1			
		2			
		3			
		4			
		5			
22	How did you r household cope with it? (list the first 5 most used strategies)				
23	Which livestock is affected mostly by flood in your field?	Type of livestock		If it was affected , explain the impacts of flood on each	
		1			
		2			
		3			
		4			
		5			
24	Which adaptation/coping mechanisms did your household apply? (list the first 5 most used strategies)				
25	How did flood affected yours household living and/or livelihood?				

26	In your opinion, how would flood occur in the future in your village?					
27	What do you recommend to be done to cope with flooding in the future?					
28	How did you perceived drought in your village?		Last year	After 5 years	Before 5 years	
		1	Severe /more frequent			
		2	Frequent			
		3	Less frequent			
4	Not at all					
29	What do you think about the causes of drought in your village?					
30	What do you think about the impacts of drought on your crop and livestock production?					
31	How drought affected yours household living and/or livelihood?					
32	How did yours household respond to the problem? (List the first 5 mostly used strategies)					
33	In your opinion, how would drought occur in the future in your village?					
34	What do you recommend to be done to cope with drought in the future?					
35	If you noticed, which type of insects affected yours household crop production most?	1	Weeds	4	Spiders	
		2	Insect pests	5	Other pollinating insects	
		3	Mosquitoes	6	Other (specify)	
36	In your area, during the last five years, have you noticed a change in insect pests?	1	Increased	3	No change	
		2	Decreased	4	If any (specify)	
37	How did pest infestation affected yours household (crop production and/or living)?					
38	How did your household cope with the problem? (list the first 5 mostly used strategies)					
39	Did your household faced with livestock disease caused by climate related shocks or extremes?		Last year	last 5 years	Before 5 years	
		1	Yes			
2	No					

40	If yes, which type of disease affected your household livestock most?				
41	If yes, how do you rate the frequency over the following period?			Last year	Last 5 years
		1	Increased		
		2	Decreased		
		3	Constant		
42	If yes, please mention the impacts on your livestock productivity and household living?				
43	How did your household cope with the challenge? (list the first 5 mostly used strategies)				
44	In your opinion, how would livestock disease caused by climate-induced shocks occur in the future in your village?				
45	What do you recommend to be done to cope with it in the future?				

Local climate change adaptation strategies response code (use these response codes for the above adaptation/coping questions)

1	Irrigation	8	Change in planting/growing/harvesting time	15	Sale of household asset (specify)
2	Water conservation (specify)	9	Resettlement	16	Food aid
3	Soil conservation (specify)	10	Crop switching (specify)	17	Collection of forest products
4	Early maturing seeds	11	Expanding farm size	18	Temporary migration
5	Drought resistant seeds	12	Shortening fallowing period	19	Permanent migration
6	High yield variety seeds	13	Cross-breeding (improved species)	20	If any, please specify
7	Income diversification (specify)	14	Expanding pasture size		

**Part IV: Information on climate change**

No	Question	Response code	
1	Have you ever heard about climate change?	1	Yes
		2	No
2	If yes, from where/who did you heard about it?	1	Extension worker
		2	Development agents and NGOs
		3	Mass media (specify)
		4	If any, please specify



#### 4.3 Access to Extension services and Agricultural inputs

1. Did your household received extension service in recent years? 1. Yes 2. No
2. If yes, from where/whom did you got it? 1. Government (specify) 2. Peasant associations/cooperatives 3. NGOs (specify)  
4. Private business enterprises (specify) 6. Research institutions (specify) 7. If any, please specify
3. If yes, on which of the following issues your household received support/advice (if possible rank according to their importance)?  
1. Soil and water conservation 2. Use of improved high yield and drought resistant seeds 3. Pasture preparation & alternatives  
4. Climate change and its adaptations 5. Alternative income generation 6. Natural resource conservation 7. If any, please specify
4. What are the major challenges your household faced with extension advices and services you have received?
5. From where/whom your household source agricultural inputs? 1. Government (specify) 2. Peasant associations/cooperatives  
3. NGOs (specify) 4. Private business enterprises (specify) 6. Research institutions (specify) 7. If any, please specify
6. Which type of agricultural inputs did your household obtained from these sources over the past 2 months?
7. What are the major challenges in accessing agricultural inputs for your household?

#### 4.4 Access to social institutions and services

1. To which basic social services did your household have access? 1. Education (specify) 2. Health (specify) 3. Electricity  
4. Transport (specify) 5. Water (specify) 6. Information and communication (specify) 7. If any, please specify
  2. What are the major challenges of your household in accessing social services and institutions over the past few years?
  3. To which of the following traditional local institutions your household belongs to? 1. Idir 2. Equb 3. Debo 4. If any, please specify
  4. If your household member participated in it, what benefits did your household obtained/received?
-

#### 4.5 Labor availability

1. How many labors are working on your household farm?
2. How many household members are engaged in agricultural activities?
3. Do your household have enough labor force for accomplishing farming activities on time? 1. Yes 2. No
4. If no, which activities are most affected by labor shortage? 1. Land preparation (plowing) 2. Planting (sowing) 3. Weeding  
4. Harvesting 5. All times
5. Did your household faced with labor shortage in livestock production? 1. Yes 2. No
6. How did your household overcome the labor shortage constraint? 1. Hire labor 2. Use labor sharing mechanisms such as Debo  
3. Hire machines (specify) 4. If any, please specify
7. What do you recommend to solve the problem in the future?

**Thank You!!!**

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## ANNEX-C

### Key-Informants Interview Questions

#### *Interviews questions to local household experiencing climate change and its impact:*

1. Demographic characteristics

Name: \_\_\_\_\_ Sex: \_\_\_\_\_ Age: \_\_\_\_\_

Marital status: \_\_\_\_\_ Education level: \_\_\_\_\_

Household size: \_\_\_\_\_

2. Major livelihood activities/source of household income:

Source of livelihood	Average monthly income in birr
----------------------	--------------------------------

i. _____	_____
----------	-------

ii. _____	_____
-----------	-------

iii. _____	_____
------------	-------

3. Do you own land? If yes, household land holding size: \_\_\_\_ No of plots: \_\_\_\_

4. What are the major crops produced on your farm?

5. Which kind of farming did you practice? (subsistence, irrigated, commercial, rainfed)

6. How many livestock do you own? (state livestock type and amount you owned)

7. How do you characterize the weather of this area in terms of its temperature and precipitation?

8. Have you heard of climate change? What does it mean to you?

9. What are the most important changes, if any, that you have noticed in your environment in recent years? [Flooding? Drought? Changes in rainfall patterns or growing seasons? Temperature? Landslide, pest and disease frequency and distribution]

---

10. What are the major climate induced hazards and extremes you have observed in your community? (flood, drought, landslide, heat waves, pests, disease outbreak, etc)
11. Have you ever experienced any climate related extremes and shocks in your village? If yes, what type of hazards and/or shocks did you experienced?
12. Explain the major impacts of the following climate-induced hazards and shocks on your crop and livestock production and your community. [Rainfall variability (decreased rainfall), increase in temperature, flooding, land slide, heavy wind, pests infestation, livestock disease outbreak, forest destruction, soil/land degradation, water scarcity, crop failure,, etc.]
13. Have you or people in your community changed their agricultural practices and livelihood strategies due to weather-related events in recent years? If yes, please explain [Difficulty in accessing water? food scarcity? Damage to your farm/livestock/property? Agricultural practices?].
14. What types of things did you or others in your community do to cope with these changes, and how difficult was it to make them? [Conserving soil? Planting trees? Using different crop varieties? Irrigating? Changing planting dates? Using different water sources? Migrating?].
15. If in the future, weather will become less predictable, with more droughts and unsure rainfall, what do you think would help you adapt to these changes? [Migrate to another area? Sell land? Livelihood diversification, etc].
16. Is there any institutions and policies that support your coping/adaptation efforts in your community? If yes, can you explain them and supports they have offered?
17. What do you suggest to be done to change the situation and improve community livelihood under the current climate change and its impact?

**Thank you!!!**

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### **Interview questions to Woreda Disaster Prevention and Preparedness Commission**

1. Name: \_\_\_\_\_ Profession/Qualification: \_\_\_\_\_ Position: \_\_\_\_\_
2. What are your organization's main responsibilities?
3. Who are your direct beneficiaries or stakeholder yours' organization?
4. What are the major climates related hazards and shocks in your woreda? (rank them according to their severity)
5. Explain the major impacts of climate related hazards/shocks on crop and livestock production in your woreda?
6. How did the farmers cope with climate change impacts in your woreda? (discuss the local coping/adaptation strategies)
7. How did your organization work with other stakeholders in prevention, reduction and recovery from climate-induced hazards and other socio-economic disaster (explain pre- and post-intervention role)
8. Did you face with challenges in your work relating to climate-induced disasters? If yes, what are the major challenges and what do you recommend to improve organizations role in the future?

**Thank You!!!**

### **Questions to Woreda Agri. and Rural Development Officers, Development Agents and Experts**

1. Name: \_\_\_\_\_ Qualification/profession: \_\_\_\_\_ Position: \_\_\_\_\_
  2. What are the major responsibilities of yours' organization?
  3. Who are the main beneficiaries and local stakeholders of yours' organizations?
  4. How do you characterize the weather/climate of your woreda in terms of precipitation (rainfall) and temperature over the past few years?
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5. Have you and/or your office observed significant change in the climate of your woreda over the past few years? If yes, please explain the change.
6. What are the major climate-induced hazards and shocks that you and your office identified in your woreda? (drought, flood, landslide, pests, disease outbreak, soil/land degradation, etc)
7. Do you think climate change is affecting your woreda? If yes, how?
8. How do you think climate related events impact agricultural production (crop and livestock production) in your woreda?
9. What are the local coping or adaptation mechanisms that farmers develop to cope with the challenge? How do you evaluate the strategies?
10. In what ways are you preparing for the effects of climate change in your work? (policies, strategies and institutional interventions)
11. Will climate change impact your agency's ability to meet its goals? If so, how?
12. How do you think climate change will affect your woreda in the future? [Health? Economic impacts? Agriculture? Food security? Environmental sustainability?].
13. Among the challenges facing you as a leader, can you describe the relative importance of climate change? How much of a priority is this issue for your organization?
14. Does your agency have plans for counteracting the effects of climate change?
15. Does your organization have plans to facilitate adaptation to climate change?
16. What are the institutions and policy interventions working on climate change and climate related extremes? (Government organs, Community based organizations, NGOs, local institutions and policy interventions both at local and national level)
17. In general, what do you recommend to be done to improve farmers' productivity and livelihoods of your community in the future?

**Thank you!!!**

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***Interview questions to Community leaders:***

1. Name: \_\_\_\_\_ Age: \_\_\_\_\_ Position: \_\_\_\_\_ Education level: \_\_\_\_\_
  2. How do you characterize the weather of this area in terms of temperature and precipitation over the last 20 years?
  3. Have you observed changes in the climate over the last 20 years? [Flooding? Drought? Changes in rainfall patterns or growing seasons? Temperature? etc.]. If yes, please explain?
  4. Do you think climate change is affecting your community? If yes, how?
  5. How do you think change/variability in rainfall, temperature, drought, flood, pests, disease outbreak and other climate related extremes impact agricultural production (crop and Livestock production) in your community?
  6. Have you ever observed significant change in agricultural activities and livelihood strategies due to weather-related events in your community? [Difficulty in accessing water? food scarcity? Damage to your farm, property, livestock? Agricultural practices?].
  7. How did people in your community do to cope with these changes, and how difficult was it to make them sustainable? [Conserving soil? Planting trees? Using different crop varieties? Irrigating? Changing planting dates? Using different water sources? Migrating?].
  8. How do you think climate change will affect your community in the future? [Health? Economic livelihoods? Agriculture? Food security? Environmental sustainability?].
  9. Are there ways that you are preparing for the effects of climate change in your work as a community leader? If yes, can you describe them?
  10. Among the challenges facing your community, can you describe the relative importance of climate change?
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11. In your opinion, what interventions would best help your community to adapt to future changes in climate?
12. What are the institutions and policy interventions working on climate change and climate related extremes? (Government organs, Community based organizations, NGOs, local institutions and policy interventions both at local and national level)
13. What problems did you identified on these institutions and policy interventions?  
What do you recommend to improve the intervention in the future?

**Thank you!!!**

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## Declaration

I, the undersigned, declare that this thesis is my original and real work that has not been given for a degree in any other university and that all sources of materials used for the thesis have been duly acknowledged.

Declared by

*Pes. Ayelán Alemayehu*  
Candidate

Confirmed by

*Qui*  
Advisor

