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Climate Change Impact on Livelihood, Vulnerability and Coping Mechanisms: A Case Study of West-Arsi Zone, Ethiopia

MSc. Thesis Submitted to Lund University Masters Program in Environmental Studies and Sustainability Science (LUMES)

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Abstract

Agriculture is one of the sectors most vulnerable to climate change impact. The impact is even stronger in Africa, where agriculture is truly important for the daily subsistence, and where adaptive capacity is low. Therefore, it is crucial to increase the understanding of the actual climate change dynamics on agricultural activities and on the societies at the lower levels. This study uses the West-Arsi zone in Ethiopia, as a case study and examines the local climatic trends and its impacts on the livelihood in the region. It also answers the questions who is more vulnerable and why, what are the local and institutional coping mechanisms, and what are the constraints that exacerbate vulnerability. The study uses semi-structured interview to garner data from local society, government officials and experts, and secondary data from published and unpublished sources, and systematically analyzes this material both using qualitative and quantitative analysis. The result shows that the trend of gradual and extreme weather change is particularly negative for the livelihood of mid and lowlands of the West-Arsi zone in Ethiopia, but has a positive role in some places where agriculture was constrained by low temperature. On the other hand, drought, rain delay, erratic precipitation, and heavy and unseasonal rain are challenges to the livelihood of the whole region. To cope with the impacts the societies use saving, diversification, changing growth season, mobility, livestock sell, wood sell, and social interconnectedness as a strategy. Awareness raising, credit, dissemination of technology and provision of safety nets to some lowlanders and emergency aid are among the coping strategies provided by the government institution. Though, on-land diversification to enset, trees and vegetables is promising in highlands and some mid land areas, the study shows that the existing local and institutional strategies are not sufficient and sustainable to cope with climatic vagaries. Though all households in the zone are vulnerable to climatic crisis, the problem is more acute for the poor, landless, children, women, large sized family and predominantly pastoralists. Vulnerability is further exacerbated by unavailability and unaffordability of agricultural inputs, landlessness and unemployment, and water shortage. The study suggests a relentless need to address these challenges both from short and long-term policy perspective.

Key Words: *Climate change, livelihood, impact, social vulnerability, coping mechanism*

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Acronyms

ARDO – Agriculture and Rural Development Office

BBMT –Broad Bed Maker Technology

CSA – Central Statistic Agency, Ethiopia

DAs – Development Agents

DPPO – Disaster Prevention and Preparedness office

FDRE – Federal Democratic Republic of Ethiopia

NMSA – National Meteorological Service Agency, Ethiopia

PAs –Peasant Associations

IPCC – Intergovernmental Panel on Climate Change

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1. Introduction

Many believe agriculture is the most susceptible sector to climate change. This is attributed to the fact that climate change affects the two most important direct agricultural production inputs, precipitation and temperature (Deschenes & Greenstone 2006). Climate change also indirectly affects agriculture by influencing emergence and distribution of crop pests and livestock diseases, exacerbating the frequency and distribution of adverse weather conditions, reducing water supplies and irrigation; and enhancing severity of soil erosion (Watson et al. 1998; IPCC 2001).

Despite worldwide coverage of climate change impact, there is intra-sectoral and inter-sectoral variation in vulnerability depending on location, adaptive capacity and other socio-economic and environmental factors. In Europe, for instance, agricultural sector is believed to benefit from gradual climate change due to the carbon effect and the warming climate (Tol et al. 2000; McCarthy 2001). On the other hand, on continents such as Africa, continent that has contributed almost nothing to anthropogenic climate change, the impact is believed to be enhanced. This is attributed to the continent's low adaptive capacity, over-dependence on agricultural sector, marginal climate and existence of many other stressors (Collier et al. 2008; McCarthy 2001). The negative consequences of climate change in Africa are already happening as prevalent from frequent floods, droughts and shift in marginal agricultural systems (Collier et al. 2008). The climate change impact on agriculture is believed to be stronger in Sub-Saharan Africa (Kurukulasuriya & Mendelsohn 2007).

To identify and quantify the impact of climate change on socio-economic sectors and ecosystems, many global studies have been carried-out and policy changes for mitigation and adaptation were proposed. However, though there are sufficient evidences of climate change and its impacts, the global policy decisions have faced continued political hindrances. Further and more importantly, the traditional top-down approach (global study) has little local and regional specificity and has *failed to address the regional and local impacts and the local abilities to adapt to climate change impacts* (Yarnal 1998; Smit & Pilifosova 2003). This is particularly a challenge in case of subsistent agriculture sector. This is because modelling or predicting climate change impact on predominantly subsistent farmer households at international level is a very difficult task due to its lack of standard definitions, absence or difficulty to get benchmark data, its location-specificity, the households ability to integrate on-farm and off-farm activities, and finally the farmers vulnerability to a range of stressors

(Morton 2007).

Owing the abovementioned facts, it is, thus, imperative to understand the actual dynamics of climate change impact at the lowest levels of the society, such as households, communities and districts (Deressa et al. 2008), and in that way enhance the relevancy of the top-down policy approaches (Ford & Smit 2004). This study aims to answer questions: what is the trend of climate change, what is the impact on livelihood, who is vulnerable to the impact and why, what are other constraints that exacerbate societal vulnerability, and what are the existing local and institutional coping mechanisms and how they can be viewed from sustainability point of view. The empirical material of this study is based on current climate impact data and interviews with local stakeholders from the West-Arsi zone, Ethiopia. By examination of directional change in the current climate impacts and responses, and predicting future adaptive capacity and constraints of the communities, this study distinguishes the community's ability to cope with the future likely climate change impacts (Smit & Pilifosova 2003). The ambition of the study is to remediate both knowledge about climate change and socio-economic condition in the West-Arsi. Although the study focuses on the West-Arsi zone in Ethiopia, it is held that the result generated from this study is relevant to many areas of the county as well as other countries with a similar climate and socio-economic structures.

1.1. General Objective: is to understand the current climate change impacts, vulnerability and coping mechanisms at the household, community and district level, and demonstrate its implication for the future most likely climate change impacts in the West-Arsi zone in Ethiopia.

1.2 Specific Research Questions

- What are the trends of major climatic change impacts experienced in West-Arsi Zone?
- How do these changes affects the society's livelihood?
- Who are most vulnerable to the events and why?
- What are the constraints that exacerbate vulnerability?
- Which are the local and institutional coping strategies and how they can be viewed from sustainability point of view?

2. Background

Currently Sub-Saharan African countries are dealing with myriads of socio-economic and

environmental challenges including poverty eradication, diminishing resource degradation, controlling alarming population growth, and improving low agricultural productivity. Though agriculture was given an overriding emphasis as a core sector to solve the current challenges and to bring future sustainability to the continent, the sector is recently challenged by climate change. Further, as the adverse impacts become more frequent and severe, the already fragile socio-economic activity of the continent is more likely to exacerbate (McCarthy 2001; Collier et al. 2008; Ngaira 2007; Adger et al. 2003).

Ethiopia is one of the Sub-Saharan countries situated at the Horn of Africa. According to 2007 census the population of the country is around 74 million (CSA1 2008). Like many other developing countries, agriculture (with the largest number of livestock in Africa) is the single largest livelihood of an overwhelming majority, 85% of the population (CSA2 2008). It also provides a lion's share of the economic activity, accounts for half of the GDP, 60% of the exports, and 80% of the national employment (CIA - World Factbook 2008). As agriculture is the backbone of the country, it is believed to continue be the determinant sector to bring sustainable economic development to the country (CSA2 2008).

The vulnerability of Ethiopia to climate change impact is a function of several biophysical and socioeconomic factors. Although the name ''Water Tower of Africa'' has been given to Ethiopia, agriculture is overwhelmingly dependent on the timely onset, amount, duration, and distribution of rainfall. Over 90% of the food supply comes from rain fed subsistent agriculture and rainfall failure means loss of major livelihood source that always accentuate food deficit (Adgolign 2006). The use of both irrigation and water harvesting technology has a long way to go to bring the desired development. According to 2008 Farm Management Practices Survey of CSA, the total irrigated crop area was estimated to 179.8 thousand hectares (about 1.5% of the total crop land) (CSA4 2008). This lag is attributed to the unsuitability of the topography for irrigation, uneven distribution of water resources and lack of technology.

The sector is also predominantly subsistent[1], hand to mouth, and characterized by poor farming practices (less technology, less agricultural input and resource degradation). The CSA Report on Crop and Livestock Product Utilization survey (CSA3 2008) for the year 2007/2008 has revealed that nearly of the 79% cereals, 64% of the pulses, 43% of the oilseed,

[1] ''*Subsistence agriculture describes farming and associated activities which together form a livelihood strategy where the main output is consumed directly by the household, where there are few if any purchased inputs and where only a minor proportion of output is marketed*'' (Barnett et al. 1996)

81% of the vegetables, 80% of the root crops, 52% of the perennial crops were used for consumption and seed. In the same way 72.19% of the milk produced, 84.24% of the cheese, 34.87% of the honey and 37.07% of the egg were used for household consumption. The remaining food crop and animal product were sold to finance household commodities and other necessities. In addition highlands, land area that accounts for only 45% of the country account for over 80% of the total population and for 95 percent of the cropped land, and has been suffering from widespread erosion, over-grazing, deforestation and loss of nutrients and consequently reduced per capita share of arable land (Adgolign 2006;Teketay, Fetene & Abate 2003 cited in Haile 2004). The population growth and resource degradation in the highland and midland areas have induced population mobility into lowland and midlands areas, the areas that are vulnerable to frequent water deficit and prone to drought (Haile 2004). Coupled with those factors climate change is more likely to results in vicious cycle of poverty and resources degradation in Ethiopia.

In the past decades the growth rate of agriculture sector in Ethiopia has lingered behind the rate of population growth; and consequently, the country has, to support the demand of the population, become one of the net importers of agricultural products and lined along with the major food aid recipients in Africa. Between 1980 and 1997, for instance, the annual population growth was around 3% per annum, whereas cereal crop production grew at a rate of only 0.9% per annum, indicating the declining food per capita, increasing food insecurity and worsening poverty (Bewket 2003). Between 1994 and 2007 the population grew at an annual average rate of 2.6 percent, and projected to around 120 million by 2025 (Goldstone 2007). Owing the above-mentioned facts, and the high sensitivity of Ethiopian agro-ecosystem to rainfall (Fraser 2007) and low adaptive capacity to respond to damages, even a slight change in climate will have a large impact on the socio-economic activity of the country.

Sufficient evidence shows that the average temperature rise in Africa is faster than the global average and is likely to persist in the future (Hulme et al. 2000). The warming is definitely hazardous for agricultural activities in the continent as many of the crops are grown close to the thermal tolerance limits (Collier et al. 2008). The warming of few degrees and increase in frequency of extreme weathers will consequently strongly influences the agricultural production and make the society victim of the events and decreases the future adaptive capacities. There are many tries to make a monetary valuation of climate change impacts. One recent study for example estimates that African farmers, on rain-fed land, will lose $28

per hectare per year for each 1°C rise in global temperatures (Robert Mendelsohn cited in LaFleur et al. 2008)

Hulme et al., (2000) also showed that rainfall decreases 'significantly' in June-July-August (JJA) over parts of the Horn of Africa which is the main crop cultivation season in Ethiopia. However, it was acknowledged that the level of information and knowledge on climate change impacts in several sectors of East Africa is exceedingly patchy, generally poor to moderate only (Thornton et al. 2006). In particular, there has been little discussion combining both climate change impact on agriculture and subsistent agricultural systems (Morton 2007).

In Ethiopia, Deressa et al., (2008) have conducted an integrated quantitative vulnerability assessment for seven Regional States of the total eleven regions by using biophysical and social vulnerability indices of Ricardian approach. The study has found that decline in precipitation and increase in temperature are both damaging to Ethiopian agriculture. The result of the study have further pointed out that Oromiya Regional State, where West-Arsi is located, is one of the most vulnerable regions to climate change impacts. The authors have acknowledged as their study was highly aggregated and further study is needed at local levels, particularly at district and villages, one of a gap this study is aimed at fi1ling.

3. Methodology

3.1. Three key methodologies when studying the impact of climate change on livelihoods

The study of the impact of climate change on the livelihoods of local populations is increasingly forwarded as an urgent research need (Morton 2007; Smit & Pilifosova 2003). A multitude of approaches and methodologies are used for this purpose. There are three concepts that are continuously reoccurring in the methodological literature also used in the analytical framework developed for the purpose of this study (see section 3.2). Therefore I will in this first section define three of these concepts.

3.1.1. Impact Assessment

Depending on the discipline literatures use different terms and definitions for the term impact. Some of the terms include hazard, risk, biophysical vulnerability or generally vulnerability (Brooks 2003). To limit the scope of the study to climate change impact on

livelihood and society, the definition of biophysical vulnerability by Deressa et al., (2008), which refers to *the extent of damage inflicted by climate change on livelihood and social systems,* is used in this study. The impact on livelihood (livestock tending and crop cultivation), and consequently on the society is analyzed based on local climatic data, impacts, vulnerability and coping strategies by employing qualitative study or using appropriate themes or indicators selected from previous literatures e.g., J. Pulhin et al. (2006), such as livestock status, crop production, people affected by the impact, deaths, malnutrition cases, food and seed shortage, income shortage, production costs or ecosystem damage.

3.1.2. Vulnerability assessment[2]

An impact study is most helpful when focussing on a single stressor, in this case climate change (Nkem et al. 2007). Thus, impact alone is subtle and may not be sufficient to show the consequences of climate impact on different members of the same or different community (McCarthy 2001). Thus, to evaluate climate change impact in the context of multiple stressors[3] that reduce adaptive capacity, many of which are not related to climate or climate change; vulnerability assessment is most helpful (Desanker & Justice 2001). Vulnerability assessment also *''helps to informs decision makers to facilitates decision-making process of specific stakeholders of a sector about their options for adapting to the effects of climate change within the scope of their resources''* (Nkem et al. 2007).

Vulnerability in this study is, thus, defined as the likelihood of households and communities in the West-Arsi zone, Ethiopia, to suffer from climatic adverse impacts on their livelihood and their inability to respond to stresses resulting from the impacts (adopted from Thornton et al. 2006; J. Pulhin et al. 2006). This definition is also in agreement with the definition of IPCC (2001), where vulnerability refers to *''the degree to which a system is susceptible to, and unable to cope with adverse effects of climate change, including climate variability and extremes''* (IPCC 2001). To assess vulnerability of rural livelihood strategy in context of shocks and other stressors Ellis (2000) used indicators such as asset (market, land holding, water availability, biological resources, social interconnectedness, labour or human capita, saving and credit availability) and asset access modification by social relations, institutions

[2] *Vulnerability is the property of a system relative to climate conditions. Impacts are the impacts of a climate on a system, whereas vulnerability is vulnerability of the system to a climate* (Smit & Pilifosova 2003)

[3] Stressors that challenge adaptive capacities can be internal and/or external. *Internal* stressors refer to ''*the defencelessness and insecurity, the capacity to anticipate, cope with, resist, and recover from climatic impacts;* whereas *external* stressors refers to *the exposure to risks and shocks''* (J. X. Kasperson & R. E. Kasperson 2001).

and organizations. Thornton et al., (2006) also used several natural capita, physical capita, human capita, financial capita and social capita to analyze vulnerability. As this study is exploratory, the selection of indicators or themes (or sub-indicators and sub-themes) is based on the analysis of responses from local society and previous vulnerabilities, *how* and *why* they are vulnerable.

3.1.3. Coping strategies to adverse climatic impacts

Societies are dynamic and they use all possible strategies to reduce the vulnerability to climatic impacts. There are two kinds of responses to crisis that overlaps across the temporal scale, coping mechanisms and adaptive capacity. Coping mechanisms are the actual responses to crisis on livelihood systems in the face of unwelcome situations, and are considered as short-term responses (Berkes & Jolly 2001). Adaptive strategies are the strategies in which a region or a sector responds to changes in their livelihood through either autonomous or planned adaptation (ibid; Campbell 2008). Coping mechanisms may develop into adaptive strategies through times (Berkes & Jolly 2001). However, it is difficult to make a clear distinction between coping mechanisms and adaptations this study considers both schemes as coping strategies (ibid.). The resilience or the robustness of coping mechanisms differ depending on the availability and access to resources and technology (Adger et al. 2003). In this study, both local and institutional coping strategies are assessed from the collected information.

3.2. Analytical framework

To assess the vulnerability of arctic communities Ford & Smit (2004) developed and proposed an analytical framework that employs focus group discussions of the indigenous communities and participant observations. The original model assesses vulnerability based on exposure to climate change and adaptive capacity in two phases: current vulnerability and future vulnerability. The technique was found to be effective on indigenous community researches in Arctic North America (ibid.).

Based on the analytical framework of Ford & Smit (2004) I developed a model that assesses impact of climate change on livelihood, societal vulnerabilities and coping strategies (figure 1).

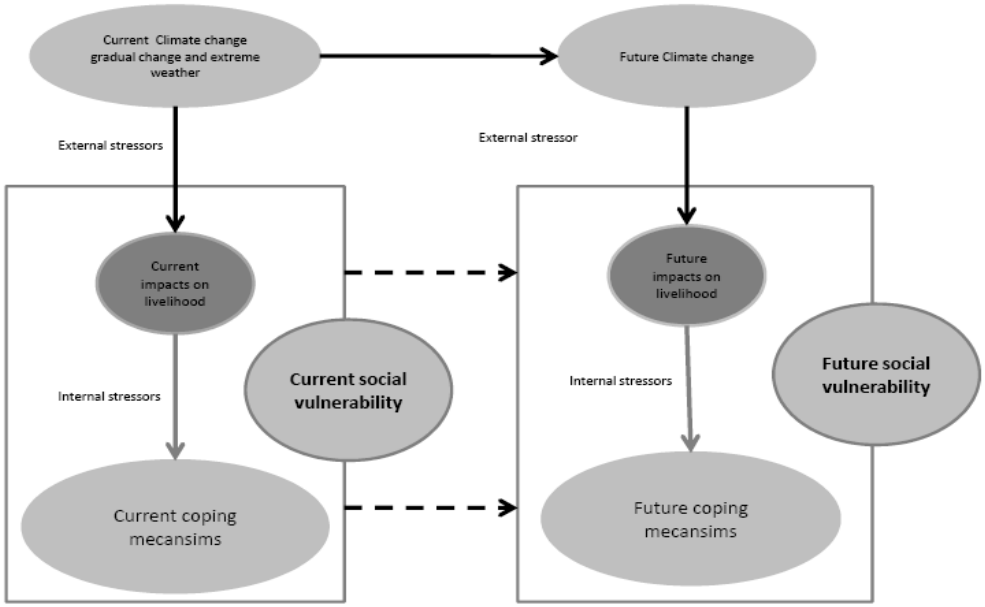


Figure 1

Analytical framework for climate change impact, vulnerability and coping mechanisms assessment.

As figure 1 shows the climate change[4] (gradual changes and extreme weathers) causes an impact on livelihood (livestock and crop production). However, the ‘*’societies across the world have a long record of adapting to and reducing their vulnerability to the impacts of weather and climate related events*’’ (Pachauri & Reisinger 2007) and thus, the coping strategies used to reduce the impact, and the presence of other internal and external stressors determine the societal vulnerability to climate change. Identification of the current climate change, its impacts on livelihood, current coping strategies and identification of vulnerabilities and stressors help to assess the future likely changes, impacts, coping strategies and social vulnerability.

The two crucial information source for regionally and locally specific climate change impact, vulnerability and coping strategies comes from local stakeholders and decision makers (Yarnal 1996 cited on Yarnal 1998) and data on earlier impacts (Titus et al. 1991 cited in ibid.). Information can also be generated from content analysis of government reports, newspaper articles, and resource use managers (Ford & Smit 2004). In this study, the current impact, vulnerability and coping strategies are assessed by collecting primary data from respondents (interviews and observations) and secondary data (temperature and precipitation trend, and published and unpublished information). The data on climate change and impact on livelihood and the society are also collected from local people interview, government officials, local experts and secondary data from government offices and other literatures. The

[4] Despite much data is missing to give an appropriate picture of the impacts and the effects of climate change in West-Arsi zone (whether it is of natural occurrence or environmental degradation such as changes in land use, or of global warming), this study views climate change as a change in mean or variability in climatic properties or both (Pachauri & Reisinger 2007).

analysis is dependent on the timeframe, for how far back the data needed exists and the quality and suitability of primary and secondary data required for analysis.

3.3. Study area

The study is conducted in West-Arsi zone, one of 19 zones of Oromiya Regional State located in central part of Ethiopia, where mixed farming and pastoralism sector are commonly practiced, both in highlands, and mid and lowlands. The West-Arsi zone was established in 2006. The zone was restructured from previously existing districts administered under Eastern-Shewa, Arsi and Bale zones, whose zonal capitals are Adama, Asala and Robe respectively. The need to establishing a new zone was to solve long-existed socio-economic and political in the society in the past. The long distance of the edges of the previous districts from the previous districts capital has increased vulnerability of the societies to challenges of injustice, extra-costs, information delays, highway robbery, conflicts among ethnic groups, and problem of unemployment. Shashamane town is now the capital town of the zone, located on the major roads passing to Arba-Minch, Awasa and Bale. West-Arsi zone has land area of about 1177440 hectares or 12938 km^2; and is sub-divided into 12 districts, namely Adaba, Arsi-Negele, Dodola, Gadab, Kokosa, Kofale, Kore, Shala, Siraro, Shashamane (rural), Shashamane (town) and Nensebo.

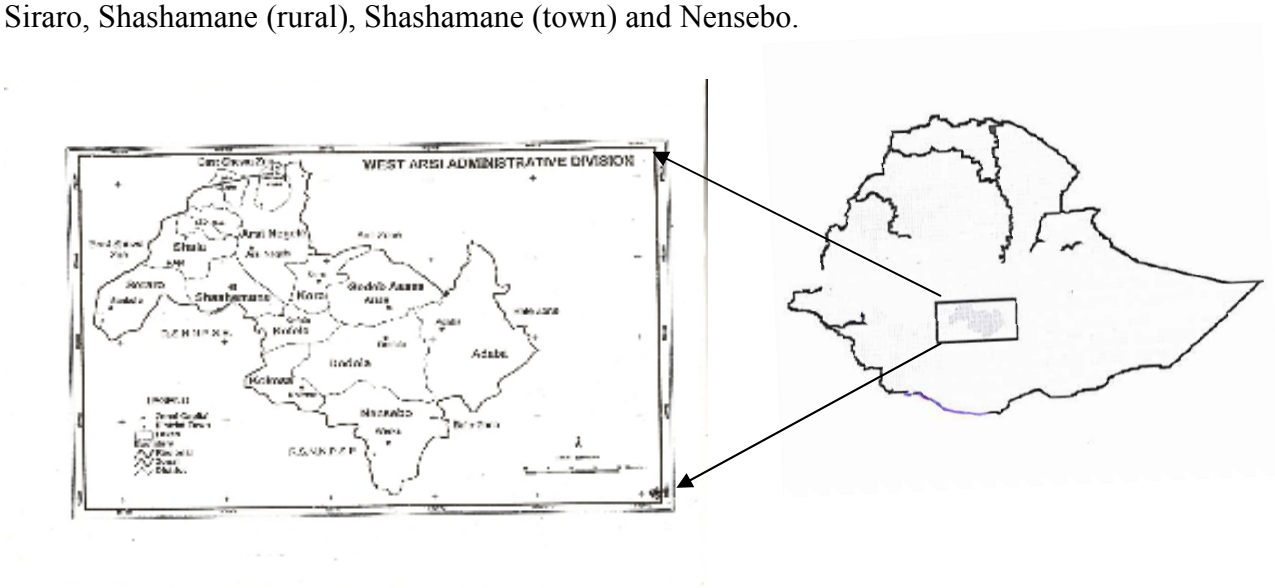


Figure 2. West-Arsi zone location and its districts (*Source*: *West-Arsi zone DPPO, 2009*)

3.3.1. Climate and agro-ecology of the zone

The climate is traditionally classified based on altitude and temperature. Topographically, the altitude of West-Arsi ranges from 500 metres above sea level (masl) to 3200masl. The

highland are temperate and cold climate (are locally called *Dega* or *Badaa* ranges from 2300-3200masl), midland (warm or locally called *Woinadega* or *Badadaree* –ranges from 1500 to 2300masl), and lowland are hot and arid (also called *Kola* or *Gamojjii*, ranges from 500 to 1500masl) each comprising 45.5%, 39.6% and 14.9% of the land area respectively. Average annual temperature in the zone varies between 15 and 20 °C.

Like most part of Ethiopia, there are three distinct seasons in the zone, two rainy seasons and one dry season. *Meher* season *(*also called *gaana*): is the main rainy season, occurring from June to mid of September. The *Meher* mean annual rainfall varies between 800 mm and 1400 mm. *Belg* season *(Arfaasaa*) is the small rainy season occurring from February to May. In the country in general, *Belg* and *Meher* contribute nearly 31% and 56% of the annual rainfall for the period 1969 to1987 respectively (NMSA 1996). *Meher* is the main production season in the zone and the country. Though, the amount of rain received is low compared to *Meher*, in districts such as Shashamane *Belg* rain accounts for about 50% crop production (West-Arsi Zone FS-DPPO 2008) and up to 40% of the production at the zone level (personal information from West Arsi Director of DPPO). Therefore, the *Belg* rain is equally important and any damage to the *Belg* has also remarkable implications on the socio-economic activities of the society. Failure of both *Belg* and *Meher* rains together leads to notorious drought and famine. The *Bega season* (also called *Bona*) is the dry season of the year and commences in October and ends in January. There are 13 identified soil types in the zone, which exist in combination of Orthic luvisols (56.6%), Eutric Combilsols (18.94%), Vertisols (12.1%) and others (12.26%) (West-Arsi zone ARDO 2008).

3.3.2. Socio-economic activity

Based on socio-economic profile of (West-Arsi zone ARDO 2008), the zone is inhabited by a total population of 1,844,542; of which 85.27% population is considered as rural, and the remaining 14.73% is classified as urban. The female population accounts for 50.5% of the urban and 49.5% of the rural population. According to the same census the household size is 7.2 for rural and 5.6 for urban. This is higher than the country level average household size of 3.9 for urban and 4.9 for rural, and for Oromiya Regional State 3.8 in urban and 5 in rural (CSA1 2008). The population density for West-Arsi is 152.8 persons per km^2, ranging from 44.2 persons per km^2 in Nensabo district to 257.8 persons per km^2 for Kofale district.

Generally, this population density is higher than Oromia Regional State, 74 persons per km^2, and that of the country, 67 persons per km^2. [5]

Livelihood strategies and classification

Like most part of Ethiopia mixed farming dominates the livelihood of the zone. Land is an important asset of households for production of crops and rearing of livestock. Livestock serves as a source of manure and fuel, pay land tax, fertilizers and as a saving to buffer bleak seasons of food/seed shortage. Oxen are the major ploughing engines. Donkeys, horses and mules play a significant role in transportation of people, water, and goods. Due to the high complexity and strong inter-linkage between crop production and livestock tending, it is difficult to consider the two livelihoods separately (Aune et al. 2006).

> The interlinkages are related to manure production, traction power, fodder production, and income generation. This makes it impossible to change one component without affecting the others (ibid.).

Though mixed farming is the dominant livelihood system there are arid and semiarid predominantly pastoralist in some mid and lowlands, and highland pastoralist-perennial crop livelihood systems. Crop production is highly practiced in most lowland and midlands, but in general the role of crop production reduces with increasing altitude with the exception of some vegetables and enset (scientific name *Ensete ventricosum*), and animal husbandry takes the ranking. The most commonly produced crops in the zone are annual crops such as barley, wheat, teff, maize, haricot beans, horse bean, field peas and linseeds, and perennial crops like potato, pepper, and coffee and enset.

The wealth classification criteria for some districts were not clearly set. But, as in all other rural parts of Ethiopia, livestock ownership and land holding are the two most important criteria for ones wealth and status measure in the society. The household size is also included in wealth ranking criteria; large family households are considered as better-offs. The number of eucalyptus tree and beehives are also considered in the classification. However, the agricultural production is predominantly subsistent and it is difficult to estimate the household yearly income. Nevertheless, it is clear that most of the produced crops and livestock or livestock products are used for household consumption. The remaining used for seed and sold to pay credits, government obligations, purchase of fertilizer, household financial expenses and others (CSA3 2008).

[5] Calculated using the 2007 population and 368,400 km^2 land area for Oromia and 1,104,300 km^2 for Ethiopia

3.4. Data collection and analysis

3.4.1. Research strategy

Since the emphasis of this research is to undergo an *intensive examination* of impacts of climate change, vulnerability and coping strategies in *association with societies with in specific location*, a case study research strategy is used (Bryman 2008 p550). In case study research, an exploratory questions, ‘’what’’ and ‘’how’’, and inductive research are most appropriate and helps to harness detailed and valuable insights and understanding of the topic which could not be achieved by a survey (A. Rialp & J. Rialp 2006; Yin 2003). The case study strategy is both ‘*’qualitative and quantitative’’* (Yin 2003). Methodological triangulation; obtaining data from different sources, such as observations, documentations and interviews, helps to harnesses diverse ideas about the same issue and assist in *cross-checking* the results, and consequently helps to increase the validity, reliability of the findings and eases data analysis (Bryman 2008; A. Rialp & J. Rialp 2006). This study obtains data from primary sources (field observation, household, government officials and local administrative interview) and secondary data.

This study uses data from primary sources (field observation, interviews with households’ government officials and local administrative) and secondary data sources (government documents, meteorological data, crop production data and livestock data).

3.4.2. Selection of case study area

The rationale for the choice of West-Arsi zone for the study is based on its wide range of agro-ecological conditions, its ideal representativeness of highlands and mid and lowland areas where pastoralism and mixed farming exists. Further, according to the socio-economic activity and geo-ecological location criteria by Thornton et al., (2006) and Morton (2007) the zone is categorized as a hotspot for climate change impacts. More than 50% of the zone is mid and lowland and many of the districts are located in the Great Rift Valley, and have been plagued by frequent climatic impacts. Whereas, the predominantly highland districts and midlands that were considered among ‘bread basket’ of the country in the past were recently plagued by climatic shocks, but ignored by aid and government agencies during past climatic crisis (Belay 1999).

The specific study sites (districts[6] and their respective Peasant Associations[7] (PAs)) were selected with the consultation of the zonal Agriculture and Rural Development officials by. Though, the socio-economy of the zone is closely related and overlapping in many ways, the abovementioned major socio-economic activities and agro-ecologic representativeness of West-Arsi zone was taken into consideration. Accordingly highland area of Dodola district (Danaba and Dodola forested highlands PAs), Kofale (Garmama Shenato PAs) and Arsi-Negele (Ashoka-Lepis PAs) were selected for the study. The mid and lowlands are Shashamane (Awasho PAs), Arsi-Negele (Maja Sibilani PAs) and Shala and Siraro (Aje, Loke and Awara PAs).

3.4.3. Collection of Primary data

Interview with local households

Primary data on impact, vulnerability and coping strategies were collected by using household interviews from January to March 2009. The interview was conducted on 73 households, 48 households from mid and lowlands, and 25 from highlands. Since the objective of the study is to get a more comprehensive overview about the study, households[8] were tracked using the data from the PAs and were randomly selected. To enhance the chance of meeting the households in their village, early morning and late afternoon time was found to be an appropriate time. In cases where the households happened to be away from home a new household was randomly found in the same village. Semi-structured interview was found to be an appropriate strategy for the study because *…questions that were not included in the interview guide were asked* and new questions were raised as ideas emerge through the process (Bryman 2008). The interview questions focus on a more comprehensive range of issues including socioeconomic status (land size, livestock number, literacy, sex, gender and age), climate change trends, climate change impact on the livelihood and the society, coping mechanisms, vulnerability and factors exacerbating vulnerability (see appendix I).

The households represented in the study encompass age groups 18 and above; which also *encapsulates the idea of all age households* (Bryman 2008). The educational level of the study

[6] District (also called *Wereda*): administrative correspondent of a zone

[7] Peasant Associations (PAs) or *Kebele/Gaanda*: are the lowest political and administrative organizations established at the reform to implement policy guidelines established by the central government.

[8] Household refers to *the smallest social unit composed of people that share the same abode for an extended period of time* (J. Pulhin et al. 2006).

groups was illiterates, primary school, high-school, and completes and graduates each comprising 45%, 34%, 11% and 10% of the respondents respectively. The total number of female respondents interviewed is 14; 3 widows, 8 married and 3 unmarried females respectively. The lower female number is mainly attributed to society's tradition and male-dominance; it is the male who is responsible to identify the stranger and give family details. Therefore, it is not a surprise to see a woman refusing an interview in the presence of the men, arguing the appropriate person for interview is the husband. The other problem identified was that in the zone polygamy is a common practice, where two or more housewives belong to one male partner, and the housewives living neighbour to one another were found to be cautious on giving family details, which may be due to fear of one another.

Based on the language know-how of the respondent Afan Oromo[9] or Amharic language[10], the two most spoken languages in the zone, were used for interview and later translated to English. The interview took place face-to-face and sound recorder was used in order to minimize information loss. In cases of lack of consent from interviewee or distractions '*'interview protocol, a form ...with questions and ample space between the questions to write the responses*'' was used (Creswell 1998). To get as much information as possible the respondents were treated as a ''carriers of information'' while I was acting as an ''ignorant knower'', but I was curious enough while the information flows from the interviewee. The interview took an average of 25 to 40 minutes each.

However, there are cases where households refused to be interviewed because of 'political fear' that was mainly emerged from their inability to read the letter of cooperation written to them. It was especially challenging to ask details that come at first (names, assets, children, age). Then I decided to move these details to the end of my questionnaire, and I also tried to convince them the studies neutrality from any politics. Since I know the languages and the tradition, to get the accessibility of information I also used informal communication as a beginning and acted like 'a non-stranger' to the area. Since the questions revolve around livelihood of households, it was also another challenge to make the interviewees focus on the questions in the questionnaire. There were particularly two topics that the interviewees wanted to discuss. The mid and lowland interviewees expected more aid due to heavy rain damage incurred during 2008 *meher* harvest, and others had complaints regarding

[9] Afan oromo (also called oromic or Oromiffa) is the language spoken by Oromo tribe and is the official language of Oromiya regional state

[10] Amharic (or Amarigna) is the official language of Ethiopia

humanitarian aid, corruption cases and lack of aid after facing sever climatic shocks during previous years. However, to focus on my research questions I tried to make clear that even if I could not help them practically now, the result of the study will hopefully contribute to the scientific and socio-economic knowledge that may help for the future sustainable alleviation of the problem.

Interviews with secretary of the PAs

Six secretaries of Peasant Associations[11] were interviewed (2 from Dodola, 2 from Kofale and 2 from Shala). Beyond helping as a good source of information regarding their PAs, they were also helpful in clarification of gaps created during household interview and in providing comprehensive information on the neighbouring PAs.

Interviews with Government officials

Interview was also held with the Zonal and Districts ARDO directors, Livestock experts and Agronomists from the zone, and Shala, Dodola, Shashamane, Siraro, Arsi-Negele and Kofale districts. Six Development Agents[12] (DAs), 2 each from Arsi-Negele, Dodola and Shala, were interviewed the same questions. Interview was also conducted with the zonal DPPO food security office director. The detailed interview with the respective officials was particularly very crucial to harness and comprehend the climatic change trends, impacts, vulnerabilities and the existing stressors (see appendix I).

Field observation

Field observation was conducted in the Arsi Negele, Kofale, Dodola, Shashamane, Shala and Siraro and photograph was taken regarding some of the current socio-economic challenges (resource endowments) and existing coping mechanisms.

3.4.4. Secondary data

Relevant and available data, published and unpublished literatures, policy documents and other relevant sources were gathered from the relevant offices. The data for affected people were found from DPPO. Relevant documents and harvest data for *Meher* and *Belg* were

[11] Secretaries of Peasant Association are individuals are assumed to be an administrative representative for their respective PAs and are believed to have better know-how of the socio-economic and political aspect of their respective area.

[12] Development Agents are sub-professionals of regional or zonal ARDO who are assigned to each PAs to advice farmers and provide technical assistance on the use of improved farm management practices and modern techniques. They are always in close contact with the farmers and due to the nature of their duties they are crucial source of information for this study

collected from District and Zonal ARDO and Central Statistical Agency (CSA). At the CSA yearly agricultural data for the zone and the districts were lacking. Communication with the CSA expert revealed that the available survey samples are not statistically significant for administrative levels below the zone. Hence, there it was impossible to find separate data for the zone beyond the year of its establishment. It was also another challenge that the data for most of the districts was not separated from their former administrative zones. Though, I went down to the relevant districts, the systems at the districts is not computerized and the staff turn-over is high, and consequently, the existing data are fragmentary or are poorly compiled. Nevertheless, this challenge has never affected the general objective of the study as the collected secondary data are sufficient to support the primary data collected by interview.

The annual crop production data collected from Dodola and Shashamane were analysed using quantitative statistical method, excel. The extreme climatic coincidence (precipitation and temperature) and/or gradual climatic change trend were analyzed by comparing with the climatic data and the primary data and secondary data collected from literatures.

The temperature and precipitation data were collected from NMSA for three stations of the zone, two representing mid and lowland areas (Shashamane station and Langano station) and one representing predominantly highland district (Kofale station). There are other stations, but since much of their data are missing I decided to discard them. The annual precipitation and temperature trends were analyzed using SPSS statistical techniques. According to NMSA (1996) the total amount of rain received in a year is important to assess the available water in order to meet demands of agriculture, human consumption and other activities. Further, it is only small amount of rain that is used by crops while most is lost by runoff (ibid.). The years of deficient rainfall not only led to droughts but also to famines (ibid.). The temperature and precipitation trend was, thus, compared with the crop production data and the respondents' perception of climate change trends and its impacts.

4. Results and analysis

The result part is divided into three sections corresponding to the developed analytical framework. The first part shows the impact of climate change on the livelihood, and consequently on the society. It combines both quantitative and qualitative data on the trends of gradual precipitation and temperature, and extreme weather changes. The second and third part presents the vulnerability of different social groups and the local and the institutional coping mechanisms and finally the major stressors or constraints are presented based on the

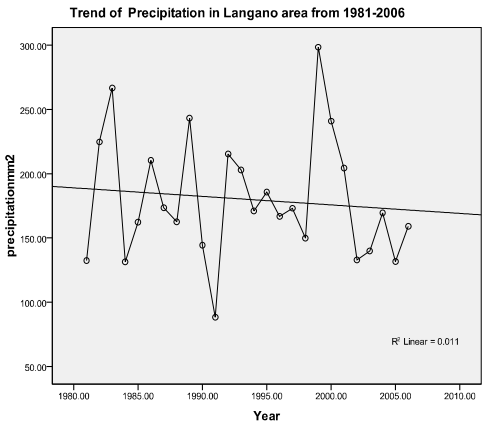
data gathered during the field study.

4.1. Trend of climate change in West-Arsi zone

Though the frequency and extent of feeling the impact varies, the frequently experienced climatic shocks are prolonged drought and delay in the onset of rain, erratic and low precipitation, and heavy and unseasonal rainfalls. The relatively recent major drought and rain delay events that hit the zone and marked in the minds of respondents interviewed are 1983-84 (both *Belg* and *Meher* failure), 1991-92 & 1997-98 (bad to failed *Belg* and *Meher*), 2002-03 (bad to failed *Meher* and *Belg*) and most recently 2007/08[13] (complete *Belg* rain failure). Most highland respondents perceived the 2007/08 prolonged drought (9 months of drought spell) as the most notorious climate shock in their lifetime (even worse to them than the well known 1983-84 devastating drought). The heavy and unseasonal rain years include 1994, 1998, 2000, 2006 & 2008. On the other hand, the interviewed households perceived the overall increasing temperature and downward trend of precipitation. The officials and secretary of PAs also confirmed the abovementioned challenges. However, according to most respondents, the challenges are severe and more frequent in mid and lowlands.

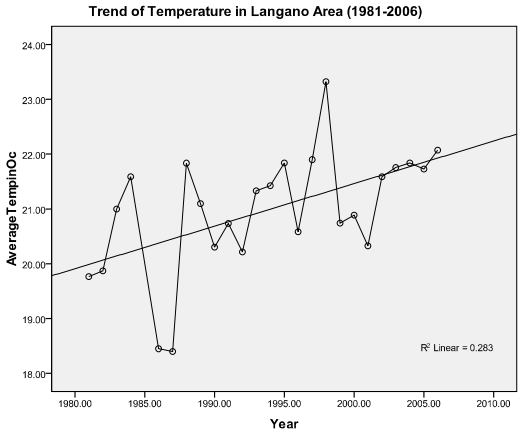
The annual available meteorological data for the three stations namely Shashamane (1970-2007), Kofale (1965-2007), Langano (1981-2006) is presented on the following graphs (figure: 1a and b; c; d and e respectively). The precipitation trend for mid and lowland areas (Shashamane and Langano station) has shown dramatic decline, but upward trend for Kofale station (predominantly highland). On contrary, though there is no temperature data for Shashamane, the annual average temperature has shown an alarming rate of increase for Langano station, and is also a reasonable increase for Kofale. However, data was not found to support the rampant temperature rise for Kofale in 1981 and 1982. The recent drought occurrence curves in the above graphs (1983-84, 1991-92, 1997-98, 1999-2000, 2002-03 and 2005) also agrees with the primary data. In 1987 the *meher* rain has badly failed though *belg* rain was quite good (NMSA 1996).

[13] At the time of data collection the temperature and precipitation data for 2007-2009 were not ready for use



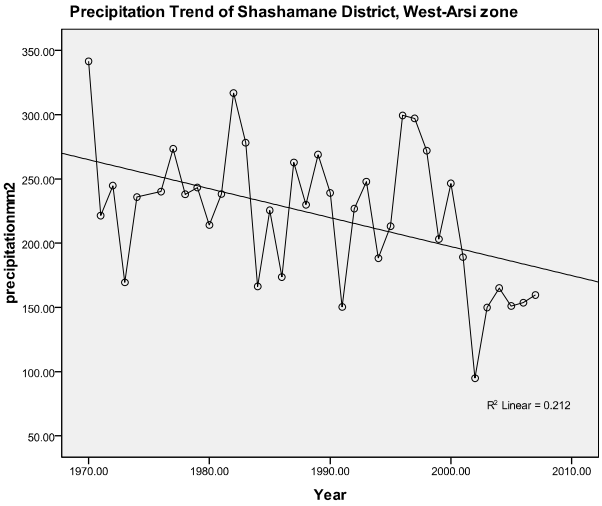
Source:NMSA, 2009

a



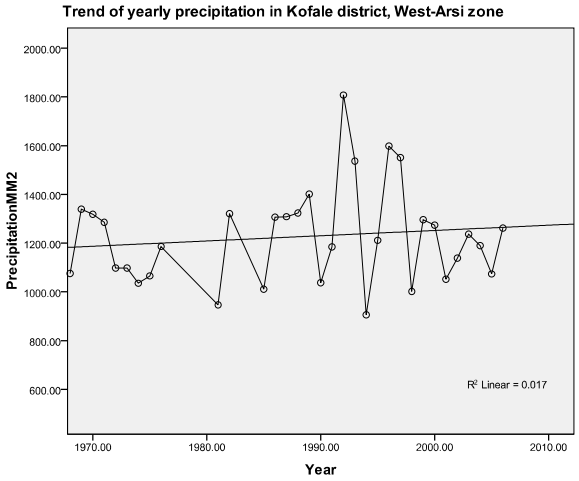
Source:NMSA, 2009

b



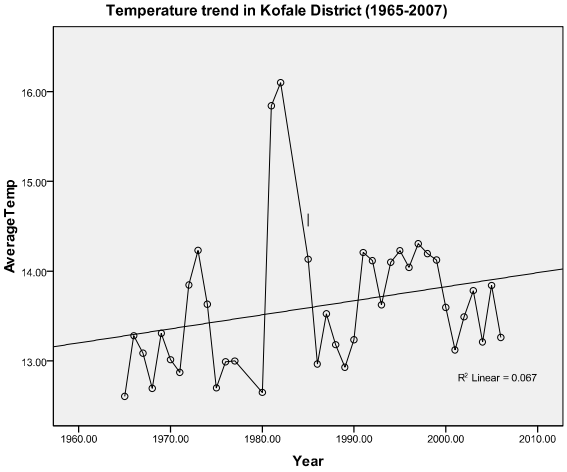
Source: NMSA, 2009

c



Source:NMSA,2009

d



Source: National Meteorologic Agency of Ethiopia, 2009

e

Figure 3 showing the trend of precipitation and temperature for Langano, Shashamane and Kofale stations in West-Arsi zone.

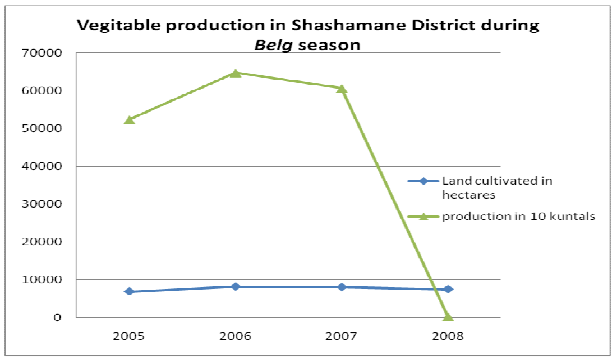
4.2. Impact of climate change on livelihood and the society

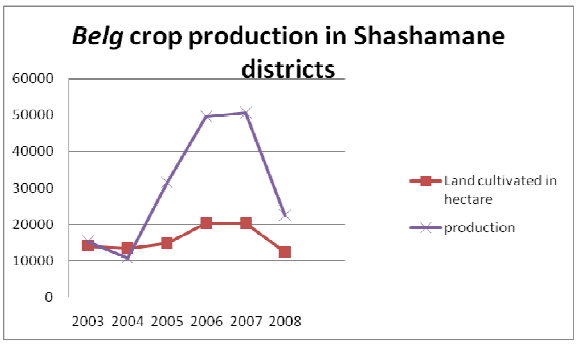
While the zone specific exact value of damages caused on livelihood by past climate-related events is scarce due to the recent establishment of the zone and poor maintenance of data, the subjective evidences gathered during respondent interview with the available agricultural production data suggests climatic change has been frequently imposing challenge on their livelihood and consequently affecting the societies socio-economic activity.

4.2.1. Impact of climate change on crop cultivation and livestock rearing

During drought and delay in the onset of rain land becomes dry and difficult to plough, forage deficit leads to weakness and oxen mortality (engine of subsistent cultivation), and lack of precipitation hinders seed cultivation and germination of cultivated seeds. Even weeks delay in the onset of rain was found to have significant difference on the harvest and has deprivation of households' livelihood. In Siraro district alone the 2007/08 prolonged drought spell and *Belg* rain failure has hampered cultivation of 19800 hectares of prepared land and spoiled germination of 2750 hectares of sown land, caused the mortality of 1279 oxen, and loss of 862400 quintals of yield (West-Arsi Zone FS-DPPO 2008). The households also suggested the situation has also created a good opportunity for weeds to stay in the cropping land so that it latter emerges with crops and out-compete them. Erratic precipitation period has also increased an opportunity for crop pests.

The following graphs show some recent production caused by delay of rainfall and prolonged drought season.





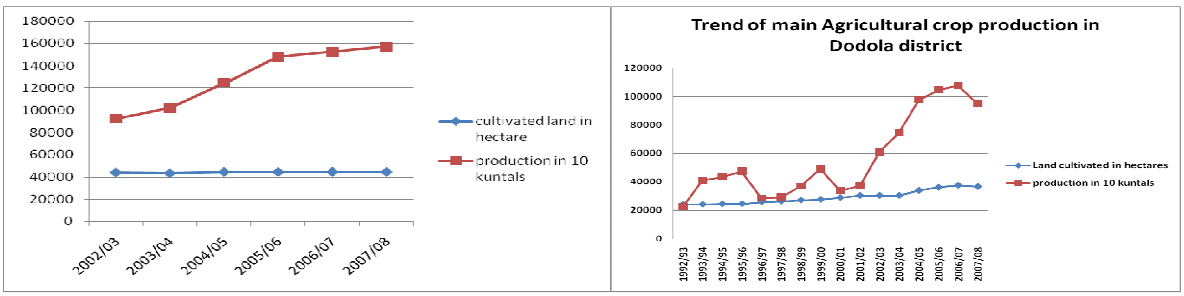


Figure 4 Diagram showing Agricultural Crop production (land cultivated versus production) in West-Arsi zone.

Recent *Belg* production trends in Shashamane district (the top two) and *Meher* production for Shashamane (below on left side) and Dodola (predominantly Meher producing district, below right side). Note that the declining points: events of prolonged drought and delay in onset of rainfall. The above fluctuation in production is mainly explained from climatic change shocks, particularly drought and late onset of the rains. The shortage of *Belg*-rain is responsible for the production crash in 2003, 2004 and 2008 in Shashamane. Similarly in Dodola, the production collapses have occurred in 1993, 1997, 1998, 2001& 2002. **(Dodola ARDO 2009; Shashamane district ARDO 2009)**.

Drought and delay in the onset of rain led to poor grass regeneration/forage deficit, water shortage and heat stress on livestock, and consequently increased the mortality of the livestock, vulnerability to diseases and physical deterioration due to long distance travel for water and pastures (interviews & and West-Arsi Zone FS-DPPO 2008). The household interview data suggests that 31% livestock per household were died during the 2007/08 drought. Though, further study is needed to find-out the relationship between climate change and emergence of specific livestock disease in the zone, it was evident that the animals were more susceptible to tick infestation, pasteurollosis, anthrax, African horse sickness, sheep & goat pox, lymphangitis coccidiosis & Salmonelliosis[14]. The problem was further challenged by the shortage of livestock clinics, experts and drugs.

On the other hand, heavy and unseasonal rain has both positive and negative consequences; it provides good harvest season, particularly in mid and lowlands, but causes mild to serious negative consequences depending on the phonological stage of the plant, soil type, topography and intensity of rain. In Shala district, where 90% of the soil is sandy, erratic precipitation and heavy rains are the two most serious climatic challenges for the livelihood[15]. Erosion from heavy rain was exacerbated by the nature of the soil (sandy soil is easily degradable and has low water holding capacity), the topography and land use change. Heavy rain also affected the productivity of vertisol soils. Vertisol soil is associated with high water logging capacity and heavy rain affects land preparation, seed germination, crop growth stunt

[14] Livestock expert from Kofale District ARDO

[15] Aman Dafo, Agronomist at Shala district ARDO

and causes inundation of cultivated seed and land degradation. It also sticks when wet and cracks when dry, and is difficult for ploughing.

Unseasonal rainfall also results in seed drop, ripened crops germination, crop desiccation delay and harvested crops spoilage and deprives the farmers' livelihood. '*'... we faced total crop loss in 2006s due to the hailstorm at harvest season and we sold our livestock to buy food crops, but we had nothing to sell to cope with the 2007/08s drought*'' Kasim Kabato, 32, from Dodola highland. The 2008 unseasonal rain has also incurred serious loss in *Meher* crop in mid and lowlands (up to 100% loss); but the impact was minor in highlands due to the late ripening of the crops. The 1994, 1998, 2000, 2006 and 2008 heavy unseasonal rainfalls are also some of the years when unseasonal rain disrupted *Meher* crop harvesting in the zone and the country (interview & FAO 1998). By contrary both heavy and unseasonal rain generally favours livestock production due to enhanced grass regeneration and increased water availability, but some deaths from bloating, over-eating of already weak animals that survived drought was suggested by respondents.

4.2.3. Impact on the society

All the interviewees anonymously reported the existence of repeated serious climatic impacts on the society, but impacts were more frequent in mid and lowlands. They reported food deficits, malnutrition cases, educational dropouts, increased susceptibility to diseases and failure to fulfil financial requirements, and lack of agricultural input. According to a Gamada Kabato, 19, from Shala district, '*'climate affects all of us ... because our life is totally intertwined with livestock and crop production…they are our life*.'' Some farmers also indicated *Belg*-crop (maize and potatoes) were their staple food, and wheat and barley are sold to fulfil financial requirements, but the frequent failure in *Belg* harvest forced them to totally depend on *Meher*. In cases of both *Belg* and *Meher* harvest fails, the situation is even worse. See the number of people affected by climatic crisis from 1995-2008 in **table 1** below.

Table 1 Populations affected by both manmade and natural disasters in West-Arsi zone districts since 1995

District	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Siraro and Shala	1000	1090		17000		27000		40515	46500				5000	14500
Shashamane				2500		16000		72473	41000				9324	15000
Arsi-Negele				16000		18000		17230	53100	5800			7000	18200
Dodola													2908	5000
Kofale														5500
Others													2727	41200
Total	1000	1090		55500		61000		130218	120600	5800			26959	99400

(*Source*: Oromiya Region DPPO, 2009)

Table 1 shows the number of people affected by disasters, but data crosschecking shows some disparity in number of victims[16] that may be attributed to underreporting by government officials or the demographic change occurred by continued restructuring of the peasant associations. The difference in populations affected in between the study areas, mid and lowlands (Arsi-Negele, Shashamane Siraro and Shala) and predominantly highland areas (Kofale and Dodola) is clearly reflected in the table. The general increasing trend of victim population in the zone is also prevalent.

As it was possible to understand from abovementioned results, the impacts of severe climatic events on livelihoods were frequent and cyclic. According to the country level study by Comenetz & Caviedes (2002) the successive drought in 1991–92 and 1993–94 has caused comparable affliction to that of 1980s. The 1994 heavy and unseasonal rain has also damaged crops. The damage incurred by 1997-98 drought was estimated to 28 million dollars (a huge loss to poor countries like Ethiopia) that was again followed by catastrophic flooding in 1998 that compounded food shortages (ibid.). The drought in 2001-2002 has caused food and water deficit to 12.5 million Ethiopians (WFP Emergency Report 2003). Though 2005 and 2006 were relatively a good harvest season in West-Arsi zone, heavy rain mixed with hailstorm in 2006 has damaged ready to harvest crops in Dodola district, and latter followed by the notorious drought of 2007/08 (total *Belg* rain failure). Similarly, the drought of 2007/08 was followed by heavy *Meher* rain during the vegetative stage of the crops and latter followed by unseasonal rain during *Meher* harvest season.

[16] According to West Arsi-Zone DPPO situation monitoring, 2008 the people affected by 2008 drought alone is 320,000; whereas the Regional DPPO, 2008 reported 94,000 only, a number less than 5-10 aged affected population in the same year.

4.3. Coping Mechanisms

4.3.1. Local coping strategies to climate change

Interview result on the major coping strategies used in West Arsi zone

On average 37% of the respondents, 41% in mid and lowlands and 33% in highlands use saving as their major coping strategies. On average 12.5% of the respondents, 23% in the highland and 4% in the mid and lowlands suggested on-land diversification as their main coping strategy. Wood sell is the third most significant coping mechanisms, on average 12.5% of the respondents, 15% in highland and 10% from mid-lowland). Diversification to off-farm and non-farm activity[17] also helps farmers to retain assets or to withstand climatic shocks (on average 10.5% respondents, 13% from the mid and lowland and 8% from the highland). On average 7.7% of the respondents, 12% in the mid and lowlands and 3% from the highlands suggested mobility to places where there is available pasture and water as a coping strategy. 9% respondents, 12% from the highlands and 6% from the mid and lowlands also use social interconnectedness (relatives) as coping strategy, credit from informal and formal sectors is used by on average 10% of the respondents, and other off-farm and non-farm activities (used by on average 8% of the respondents, 6% in highlands and 14% in mid and lowlands).

Saving: respondents used the term saving in two ways: *during impact saving* - using less amount of available resource during climatic crisis; eating less food, using less feed and reducing purchases. The second type is *pre-impact saving* - households keep sufficient assets (crop, forage, livestock, money or other form of asset) that help them to bridge hardship times. According to the respondents, after facing perlious income and food deficit in the recent droughts and rainfall delays pre-impact saving became their main strategy. During the field work heaps of crop-residue around houseyards were also observed. In addition to managing household food consumption, to pay-off expenses and to fulfill household financial requirements the households are selling livestock instead of food crop.

However, in mid-lowlands the coping mechanisms are still poor[18]. Households sell their produce during the harvest season and become victims of crisis. For instance, much of the

[17] 'off-farm' means off-own-farm activities, while 'non-farm' refers to non-agricultural livelihood activities (Ellis 2000)

[18] Aman Dafo, Agronomists at Shala ARDO and Agronomist from Gadab-Asasa ARDO

maize in Shashamane, Siraro and Shala is harvested and sold while it is green. Though *Belg* green harvesting is used as a coping mechanism to cultivate crops twice a year, the *Meher* green harvesting compromises with the savings as it cannot be stored for long periods. Further, though further research is needed, the dependency on the exterior aid was indicated to have paralyzed the local coping mechanisms.

On-land life-diversification: the study in Kofale and mid and highlands of Arsi-Negele and Shashamane also revealed a significant move toward on-farm diversification practices, where farmers grew *enset*, eucalyptus tree, cabbage and grains. It was interesting to hear Kofale households emphasizing the importance of enset crop by reiterating, ‘*’no enset no life, if households lacks enset ther are already dead.* Enset crop (also called ‘’*worqe*’’ which is literally translated to ‘’my gold’’) is highly productive, has high water holding capacity. Unlike many other crops, enset also have high drought and rain tolerance capacity. Moreover, it can be harvested at any time of the year and few stalks can feed a household for months while the remaining part is used as a feed. According to respondents from Arsi-Negele highland, in 2008 the ARDO has awarded those households having many stalks due to their better coping ability during the drought situation, and to motivate them to keep or expand the existing cultivations. Diversification to eucalyptus tree also serves as a source of firewood, house construction, income source and buffer times of climatic crisis, but according to respondents the tree is out-competing the crops and grasses. To remediate the negative consequences, the ARDO is advising households to make a distance of at least 20m between cropping land and the tree[19]. Vegetables are also vital coping strategies during the crisis.

Mobility and relatives: There is semi-nomadic tradition in the zone. During *Meher* season highlanders and mid-landers move to lowlands, where there is ample pasture and water, and return to their origin during the harvest season when there is sufficient crop residue and grasses. Many pastoralists in highland also rent land from mid-lowlanders to get food crops and crop-residues. In the same way lowlanders and midlanders also move during dry seasons. There is also a long-standing tradition of social interconnectedness that plays significant role during crisis, which promote mobility and resource share and exchange during security problem.

[19] Fayissa Gamada, Development Agent at Arsi-Negele District

Credits: Credit from better-offs, informal social organizations and government institutions are also crucial during climatic crisis. Civil society organizations (such as Idir[20]) support members during emergencies and also provide credits during crisis.

Since few years Oromiya Credit and Savings Share Company is also providing credits to help farmers buy agricultural inputs, livestock and create an asset. As learned from the farmers and credit association managers, the peasant farmers organize themselves so that the members are responsible for individual's credit. The credit is granted during the months of January and February each year, around the commencement of *Belg* season, and the deadline for paying back is December, after crop is harvested.

Changing growth season and growing early maturing crops: Changing cultivation or crop cultivated type by following the trend of precipitation is being on practice. Apart from the *Meher* and *Belg* season, some households are moving their cultivation to *Ginbot* season (May cultivation) and grow early maturing seeds afterwards. Use of early maturing or drought resistant crops such as chickpea, grass pea, haricot bean, potatoes and katumane maize are also in practice. As eye-witnessed during the field work, in highland places where *Belg* cultivation was not tried before (e.g. Dodola) households have started preparing land to grow *Belg* crops.

Other off-farm and non-farm activities: wood sell from private plantation to illegal government forest was another coping strategy. The Dodola-Adaba forest, for instance, is managed by the community comprising around 4000 households living in and around the forest (Amente 2005). During normal times 50 % user groups sell two donkey loads of firewood every week (Shiferaw, 2003 cited on ibid.). As confirmed from the study the dependence on the forest is definitely higher during climatic crisis.

On the other hand, in spite of its limited opportunity of employment opportunity and its low income return, off-farm and non-farm activity also helps households to retain assets or to withstand climatic shocks. Women generate incomes by producing local drinks (*areke, tela & shameta*) and other petty-trading. Poor and landless also make earning from daily labour on better-off farmers' land, construction activities, equine carts and on small scale businesses.

[20] The informal civil society organizations are traditional self-help systems that function during funeral arrangements and giving financial support to members in the event of death of a family member. They also serve as providers of emergency insurance to communities in cases of disruption of community level basic services or even serve a political function (Tefferi & Endeshaw 2006)

4.3.2. Coping mechanisms provided by exterior aid

The ARDO is providing awareness on saving, use of Broad Bed Maker technology (BBM[21]), advising to scale-up traditional water pond to modern water harvesting technology, and providing agricultural inputs during climatic crisis. However, still the adoption of oxen-drawn BBMT was limited due to 'its heaviness', price unaffordability, unavailability and lack of awareness. BBMT impact assessment study in Oromiya and Amhara region has also found disappointing households welfare improvement among users of the technology, insufficient training, underestimated human labour requirements and oxen draught power, price unaffordability, and consequently the land cultivated by BBMT is 1% of the estimated 7.6 million hectares of vertisol soil in the Ethiopian highlands ((Rutherford 2008).

Community water harvesting was also challenged by less precipitation, water seepage and quality deterioration. In some places plastic cover was tried to prevent seepage, and spit irrigation was used in case of less precipitation. However, in 2007/08 only 2902 hectares of cropland (0.85% total cropland in the zone) were irrigated (CSA4 2008).

Emergency aid and Productive Safety Net Program (PSNP)

During emergencies NGOs and government were providing emergency food, seed varieties and health services for the affected people (see table 1 appendix). On the other hand, the safety net[22] program is an extension of ''the food for work'' program of Derg-regime (previous Ethiopian regime), but now modified to have two components, public work and direct support. In case of public work, money is given after the individuals have participated in community development work such as water harvesting, road construction, spit irrigation, soil water conservation and other development activities. There are five working days per month for six consecutive months a year, and 180birr/person/year is given. Direct support is given for children, disabled people and old people without any need to work. However, it is limited to few households in lowlands of Shala, Siraro and Arsi-Negele (West-Arsi Zone FS-DPPO 2008). In principle the program's beneficiary should be ''the poor of the poor'', but

[21] The BBM is ''a type of a plough that was developed from the traditional dual oxen-drawn plough, the *maresha,* in order to more efficiently make raised seedbeds and furrows at the time of seed covering - thus reducing water logging.'' (Rutherford, A.S. 2008)

[22] Safety net project was designed in 2005 for consecutive 5 years with two main objectives: first, to provide farmers a platform to maintain their asset and create or multiply the existing assets. Secondly, it is to ensure food security. The inception of the program is to bring environmental, social and economic sustainability to the regions.

there are still complaints on inclusion of non-poor larger family size households that get disproportionate amount of aid/money compared to the targeted poor households. The program is also challenges by lack of communities' eagerness to participate in development work, insufficiency the aid (only ~0.5$/person/each working day), aid delay and fruitlessness of the activities or their negative consequences (harvested water caused malaria emergence, quality deterioration and water seepage)[23].

4.4. Who is vulnerable to climate change impact and why?

Table 2. Interview result showing the percentage of respondents on showing the most vulnerable social groups

Vulnerable group	Poor	landless	Children	All group	Women	Large size family	Livestock tenders	Youth	Old	men
Highland (%)	23	14	12	4	11	12	11	11	2	2
Mid and lowlands (%)	23	12	14	16	10	6	7	3	6	4
Average (%)	**23**	**13**	**13**	**10**	**10**	**9**	**9**	**7**	**4**	**3**

On average of 23% and 13% respondents suggested poor and landless households are most vulnerable to climatic shocks. Whereas on average 13%, 10% and 9% respondents suggested children, women and large sized families respectively are affected most by the events. On the other hand 11% respondents suggested all farmer households are disproportionately affected and are equally vulnerable. The average respondents who suggested youth, elderly people and men are most vulnerable to climatic impacts accounts for 6%, 5% and 3% respectively. The interview with Shala district officials and experts suggested that landless, women and children are most vulnerable than the other groups. The Dodola district officials on the other hand said large sized livestock tenders, children, women and landless are most vulnerable. In Siraro officials suggested all farmers, particularly old, poor, children and women are vulnerable. Kofale experts reported the vulnerability is acute on landless and large sized family households.

[23] Households, Secretaries of PAs and Officials

4.4.1. Poor

The poor depends on daily labour and have low income and fewer reserves to absorb climatic shocks. It was also reported that the middle class farmers are affected, but they respond to the impact by selling the available assets, taking credits and leasing part of their land. So, the situation may also move the middle-class farmers to the lowest level of wealth class, i.e. to the poor farmer level. By contrary, though it was indicated that better-offs suffer from worries and from the impacts on their property; however, in most cases their saving helps them to redeem the situation. Usually using the events as an opportunity, the better-offs also rent land from other groups at cheaper price, and give fertilizer and seed for share-cropping, and give crops to get higher-returns[24].

Poor is also not trusted for credits due to the general perception that poor cannot afford paying it back. From all studied areas households were complaining about humanitarian aid corruption and marginalization of the poor during the aid. It was also understood that the politicians and the local representatives usually over-report the numbers of victims, and the aid is distributed among all groups, and in most cases poor receives marginal amount of the aid.

4.4.2. Landlessness and unemployed

Though, poor and landless were treated differently by respondents, it is difficult to make a clear demarcation between them as they are closely associated in wealth and status classification. Landless are grouped under very-poor household categories (Kofale ARDO 2009). According to zonal wealth classification and household asset data, most of the interviewed households are grouped under poor and very poor categories, farmers who are landless or nearly landless and/or have few or no livestock. The average livestock for the households interviewed is 6; ranging from 0 to 50; and 35 % of the households have 2 or less livestock[25]. The average landholding per household interviewed is 0.96 hectare, ranging from 0 to 4 hectares, and the percentage of households with 0.5 or less hectares is 44%. Despite the lack of zonal information regarding acreage farm size, the average landholding per household most likely couldn't show much deviation from this result, and even could be less for the highlands due to its high population density. This shows that the frequent subdivision of land as an inheritance has generally led to land fragmentations to the point where no more

[24] Abdurhaman, Agronomist from Shashamane district and household interview

[25] The calculation is regardless of type and age of livestock

meaningful sub-division can take place. Landless households can reach as high as 25% in PAs of some district (West-Arsi zone ARDO 2008). Landlessness/unemployment is also the second most challenging problem for Shala district next to only water shortage[26]. Note that,

> *According to the Ethiopian Economic Association (EEA) study if the existing level of productivity and price structure continue, the average grain producing farm household needs 2.8 hectares of land to satisfy the minimum food and non-food consumption requirement of its members and so lead a life above the poverty line, if reliant exclusively on farm related incomes* (Gebreselassie 2006).

Moreover, the more vulnerability of youth compared to old in this study is only explained by the difference in landholding and absence of employment opportunities in the zone. Though old have inherited land to their offspring, they are generally better in landholding and have better immunity to cope with climatic shocks, whereas youth are generally poor because of unemployment and landlessness. Further, the fact that 11% respondent suggested *all households are equally vulnerable* in this study can also be partly explained by the lack of flexibility for multiple income sources during climatic vagaries. To alleviate the problem of landlessness the government is undergoing resettlement program to freely available communal land, where people move their livestock during water and pasture shortage, and division of the government's farms[27].

4.4.3. Livestock tenders:

Pastoralists' wealth and status measure and coping with crisis is usually based on their ability to re-invest on livestock growth, but the prolonged drought of 2007/08 has challenged the societies ''many livestock better coping'' discourse. In Dodola-Adaba forest forage is usually available all year round and the pastoralists follow rotational grazing[28]. The 2007/08 drought, however, was followed by depletion of forest grass and drying out of water resources, and since the drought was not-localized and the animals were weak, it was difficult for households to migrate to other places. According to the officials and the households, households with less number of livestock were better at coping due to their better fodder management, less cost to buy feed and less effort to store or prepare fodder at home. Households with large livestock could not manage feed and lacked other income sources or

[26] Aman Dafo, Agronomist at Shala ARDO

[27] Officials and households from Dodola and Shala district

[28] Rotational grazing is cyclical sequences of herd management; livestock is kept at the lower altitudes on open grazing land during rainy season and shifted to forest grazing during dry season, when the availability of fodder on the open pasture is exhausted (Amente 2005)

savings as the livestock body deteriorates and livestock market price continue to fall, and finally as the drought continued to worsen ''grasp all lose all'' situation has happened to them. By contrary the price of food and feed went-up and market unbalance was created, *the situation that aggravates the problem of pastoralists by shifting the terms of trade in favour of their purchases than their sales* (Futterknecht 1997 cited on . According to the respondents from Dodola and Arsi-Negele, during 2007/08 drought fagulo price (oil bi-product used as animal feed) jumped from around 100 birr[29] per quintal normal price to 450 birr during the drought, and that of *atela* (residue of local drink that is used as a feed) has similarly increased from normal 3 birr per jerry-can to 12 birr. The Country and Regional level Consumer Price Index (CPI)[30] displays that the dramatic increase of food price at the country level, from 100 birr in December 2006 to 220.8 birr in September 2008 (CSA5 2009). Further, the intervention from government was slow and insufficient (respondents). However, currently the ARDO is advising households to enhance feed saving and reduce the herd size and focus on livestock quality.

4.4.4. Vulnerability by gender

10% of the respondents suggested that women are more vulnerable to climate change compared to 3% respondent for men. The men's vulnerability was explained from their prime responsibility of income generation. In cases of crop failure or animal death they are supposed search other off-farm and non-farm activities income sources, take credit and pay it off, and find seed and fertilizer for the next cultivation season. According to Fate Beriso, 40, from Shashamane district '*'man is the victims of the situation … it is his responsibility to feed his family, whether the crop fails or not, it is his own...''*

Whereas, the vulnerability of women was explained from their lack of access to property, confinement at home caring for children and family members, worry about feeding the family, poor nutritional status, responsible for enset processing, and long distance travel to collect water and waiting long queues. According to experts from Shala district, *Women's closeness to family members and confinement at home makes them suffer the most, because*

[29] Birr is a unit of Ethiopia currency – 1 birr = 0.1100 U.S. Dollar on May 21, 2009

[30] CPI measures the average change in the price paid by consumers for a fixed market basket of goods and services (CSA5 2009)

men can take breath by being away from home…during the shortage of food women also go for an alternative means of making life, like small businesses[31] *(paraphrased).*

As it was possible to understand from the respondents the correlation between climatic impact and vulnerability of widows or divorced women, in particular, is much stronger. Traditionally, in the zone and the country at large, women are dependent on income generated by men, and thus, they don't engage on agricultural activities like ploughing, sowing and crops harvesting except on activities such as weeding and enset processing. However, in cases of the death of the husband or divorce, the woman takes all the responsibility of taking care for the household by selling local drinks, leasing land, petty trading or firewood (charcoal) sell. Particularly, if she is landless and has no elders but more dependents, the situation becomes more difficult to manage the event, and thus she is obliged to face the socio-economic pains of the situations. In case she is old the challenge is more intense.

Though the constitution of Ethiopia has recognized the right of women and their role in sustainable development since 1995[32], women's equity in socio-economic sectors in West-Arsi zone is still low. The 2007/08 West-Arsi zone socio-economic profile depicts that women represent only 20% of the total landholders (West-Arsi zone ARDO 2008). The percentage of women students attending grade level 1-8th, 9-10th and 11-12th (preparatory school) in 2007/08 were 40%, 21% and 20% respectively. Similarly, the percentage of women teachers with certificate, diploma and first degree were 32%, 22%, and 10% respectively. This literacy indicator shows a declining trend of women at higher school levels and at higher ranks, demonstrating poor school attendance and low achievement and/or high drop-outs. Whereas the data collected from respondents as the relationship between literacy and vulnerability is negative due to their better choice of opportunities, additional incomes, better asset accumulation, better awareness of climatic change impacts and better use of fertilizer and new varieties.

4.4.5. Vulnerability by family size

In West-Arsi zone polygamy is a common practice and household size is among the wealth classification criteria. For instance, in Kofale district household size 9-11 and above is one of

[31] *Jeware Hedato, Family Science expert at Shala district ARDO and Aman Dafo, Agronomist at Shala district ARDO*

[32] Article 35 in the 1995 constitution http://www.africa.upenn.edu/Hornet/Ethiopian_Constitution.html

the criteria considered to be classified as better-off (Kofale ARDO 2009). However, the tradition is backfiring with rising land scarcity, unemployment, high dependency ratio and increased climatic unpredictability. According to Re'oo Muda, 60, the head of 20 family interviewee from Kofale district, '' *we are always vulnerable because our family size can reach up to 20 to 30 persons per household, whereas the asset available can't exceed 10 livestock and 0.5 hectare of land, ... the asset is not even sufficient for surplus seasons*.''

The households interviewed have household size that ranges from 0 to 20 persons per household; the overall average household size is 7 (note that, around 14% of the respondent are singles). This number is almost consistent with the 2007 population and housing census that reported 7.2 persons per household in the zone. The same census also states that the age groups 0-14, 15-64 and 65 years and above comprises 47.8%, 45.7% and 2.6% respectively. This demographic composition shows that the majority of household members are young, which are economically passive and susceptible to malnutrition and other diseases; thus the situation is more desperate as few household members cannot afford to manage the requirement of the family including sending children to school. Population growth and more dependent ratio is also a challenge for the country at large. According to the 2007 Population and Housing Census results, the population of Ethiopia grew from 39.9 million in 1984 to 53.1 million in 1994 and to 73.9 million in 2007. The country level average annual growth rate was 2.8% between 1984 and 1994, and 2.6% between 1994 and 2007, and the annual growth rate for Oromiya Regional State between 1994 and 2007 is 2.9%. The census also showed 45% of the country's population is under age 15.

4.4.6. Children

In addition to 13% of respondents suggesting children are more vulnerable to the event, vulnerability of children to climatic crisis is apparent from malnutrition cases, and drop-outs and poor academic achievements. In Dodola district where malnutrition is not known or documented before, there were 752 under 5 children and 243 children 5 to 10 year old malnutrition in 2007/08 drought[33]. On the other hand, the available data for 35 schools in Siraro district depicted that the school dropout has increased from 2% during normal time to 21.76% during the drought event (West-Arsi Zone FS-DPPO 2008). Low class attendance, late coming and early departure, low educational achievement and high teacher turnover was also indicated on the report (ibid.). The same report has also exposed the more dropout and poor

[33] Dodola Health Documentation Centre 2009

educational performance cases in the other districts. It was possible to understand from the respondents that the households are extended and more than one child per household is sent to school; and consequently fulfilling the educational requirement for all is a very difficult task during the events. Long distances travel to collect water and to look after livestock was also another challenge that causes delay or low class attendance or dropout. The active growth stage and immaturity of children's immunity also makes them vulnerable to malnutrition.

4.5. Major challenges exacerbating vulnerability

The major challenges discovered in the zone during the study were unavailability and inability to afford agricultural inputs, fertilizer and selected crop variety (on average 34% respondents). In 2008 the price of inorganic fertilizer was 1000birr/quintals, thrice the price before three years[34]. Though, it is clear that agricultural input plays key role in increasing productivity under increasing land scarcity and resource degradation, the current price haul is constraining the farmers from using of fertilizer, particularly the poor farmers. Field study has also given me an eyewitness of a crop land left without cultivation in 2007/08, which the farmer claimed was due to lack of agricultural input and price inflation that followed the drought.

Water shortage is another overarching challenge for Siraro and Shala districts and other low land areas according to 18% of respondents, 34% respondents in lowland and midlands and 0% respondent in highlands). As one travels through the mid and lowland districts, it is common to see chain of people travelling with water jerry-cans or waiting long queues for pipe or well-water. For instance, in Shala district no river exists at all, but one lake, Lake Shalla, which is not used for drinking[35]. According to respondents, during the 2007/08 drought, the price of water has reached 25 birr per jerry-can, and part of their earning has been going to fulfil their water need. The high temperature stress also forced men to travel during the nights, up to 40kms, to take livestock to where water is available; and the women in turn were travelling around 8kms to collect water for household consumption. The clean water coverage in Shala is claimed to be 21.9% in 2005/06 (Oromiya Region New Zone study group 2006), yet in many places the pipe power is extremely low, the queues are very long and the price is high. At the time of data collection the price of water was 3 birr/jerry-can in both

[34] Households and officials interview

[35] Ibsa Tibeso (DA) and Aman Dafo, Agronomist, Shala District ARDO

Aje and Senbete town, capital of Shala and Siraro district respectively, and three water trucks (also called *botes*) were distributing water for Siraro district. Though the clean water coverage is low for the other districts, they have better well and river water endowment compared to mid and lowlands.

On the other hand, landlessness and unemployment is the major challenge according to 33% respondents, and as also indicated above. Others challenge such as transportation, light and telecommunication are other major challenges according to 11% of respondents.

5. Discussion

According to this study of the climate change impact on livelihood, vulnerability and coping mechanisms in West-Arsi zone of Ethiopia, the frequency of climatic change is increasing, both in terms of extreme weather frequency and gradual changes, and consequently aggravating the impact to crop production and livestock rearing. However, there are local coping mechanisms that are used to reduce the climate change impacts such as saving, diversification, wood sell, mobility, social interconnectedness and credits. There are also institutional coping strategies such as emergency aid, credit services, safety net, water distribution, awareness rising on saving and use of technology. Though, the coping mechanisms are not sufficient to address the challenges, and all societies are vulnerable to climatic shocks, and vulnerability is more acute on the poor, landless and unemployed, children, women, livestock tenders and large sized households. Wedded with landlessness and unemployment, water scarcity, unaffordability and unavailability of agricultural inputs and other stressors, climate change is more likely to continue to gamble the socio-economic activities and exacerbate the society's vulnerability.

The respondents' perception and meteorological data shows that the trend of agro-ecology is gearing toward hotter and less humid environment.[36] However, the annual meteorological data shows an increasing precipitation trend for Kofale, despite that the perception of the respondents was that there was not enough rainfall. This perception may be due to the lack of optimum rainfall needed for agriculture as well as other interlinked factors (resource degradation and increased temperature) that offset the moisture needed by a plant (Meze-Hausken 2004), or uneven distribution of rain throughout the year. A country level study performed by Tilahun (2006) has found the declining trend in rainfall since the 1960s in

[36] The respondents viewed agro-ecology trend moving from highland to midland, midlands to desert and deserts to more dry and hot environment in characteristics.

Ethiopia (Cited on Fraser 2007). The changing in global climate observed in the other parts of the world is consequently also prevalent in West-Arsi zone.

However, the gradual climate change in West-Arsi shows a differential impact depending on the agro-ecology of the studied region, where the increase in temperature benefits some highland places and counteracts the livelihood activities of the mid and lowlands. The interview with Agronomist and households from Kofale district suggested that before decades the livelihood of most of Kofalians were based on animal husbandry, whereas crops such as maize, barley and wheat were not productive. However, since the 1980s and 1990s the changing of agro-ecology has created a good opportunity for farmers to grow maize, wheat and some other crops also in the highlands. The fact that the gradual increase in temperature fosters agricultural activities in the highlands is consistent with the study by Kenny & Harrison (1992) who showed that temperature is the major constraint for the expansion of grain maize into higher latitudes in Europe. However, the most general implication could also be that coupled with the current land scarcity, the extreme weathers cycle and the alarming population growth, the gradual climate change is more likely to continue to exacerbate the apparent resource degradation in the highlands by promoting land use change and enhancing illegal resettlement, than to increase and diversify productivity.

In contrary to the changes in the highlands, in mid and low lands the increasing temperature and declining temperature has double implications on livelihood; it decreases precipitation input and enhances evapotranspiration, which in turn implies the high probability of precipitation deficit and drought, even at relatively higher precipitation levels. The mid and lowland districts are already experiencing frequent precipitation deficit and frequent water shortage, and as climate change trend continues the change is more likely to obstruct agricultural activities and consequently reduce the societies coping range to the future likely climate changes. The challenge can also evident from the fact that water became the first most stressor for the mid and lowlander societies of the West-Arsi. This is consistent with (Collier et al. 2008) who have shown that climate change increases the heat stress on livestock and plants, decreases land suitable for agriculture and promotes shorter periods of seed formation, and consequently, lowers the yield of production. Study in most parts of Southern Africa also showed similar trends of gradual change and increasing trend of drought stress on maize production (ibid.). This implies that the current Ethiopian population move to exploit degraded lands and desert areas (also see Haile 2004), without any irrigation facilities or efficient water harvesting strategy is more likely to fireback as the climate change continues

to exacerbate.

On the other hand, the increased frequency of impacts of heavy rain and unseasonal rain, and delay in the onset of rain and prolonged drought and the impact on livelihood observed in West-Arsi are also the prevalent in most developing countries, particularly where agriculture is subsistent and crops are gathered by traditional means, e.g. in Bangladesh (Harun-ur-Rashid & Islam 2007). The land preparation obstruction during prolonged drought or rain delay worsens due to the traditional way of farming, land dry up and increased mortality and weakness of oxen to plow the land. The seed cultivation and germination is also hindered due to the absence of irrigation technology. According to O'Brien et al., (2004) districts with higher irrigation rates are expected to have a higher capacity to adapt to climate challenges and other economic shocks. Similarly, a survey of farmers performed in 11 African countries has shows that the dry farm lands are particularly sensitive to climate change and have less resource to respond, but the irrigated farms have a positive immediate response to warming (Kurukulasuriya & Mendelsohn 2007). The heavy rain harm on ripened crop was also exacerbated by the inefficiency of traditional methods to save the harvest (Harun-ur-Rashid & Islam 2007).

Yet, the examination of the existing coping mechanism showed that even the marginal groups of the society were found using one or more strategies to enhance their resistance against the crisis. Saving of livestock, food crop and feed have been dominant and it is more likely to continue to play significant role to cope with crisis. Though, it is currently challenged by land use change and frequent droughts, mobility is very common practice in East-Africa and Asia (Ahmed et al. 2002). The significance of social interconnectedness and informal associations seen in West-Arsi is also prevalent in the other parts of Ethiopia and other countries of the world. The study by Fraser (2007) depicted that the worst affected households in Ethiopia during the 1983/84 drought were those from newly built communities in the northern provinces of Wello and Tigray, who were far away from their relatives. Similar findings have been shown from Vietnam where informal, but illegal credit systems and social associations have played a pivotal role in sustaining kinship and lineage ties which are necessary for security in times of crisis (Adger 1999).

Of particular interest in coping mechanism in some midland and highlands of West-Arsi is on-land diversification where farmers allot land for eucalyptus trees, enset, cabbage and cereals. In those areas the variation in vulnerability was prevalent between households; households that have enset were better at coping to climatic shock than those who lack it.

Unlike other crops, enset have high drought and heavy rain resistance capacity. It is an indigenous multipurpose crop that serves as all time food, feed, income source, house yard ornament, wrapping bread while baking, and can also be intercropped with coffee and vegetables, and can creates a good micro-climate for sun-sensitive plants. It is usually cultivated using manures (easily available and affordable fertilizer). Eucalyptus also serves as an income source during the crisis on livelihood. The importance of enset and eucalyptus tree as all time source of livelihood in this study demonstrates the fact that it is not only on-land diversification, but also the effectiveness of that coping mechanism determines resistance to climatic crisis. The finding in Botswana also supports this result, where diversification and fibre crops was indicated to have improved the individual smallholder's income, helped them to hedge reduced impacts from price fluctuations, protection against diseases and reduced impact of climatic vagaries (Glantz 1987).

However, the currently available coping mechanisms are not sufficient, particularly for the mid and lowlands, and all societies were vulnerable to different socio-economic challenges. Vulnerability was further exacerbated by other internal and external stressors. It seems surprising that 89% of all the households interviewed suggested that unavailability of fertilizer and selected crop variety, water shortage and landlessness/unemployment are their overarching stressors that exacerbate their vulnerability to crisis. Obviously, like other poor developing countries, there are many other challenges such as transportation, light, telecommunication and health centres. However, this result shows that the three stressors are serious and are priorities for the livelihood of the households.

The recent fertilizer price increase is the first top challenge for farmer households in the zone, but only next to water shortage in mid and lowlands. This depicts that smallholder farmers are strongly vulnerable to the international increase in fertilizer price. Similarly to this study (Denning et al. 2009) have shown that the low agricultural production caused by less agricultural input and climatic crises has deteriorated livelihood in Malawi. Though, Malawi's government agricultural inputs subsidy has resulted in bumper production in 2006 and 2007, from 43% national food deficit in 2005 to 53% surplus in 2007, the current fertilizer price hike has challenged fertilizer use by smallholder farmers. Similarly, Hargrove (2008) have confirmed that the recent unprecedented rise in fertilizer prices in the international market, more than 200% in 2007, affects poor farmers in developing countries, particularly farmers in Sub-Saharan Africa. Hargrove (2008) also indicated the fertilizer use in Africa is still the world's lowest (about 8 kg per hectare); and the lack of fertilizer worsens

hunger and poverty in the continent. Study in other countries like Asia and Latin America suggests 50 to 75% of the food crop production increase within two decades was due to the use of inorganic fertilizer (Viyas 1983; Narayana and Parikh 1987 cited in Mwangi 1996).

The absence of employment opportunity and landlessness is also one of the greatest challenges for the West-Arsi zone, and is the indicator for the indiscriminate vulnerability of majority of the society. One of the particular interests that show frustrating or the livelihood contraction in this study is the more vulnerability of youth compared to elders, which was explained by the difference in land holding, where elders are better in land holding and youth are landless and unemployed. The response that shows all societies are equally vulnerable can also partly confirm the exacerbating vulnerability of all societies to climate change due to the stressors. In contrary to this study and the mainstream economic postulation that shows negative relationship between landlessness and economic development, and hence vulnerability, one study in Bangladesh has found a positive relationship between landlessness and economic growth. The study has shown that the failure in income due to landlessness forces people to migrate for better incomes in the city (Rahman & Manprasert 2006). On the other hand, the households in rural Botswana are shown to be drought-prone but they are considered to have high household income compared to other Sub-Saharan African countries. This is because they receive an income from five to six sources on average, 71% of the households income is from non-farm activities (Hassan, n.d.). However, this is not the case in Ethiopia.

In Ethiopia flexibility to multiple income sources is limited due to limited employment opportunity and its low return (Bigsten et al. 2005). More importantly, agriculture accounts for the majority of the total national labour force (80% total employment in 2008). Thus, the exposure of agriculture to climatic change impact is, particularly for the poor and the landless livelihood, double exposure as they have few assets to absorb climatic shocks and as the employment opportunity further depreciates with the events. O'Brien et al., (2004) also found that landless Indian farmers are poor and have little security and '*'in times of agricultural distress, landless labourers are the first to lose their income.*''

In addition to poor and landless and unemployed, vulnerability is also acute on children, women, large sized family households and large-sized livestock households. Children's vulnerability is mainly attributed to their susceptibility to food shortage and diseases, and their responsibility to look after livestock and water collection. The family's status and household size also determines the household's affordability to feed and/or send a child to

a school, school dropouts and academic achievements. This climatic change impacts on children also show the multidirectional and intergenerational effect of climate change on the socio-economic activity of the country. On the other hand, women's vulnerability compared to men is attributed to illiteracy, less accessibility and entitlement to resources, cultural or gendered division of labour, and poor nutritional status. Vulnerability is more intense on women headed households due to their responsibility for both household and outside activities. Study in drought-prone areas of Botswana has also shown the more vulnerability of women and female headed households due to more dependency ratio, less access and entitlement to resources (Hassan n.d.). The study by Roy & Venema (2002) in India even has shown more vulnerability, because beyond being marginalized, less literate and contributing to majority of household chores, unlike West-Arsi they contribute to the majority of on-farm activities. According to Cutter (1995) the lack of equity makes both children and women to bear and continue to bear the impact of climate change.

On the other hand, in contrary to the West-Arsi zone's wealth measure criteria, where large sized households are considered to be better-offs, this study shows the escalating resource scarcity and the more dependency ratio exacerbated the vulnerability of large size households to crisis. This is in consistent with Vincent (2004) who suggested the positive relationship between dependency ratio and vulnerability to crisis. The high population growth rate in this study is also an indicator of continued Malthusian population trap and the disappointing progress in family planning in the country. The population increase, unemployment and overdependence on natural resource base as a coping strategy have significant implication on the future vulnerability of the society. According to Thomas & Twyman (2005) ''*the fact that diversification occurs is an indicative of a level of responsiveness to external forcing factors that may be significant in terms of the capability to adapt, however diversification within natural resource use may be regarded as reinforcing vulnerability to climate change.''* The increased landlessness and land fragmentation are also reflections of burden on natural resources (O'Brien et al., (2004).

The large sized livestock household vulnerability, high livestock mortality, high malnutrition cases, livestock price failure, rising food crop price, school dropouts and food shortages shown in this study also partly demonstrates the slow and the insufficiency of institutional intervention in early warning and identification of vulnerable groups. The humanitarian aid corruption cases and the failure to address vulnerable groups in West-Arsi zone was also evident from geographic bias at the country level where 78% of needy Ethiopian households

received no food aid at all due poor proxy indicators, institutional rigidity and consequent generous allocations of food aid to historically drought-prone areas by ignoring others or improving of past ignorance (Devereux 2000).

Currently governmental institutions are engaged on different development programs. However, there are complaints from government officials that show the existence of societal hindrances such as failure of adopting technology, lack of eagerness to participate in development programs, the programs unpopularity and societies failure to make lesson from advices and previous impacts. I advocate the in-depth study of uncovering the societal barriers, but I first suggest to ask the question 'how much the current institutional measures has escaped the traditional top-down approach orthodoxies in considering the holistic, coordinated, research based, long-term and other effective sustainability approaches? After all are the programs really sustainable?

I argue that the failure to adoption of BBMT (due to its heaviness and cost), 'fruitlessness' of safety net programs, lack of awareness, poor implementation of institutional advices, water quality deterioration and seepage and emergence of malaria after harvesting, and the unpopularity of the development program reflects the predominance of previous top-down approach. After all, these challenges are equivalent to the challenges faced by ambitious and appreciated, but failed food-for-work program of Derg regime. According to Hoben (1995) the 'Derg's Food for Work' program has failed due to lack of on-farm studies or environmental effects, the programs top-down approach; late food deliveries, limited coverage of food insecure communities, and the unpopularity of the programs. Further,

> *the conservation structures reduced arable area by 10-20%, the structures harboured rodents whose habitat is normally destroyed by ploughing; problem of water-logging, weeds, and difficulty of ploughing, terracing has reduced yields by raising subsoil to the surface and making it hard to plough (Herweg, nd, pp. 1 l-12 cited in ibid.). Some also complained increased problems from soil erosion, reduced agricultural production through tree shading, root interference and attracting anti-crop wildlife (ibid).*

Consequently, despite its inception of bringing long-term socio-economic and environmental sustainability to the country, the ''the food for work'' has failed to bring the desired change. The current institutional programs are also not claimed to be free from the past orthodoxies. For instance, in response to the current increased vulnerability of livestock tenders the West-Arsi ARDO is advising households to reduce their herd size and focus on the livestock quality instead. While helping to buffer the impacts, the advice may tend to counteract the

traditional habits, and it may create new impacts and exacerbate land use change and future vulnerability especially if more productive animals are bought without sufficient sustainability study. Studies show that in pastoralist areas herd accumulation is a rational form of insurance against drought (Ahmed et al. 2002; Morton 2007). More productive species may be more vulnerable to starvation than poorly productive animals (Coppock 1994, 11 cited in (Ahmed et al. 2002). The advice may also further reduce the available range land, increase resource degradation and hinder pastoralists' mobility as observed in case of Mongolia's communist government collectivization policy and land use change (Chuluun & Ojima 2002).

7. Conclusions and recommendations

This study shows that the increasing trend of climate change and its impact on livelihood of West-Arsi zone is exacerbating the vulnerability to different socio-economic activities of the society. Though, the gradual change is fostering crop cultivation in some highlands, the water deficit in mid and lowlands is more likely to continue to constrain livelihood activities, and consequently exacerbate societal vulnerability. On the other hand, the frequent rain delay, erratic precipitation, drought, and heavy rainfall and unseasonal rainfall are also grave concerns for all societies in the zone. The current local coping mechanisms are saving, wood sell, mobility, social interconnectedness and diversification. The institution is also disseminating BBMT, credits services, awareness raising on saving and use of technology, providing safety net for some lowlanders, and emergency aid. However, the current coping strategies are not sufficient. The institutional coping mechanisms are also predominantly top-down, and fail to bring the desired change. The overarching stressors that are enhancing societal vulnerability to crisis are land scarcity and unemployment, unaffordability and unavailability agricultural input and water shortage. Though, all farmers are vulnerable to climate change, vulnerability is heightened on the poor, landless, children, women, large family size, and predominantly large herd sized pastoralists. As the climatic and non-climatic stressors continued to increase the degradation of natural resource base and is more likely to exacerbate the society's vulnerability.

Recommendations

→ With the ever increasing weather unreliability, strong dependence on climate sensitive sector and continued water deficit, the involvement of institution on early warning and robust contingency planning is crucial. Countries such as Egypt, who receives around 85% of its

water from Ethiopia, has developed an institutional level adaptation to prolonged periods of low and high water flows through robust contingency planning and early warning systems (D. Conway 2005). Something similar should be possible to create in Ethiopia as well.

→ The vulnerability of mid and lowlands is a grave concern in future and intervention is needed to address water shortage, e.g. irrigation and scaling up traditional water harvesting.

→ Using effective level of fertilizer input under increasing land scarcity, improving the efficiency of inorganic fertilizer and promoting sustainable cropping practices is crucial to reduce social vulnerability. This can be addressed by using pro-poor "smart" agricultural input subsidies work, where equal access to the equal amount of input and increases fertilizer use by poor (Denning et al. 2009). Since livestock rearing and crop production are inseparable activities in Ethiopia, use of organic fertilizer should also considered since it provides a comparative advantage for the country due to its ease availability, less cost, better yield, better long-term restoration of soil fertility and moisture (Edwards 2007).

→ There is also a relentless need to alleviate landlessness and unemployment by enhancing the micro-financing efficiency, creating employment opportunities and sustainable and well-studied resettlement programs

→ Sustainable on-land diversification should be promoted to cope with the future likely climate change impacts. Enset has long history in Ethiopia, but its use as a staple food is limited to some parts of the country. In West-Arsi it is used mainly as a lifeline crop, may be due to its *poor protein and vitamin content* (Negash & Niehof 2004). Study is also needed to identify the societal and biophysical barriers that hindered the expansion of *enset* to other mid and highland places.

→Promotion of development programs and addressing vulnerable groups through development of better proxy indicators of societal vulnerability, like the way vulnerable groups identified in this study, addressing them from short and long term perspectives, e.g., institutional policy intervention in market during the impacts, post-impact recovery strategies, discouraging land use change (Ahmed et al. 2002).

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Appendix

Questionnaires

Introduction

My name is Abate Feyissa Senbeta. I am studying Environmental Studies and Sustainability Science (LUMES) at Lund University. I am doing my master's thesis on the impact of drought and flood on the livelihood of Ethiopians and the extent of people's vulnerability to it. Thus I appreciate your cooperation to give me your time for the success of the project.

Interview question: local households

1. Name …… Sex …….. Age ……..
2. Marital status Married …….. Not married …… other specify ……
3. What is your educational level? Illiterate…… Primary school … Secondary School ….. Graduate ……
4. Do you have children? Yes/no If yes, how many …… ……....
5. How do you make your life? Cattle rearing…… Crop production …….. Other (specify)……
6. How much money you earn per year (approximately)? ……..
7. Do you or your family member have another source of livelihood other than agriculture? Yes/No, if yes specify …….
8. Do you own land? …. If yes how much? …..
9. How many livestock do you own?

10. How do you characterize the weather of this area in terms of its temperature and precipitation? Is there any change? If yes, how?
11. Have you ever faced any climate related impact in your life time? If yes, what type of climatic shock?
12. If the answer to Q13 is yes, did it affect your cattle or/and crop? Yes/No, if yes how much? .....
13. To what extent that has affected you and/or your family?
14. If the answer to Q13 is yes, how did you cope or what did you do to cope with the situation?
15. Who do you think is most harmed by the event? Why?
16. How did the government, GOs and NGO's responded to reduce the impact?
17. Which type of climatic shock is your main concern?
18. What are the major constraints you have that hinders your coping mechanisms?

Thank you!

Interview questions: Disaster Prevention and Preparedness Commission (DPPO)

1. Name ……. Position/profession ……
2. What are the impacts of climate change on livelihood in West-Arsi zone?
3. Who is more vulnerable to the impact?
4. What is your role in prevention of socio-economic disaster caused by climate change and variability before and after the disaster? How?
5. What are your major challenges in alleviation of the problem and what should be done?

Thank you!

Agriculture and Rural Development Office officials, Development Agents and other Experts

1. Name …….. Position/profession ……
2. What is the agro-ecology of your zone/district/peasant association?
3. Is there any form of climate change in your zone or district? If your answer is yes, please can you explain?
4. If the answer to Q2 is yes, please would you like to explain the extent of climate change and variability impact on crop and livestock of your zone/district/peasant association?
5. What is the impact of climate change and variability on the livelihood of the people there?

6. Who is more vulnerable to the impacts? Why?

7. What are the local coping mechanisms used to reduce the impacts?

8. What is the institutions effort to reduce future impacts?

9. What are the main challenges and how do you think they can be improved?

Thank you!