Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.8, No.2, 2018

Socio-economic Impacts of Climate Change on Smallholder Livelihoods in Shashogo District, Hadiya Zone, South Ethiopia

Solomon Chufamo Ludago[1] Teshale W.Amanuel [2]
1.Department of climate change and development Hawassa university wondo Genet College of forestry and natural resources,Ethiopia
2.Department of Natural resource economics and policy Hawassa university wondo Genet College of forestry and natural resources

Abstract
Livelihood strategies, mainly crop production and livestock production on which smallholders depends are seriously threatened by climate change. This study examines socioeconomic impacts of Climate Change on Smallholder Livelihoods in Shashogo district Hadiya zone, south Ethiopia with specific objectives of investigating smallholders' perceptions to climate change and examining climate change impacts on smallholders. The data for this study was collected from both primary and secondary sources by using multi-stage random sampling techniques. As a result of that 43 households from poor, 88 households from medium and 31 households from rich; a total of 162 households were selected by using rule of thumb ($N \geq 50+8n$) as a source of primary data. In addition key informants' interview and focus group discussions were also used as a primary data sources. While secondary data was collected from review of literatures and related documents both from published and unpublished sources. Descriptive statistics was used to analyze data on households, perception to climate change and household choice of adaptation strategies. As a result of that smallholders perceived that there was significant evidence that shows climate change in Shashogo district. Moreover smallholder's perceptions to drought and flood impacts were important evidences that verify the prevalence of climate change in the study area. Besides to household perception; local climate change indicators like temperature increase, decreasing of rainfall, shortening of cropping period, rainfall erratic nature, drought incident and flood impacts substantiate existence of climate change in the study area. Moreover the temperature and rainfall trend analysis shows observable increase of mean annual temperature by 0.16°c per year and decreasing of mean annual rainfall by 4.98mm per year in the last 25 years. Because of the climate related problems smallholders were facing drought and flood impacts, food shortage and emergency of crop disease in the district.
Keywords: climate change, impact, smallholders' livelihood.

1. INTRODUCTION

Climate change is the most serious threat that humanity may ever face (IPCC, 2007) and scientists have invariably proved that the level of change is happening much faster than what was anticipated before. Furthermore today's Climate change scenario represents a significant threat which is now recognized by world's governments and scientists as an issue of extreme concern (IPCC 2012). Rising fossil fuel burning and land use change (UNEP, 2005) has been steadily rising the concentration of greenhouse gases (Etheridge *et al*., 2002; NRC, 2010). Anthropogenic CO_2 emissions from the burning of fossil fuels are the main contributor for the rising of its concentration followed by land use, land use change and forestry (LULUCF) (IPCC, 2014). The natural environment and livelihoods of society's affected by global environmental change, which is driven by human development and growth (Rachel *et al,* 2007). According to IPCC (2007), Human beings are exposed to climate change directly through changing weather patterns and also stern (2006) indicated that Climate change has negative implications on natural ecosystems and human society and considerably endangering current and planned development outcomes. The effects of climate change in recent past have challenged progress in the alleviation of poverty and food insecurity (IPCC, 2012). Climate change is having profound impacts in sub-Saharan Africa (SSA) on their livelihood strategies through climate-related disasters (IPCC, 2007). Rural areas experienced particular vulnerabilities to climate change through their reliance on natural resources and weather-dependent activities (Mertz *et al*., 2009a).

Notably Ethiopian agriculture is heavily dependent on natural rainfall, with irrigation agriculture accounting less than 1% of the country's total cultivated land. Over the last decades, the temperature in Ethiopia increased at about 0.2° C per decade. The increase in minimum temperatures is more pronounced with roughly 0.4° C per decade. Precipitation remained stable over the last 50 years over the country. How-ever, the spatial and temporal variability of precipitation is high (Marius Keller, 2009).

The impacts of climate change on agriculture are well known in Ethiopia. The short term costs of extreme climate events such as droughts and floods could have devastating consequences for human development like, it wipe out crops, reduce opportunities for employment, push up food prices and destroy property, confronting people with limited choices. Droughts are identified as a potential risk and source of losses in agricultural production in the study area. Having increased drought incident in the study area leads to declined agricultural

production by which farmers seriously loss their livestock and crops. Affected farmers are likely to fall into poverty. Drought losses in Shashogo accounted for high losses in crop and cattle population and environmental degradation. Climate change and variability increases farmers' vulnerability as they lose their natural assets (crops and livestock) upon which their livelihoods depend (REWRFS, 2011). So Climate change is one and the most persistent stresses that individuals and communities face today in the study area.

2. OBJECTIVES

2.1. General objective of the study

The general objective of this study was to examine the impacts of climate change and impacts on the livelihoods of the smallholders and identify adaptation strategies practiced by them in the study area.

2.2. Specific Objectives of the Study

The specific objectives of this study were

1. To investigate perception of smallholders to climate change.
2. To examine the impact of climate change on the livelihood of smallholders.

3. METHODOLOGY

3.1. Overview of the study area

Shashogo district is situated in the north eastern part of SNNPR, Hadiya Zone. It is located about 117km from Hawassa, the Regional capital and at a distance of 224km far from Addis Ababa, the national capital. Astronomically, it is situated at 7.41º and 7.7º North of Latitude and at 37.92º and 38.12º East of Longitude and covers a total land area of 32,320 Hectares (Gashewu, 2013)

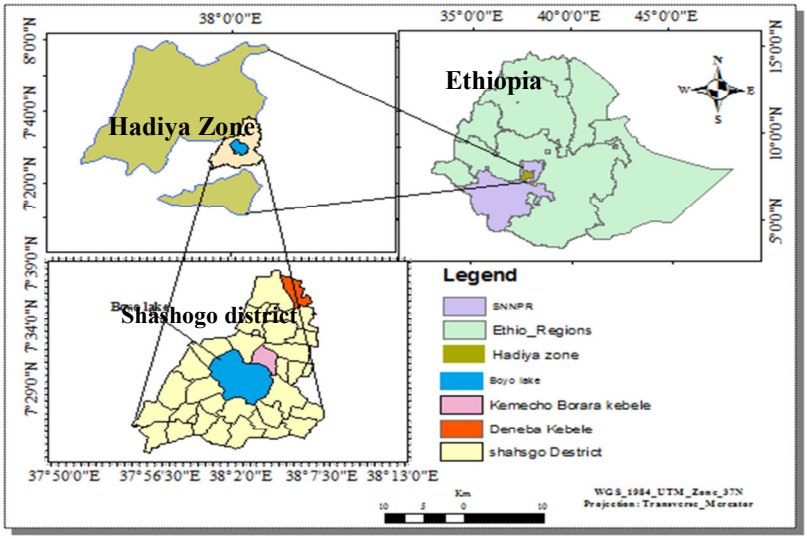

Figure 1: Map of the study area

Agro-ecologically the district is fully characterized as *arid woyina dega (*semi-arid*)* in which its altitude ranges from 1800 meter to 2300m asl. The area has a Bi-modal rainy season, *belg* (small rainy season) ranges from February to April and *meher* (main and summer rainy season) from June to September. Average annual rainfall is about 982.9mm with peak rainfall occurring at late July to early September (NMA, 2015). In addition mean annual minimum and maximum temperature of the study area ranges from 13-28 ºC respectively (REWRFS, 2011).

Agriculture is the main economic activity and livelihood strategy for smallholders in Shashogo district which involves more than 85 percent of the population. From the total population, 26% of them were living in flood susceptible areas. The main source of income for the society were both crop and livestock production. Majority of the population in the district depends mainly on traditional farming with entirely depending on rainfed agriculture. The production of crops and livestock rearing has been badly affected by the climate change especially flooding at summer season and elongated drought incidents in the winter (Gashewu, 2013).

3.2. Methodology

This study employed multi-staged sampling techniques. In the first stage; two agro-ecological zones from Shashogo district were selected purposively. In the second stage; from each agro-ecological zones one sample *Kebele,* a total of two Kebele's out of 34 Kebele's were selected by using simple random sampling techniques. In the third stage; Wealth ranking exercise was conducted within each kebeles' in order to classify households

under different wealth categories by using household's asset and resource endowment. Accordingly household head's were grouped under poor, medium and rich wealth category by using stratified sampling techniques and at fourth stage; random and proportional sampling (RS) methods were applied to draw sample households from each category. Accordingly, 43 households from poor wealth category, 88 households from medium wealth category and 31 households from rich wealth category, with a total of 162 sample households were selected based on the rule of thumb (Green, 2000).

$N \geq 50 + 8n$……1

Where, N= total sample size, n= number of explanatory variables. The explanatory variables included in this study were thirteen. So that the minimum sample size was $N \geq 50 + 8*13 \geq 154$. The formulas required a minimum of 154 households, but in this study a total of 162 sampled households were interviewed. The study relied on a combination of quantitative and qualitative data collection from both primary and secondary sources. The primary data was collected by using household survey, key informants interviews, focus group discussions and field observations. This was also supplemented by secondary data that was collected through review of related literatures and relevant documents.

3.3. Method of data analysis

Qualitative and quantitative data collected from both primary and secondary regarding perception to climate change, climate induced impacts were analyzed by using percentage, frequency, graphs, pie-chart, mean and standard deviation. The associations between variables were also tested by using a Chi-square test. In addition the ANOVA test was also used to test significance level and to compare means of continues variables. The collected data were analyzed by using statistical package for social science (SPSS) version 20 and excel sheet.

4. RESULTS AND DISCUSSIONS

4.1. Demographic Characteristics of Households

4.1.1. Age of Household Head

The mean age of the total sampled household heads was 44.91 with stander deviation of 9.77. Moreover minimum and maximum ages of the total household heads were 27 and 68 respectively. The age of household heads is also analysed in respect to their wealth category. Accordingly the mean age of poor household's heads was 48.19 with the standard deviations of 8.55 while rich and medium households had the mean age of 47.35 and 42.44 respectively. As it is presented on the (table 1) all of the households head had longer mean age which allows them to have better experience in farm activities. This means that household heads with longer mean age have better farming experience which helps them to compare the past and present climatic conditions of an area which in turn help them to have better adaptation probability. Similarly study by Gbetibouo (2009) in South Africa and Gebrehiwot (2013) in Ethiopian highlands found that households with larger mean age are more eager to use the accessible technologies to adapt climate change because of their better farming experience. In addition study by Abaje (2008) in Ethiopia shows that, experienced farmers have a higher probability of perceiving climate change over a longer period of their farming time. However, Adesina and Baidu-Forson (1995) in West Africa found that more experienced or older farmers tend to be risk reluctant and delay behind in deciding and making adoption decisions.

Table 1: Demographic Characteristics of households

Age of Households							
Wealth of Households		Total	Min	Max		Mean	std.
	Poor	43	28	60		48.19	8.55
	Medium	88	27	68		42.44	9.67
	Rich	31	29	67		47.35	9.96
	Total	162	27	68		44.91	9.77
Gender of households across Agro Ecology							
		Mid land	Low land	Total	%	χ^2	P.Value
Gender	female Headed	6	7	13	8.02		
	Male Headed	53	96	149	91.98		
	Total	59	103	162	100	0.58**	0.55
Family Size of Households							
Wealth of the Households		N	Min	Max		Mean	Std
	Poor	43	4	9		6.72	1.33
	Medium	88	3	11		6.08	1.61
	Rich	31	4	11		6.97	1.94
	Total	162	4	11		6.42	1.65

4.1.2. Gender of Household Heads

The result shows that 149 (91.98%) was male headed households and 13 (8.024%) was female headed households. Furthermore, the chi- square test indicated that gender of households head was not different across ecology with chi-square value of 0.58 by the probability of (p=0.55) at 95% confidence interval (table 1). This study found that gender of household head is not significantly different in between different agroecology in the study area. This means that male headed households are considerably higher than female headed households in mid land and low land agro-ecology. This is because of many socio-economic and cultural settings allow males to be household head rather than females in the study area. Studies in Ethiopia by Asfaw and Admassie (2008) shows that, gender is also taken as a limiting factor for the adoption of new technologies because gender based discrimination could limit female's participation in different economic activities. According to IPCC (2007) Climate change reaction varies considerably across socio-economic groups of the society. Different role players within the societies face different limitations, which cause various adaptive capabilities and opportunities for adaptation decisions (Wolf *et al*; 2013). In addition Study from Nepal and India indicated that climate change adaptation decisions of womens can be inhibited by socio-economic barrier that support male land ownership (Jones and Boyd, 2011).

4.1.3. Family size

As it was indicated in (table 1), the household heads had the maximum and minimum family size of 11 and 4 respectively. However, the mean family size was about 6.42 with a standard deviation of 1.65. The mean family size of household's in the study area was much higher than Ethiopian mean family size of 4.3 (Central Statistics Authority 2007). The family size of households were also varies among different wealth categories. Accordingly the poor and medium households had a maximum (9 and 11) and minimum (4 and 3) family size with standard deviation of 1.33 and 1.61 respectively. Whereas the rich household's had a minimum and maximum family size of 4 and 11 respectively (table 1).

Like most households in Ethiopia, the family size can determine their social status in the study area which can affect the livelihood strategies of them too. Because of this fact the family size in the study area was relatively large compared to the Ethiopian average family size. Literature review on climate change adaptation confirmed that family size has a

varied impact on adoption of agricultural practices because households with different family size have different level of adaptive capacity. Accordingly on this study household who has large family size have positive influence on the households adaptation strategies in the study area because households with large family size have better probability to participate on various economic activities to maintain income generation. Similarly study by Anley *et al*. (2007) in western Ethiopia and Nyangena (2007) in rural Kenya indicated that large family size is likely to allow farmers to have labour intensive adaptation measures in agricultural livelihood. In addition studies by Croppenstedt *et al.* (2003) in Ethiopia and Nhemachena and Hassan (2007) in Southern Africa indicate that larger family size may allow the household to perform a variety of agricultural activities. However Deressa *et al*. (2009) in Nile basin areas of Ethiopia found that large family size did not considerably increase the probability of household adoption to the prevailing climate change. Furthermore study by Tafere *et al.* (2013) in Tigray (northern Ethiopia) and Wolaita zones (South Ethiopia) and Awraris (2012) in Konso areas of Ethiopia shows that households with large family size faced resource shortage and struggle to adopt climate change because large family size might results on over exploitation of soil and other natural resources which may lead them to face resource degradation which in turn resulted on food insecurity.

4.2. Socio-Economic Characteristics of Households

This section comprises of five sub sections about socio-economic characteristics of household heads which includes educational status, household's income sources, farm size, livestock holding, and wealth status of the households.

Table 2: Socio-Economic Characteristics of Households

Educational status in relation with Gender							
Variable	Response	Female headed	Male headed	Total	%	χ^2	P.Value
Educational status	Not read and write	3(1.85%)	41(25.3%)	44	27		
	Read and write	8(5%)	66(40.7%)	74	45.7		
	Primary school	1(0.62%)	26(16%)	27	16.7		
	Secondary school	1(0.62%)	16(9.9%)	17	10.5		
	Total	13(8%)	149(92%)	162	100	1.65**	0.65

Income source across agro-ecology							
	Response	Mid land	Low land	Total	%	χ^2	P.Value
Income source	Nonfarm activities	9	8	17	10.5		
	Crop and livestock production	42	87	129	79.63		
	Off farm activity	8	8	16	10		
	Total	59	103	162	100	5.5**	0.06

Farm size of households under different wealth status

	Response	Poor	%	Medium	%	Rich	%	χ^2	P.Value
Farm size of HH	<1ha	41	25.3	14	8.64	-	-		
	1-1.5ha	2	1.23	71	43.8	-	-		
	1.5-2ha	-	-	3	1.85	20	12.34		
	>2ha	-	-	-	-	11	6.8		
	Total	43	26.5	88	54.3	31	19.14	236.13**	0.00

wealth status of households across Agro-ecology						
	Mid land	%	Low land	%	total	χ^2	P.Value
Poor	18	11.11	25	15.43	43		
Medium	28	17.28	60	37.04	88		
Rich	13	8.02	18	11.11	31		
Total	59	36.41	103	63.58	162	1.762**	0.414

4.2.1. Educational Status of Household Heads

From the total household's 27.2% and 45.7% could not able to read and write and could able to read and write respectively, whereas the remaining 16.7% and 10.5% of households had attended primary and secondary school respectively. In addition 1.85% and 5% of female households were not able to read and write and could able to read and write respectively. Moreover only 0.62% of female households did attended primary and secondary education. On the other hand 25.3% and 40.7% of male households could not read and write and could able to read and write respectively. Though, 16% and 10% of male respondents did attended primary and secondary education respectively. However chi-square analysis shows that there is no significant variation in education level of households among female and male households in the study area. This is because of that female and male households were found at similar and low educational status in the district.

Human resources are key component in national socio-economic planning to achieve holistic development in general and improvements of citizens' living standards specifically. In this regard education is one of those tools which are invested on human capital to influence different socio economic activities. In the study district majority of respondents could not able to read and write and large number of households who able to read and write did not attended formal educational. This signifies that, there was high illiteracy level in the district. Equally households who attend primary and secondary school education were also very small in the district (table 2). Therefore, there are many reasons for low educational level of households in the study district, like lack of school in nearby environment in the past, economic problems, lack of awareness about the advantage of education. Similarly study by Hassan (2006) in sub-Saharan Africa shows that adaptation to the climate change depends and may perhaps is a function of household educational level in

which it has a positive relationship. Lin and Yanjie (1991) in China and Gebrehiwot (2013) in Ethiopia also found that the increase of educational level raises the household's probability to get information regarding the changing climate, which thereby increases household adaptation options. As the study results of Maddison (2007) in Africa and Norris and Bati (1987) in Virginia sited on Deressa (2007) the more farmers educated, they are more likely access to information, perceive and adapt to changing climate. As a result, households with higher educational levels are most likely to adapt to existing climate change.

4.2.2. Household income sources

Crop and livestock production were the main income sources for the households' which accounts 79.63%. In

addition to crop and livestock production, small number of household's (10.5% and 10%) earns their income from nonfarm and off farm activities like selling of sand, remittance and pity trade. Furthermore the chi-square analysis was also used to test the level of significance of income earned from different income sources across agro-ecology. Accordingly the analysis result shows that there is no significant variation in income sources of households in using crop production, livestock production, and nonfarm activities and off farm activities in the study area. This is because of that crop and livestock production was the main means of income source and income generated from nonfarm and off farm activities do not have significant contribution to household income.

As KI interview and FGD results indicated that for peoples living in rural semi arid regions of Shashogo district, adaptation to climate change is difficult because of their low adaptive capacity and dependence on climate sensitive livelihood strategies. In addition households do not have permanent nonfarm livelihood strategy to adapt to climate change. Similarly as Adem and Bewket (2011) found that both crop and livestock production with small income from nonfarm activities is the main sources of livelihood to rural dwellers in Ethiopia. On their study Admassie et al. (2008) and Alliance for Green revolution in Africa (2014) also clearly found that rural communities in Ethiopia depend on agricultural activities as livelihood strategy and their activities are highly vulnerable to climate change. According to the recent studies in different parts of Ethiopia by Gebrehiwot (2013) and Gecho (2014) rural households mainly depends on rain-fed subsistence agriculture to lead their livelihoods. Likewise Cranea *et al*. (2011) found that peoples in the drier regions of Sahel, were farmers (crop and livestock producers) in their livelihoods strategies, and set to diversify their livelihood strategy to reduce climate change impacts.

4.2.3. Farm size

On this study a total of 26.5%, 54.3% and 19.14% of poor, medium and rich households with different farm size were studied. Study result indicated that 25.3% and 1.23% of poor household had farm size of less than 1hectare and 1 to 1.5 hectare respectively. While 8.64%, 43.8% and 1.85% of medium households had a farm size of less than 1hectar, 1 to 1.5 hectare and 1.5 to 2 hectare respectively. Although 12.34% and 6.8% of rich households had a farm size of 1.5 to 2 hectare and greater than 2 hectare in the study district respectively. Moreover chi-square analysis results also point out that there was significant variation in farm size of household's among different wealth category with chi-square value of 236.13 at probability (p=0.00) under different wealth status at (95%) confidence interval. Farm size had positive relationship with household's wealth status which indicated that, as farm size of household increases the wealth status also altered from poor to medium and from medium to rich. This is because of that farm size is one component of asset which determines wealth status of households in the study district as elsewhere in rural Ethiopia (table 2). This study found that farm size is an indispensable asset for rural households in the study area by which farmers entirely depend on it to produce income for their livelihood. With large farm size households could have better chance to produce relatively more because large farm size allows households to produce variety of crops on their farm land. In addition large farm land allows farmers to have better grazing lands for their livestock. Similarly study by Asfaw *et al.* (2011) in Ethiopia indicated that farm sizes clearly determine adaptation capacity of farmers. In another way farm land scarcity was one of the major problem in Ethiopia to adapt changing climate (Bryan *et al.* 2009).

4.2.5. Wealth Status of Households

The poor, medium and rich households in mid-lands of the study district were 11.11%, 8.02% and 17.28% respectively. Whereas poor, medium and rich households in low land respectively were 15.43%, 11.11% and 37.04%. In addition, to see the difference of households' wealth status across agro-ecology (mid land and low land) the chi-square analysis test was conducted. Accordingly the chi-square value was 1.76 by the probability level of (P= 0.41) at 95% confidence interval. As a result there was no significance difference observed on wealth status of households across agro ecology in the district. This is because of households in mid land and low land agro-ecological zones have similar wealth status in the study area (table 2).

However, Deressa *et al*. (2009) in Ethiopia found that there was variation of wealth status of households in different agro-ecological zones which in turn affects adaptation strategies of smallhold household's because of difference of access to resources. Consequently it resulted on various adaptive capacity and strategy preferences among households. Therefore, households' wealth status essentially determines adaptive capacity of households.

4.2.4. Households Livestock Holding in (TLU)

The results show that the mean livestock holding of poor and medium households were 4.04 and 6.88 in TLU with their respective stander deviation of 1.12 and 2.94 respectively. In addition the mean livestock holding of the rich households was 14.14 TLU with standard deviation of 4.45 (table 3). In this study TLU values indicates the positive relationships of household's livestock holding with wealth status. Accordingly there was visible difference among different wealth status of households in livestock holding in TLU which might affect households' adaptation strategies to climate change. This study found that rich households with better livestock asset in TLU have better opportunity to adapt climate change easily. This is because of households who have large livestock number in TLU adapt climate cha change by selling their livestock asset to adjust livelihood problems. Similarly the study findings by Gecho (2014) in Wolaita, south Ethiopia and Deressa *et al.* (2009) in

Nile basin areas of Ethiopia indicated that livestock holding can determine farmers' choice of climate change adaptation strategies. In the same way study results by Legesse *et al*. (2013) in west hararghe zone, Ethiopia revealed that, the number of livestock holding in TLU has positive and significant impact on the adaptation strategies of households.

Table 3: Household Livestock holding (TLU) by wealth status.

wealth status of Households

	Poor				Medium				Rich			
Livestock type	**min**	**max**	**mean**	**SD**	**min**	**max**	**mean**	**SD**	**min**	**max**	**mean**	**SD**
Ox	0	2	0.4	0.5	0	4	1.4	0.6	1	4	2.6	0.9
Cow	1	6	2.5	1.0	1	13	4.0	2.2	2	14	8.8	3.1
Calf	0	0.5	0.1	0.2	0	0.8	0.2	0.2	0	1	0.5	0.3
Sheep	0	0.5	0.0	0.1	0	0.5	0.1	0.1	0	0.7	0.2	0.2
Goat	0	1.2	0.4	0.4	0	1.2	0.5	0.4	0	1.4	0.9	0.3
Chicken	0.0	0.2	0.1	0.0	0	0.2	0.1	0.1	0.0	0.2	0.1	0.1
Donkey	0	2.1	0.5	0.4	0	1.4	0.7	0.3	0.7	2.1	1.0	0.5
Total TLU**	1.12	6.3	4.0	1.1	3.22	18.5	6.9	2.9	5.3	22.0	14.1	4.5

Note: (number of observations; poor= 43, medium =88, and rich =31.

4.3. Smallholders' Perception to Climate Change and its impacts

4.3.1. Smallholders' Perception on temperature and rainfall change

To detect the smallholder's perception on climate change in the study area, different questionnaires were used on temperature and rainfall change. Accordingly majority of smallhold farmers (87.04%) perceived that temperature of the study area was increased and about (4.94%) perceived that the temperature of the study Area was unpredictable. However 5.5% and 2.5% of the respondents indicate on no temperature related climate change, but there were increase and unpredictable nature of temperature of an area. In addition, to see the temperature change in the study area the chi-square (χ^2) analysis was applied and there was strong evidence that indicated considerable increase of the temperature with chi-square value of 11.25 by probability (P=0.00) at (95%) confidence interval. That means the today's temperature is significantly different compared to the past temperature conditions of the Shashogo district.

In addition to temperature change of an area, (81%) of households responded on decreasing nature of rainfall and (6.8%) and (4.2%) of responded on increasing and unpredictable change of rainfall conditions respectively. However 5%, 1.2% and 1.8% of respondents reported on decreasing, increasing and unpredictable but no climate change in the district respectively. Furthermore perception on the rainfall change was also tested by using chi-square statistical method. Accordingly the chi-square analysis results indicated that the today's rainfall conditions is significant different from the last two and half decades rainfall conditions with chi-square value of 8.47 and probability (P=0.01) at (95%) confidence interval. That means household perceived that the present rainfall is by far different from the past rainfall conditions (table 4).

Table 4: Perception on Temperature and Rainfall change

	Perception on climate change								
Variables	Response	No climate change	%	there is climate change	%	Total	%	χ^2	P.value
Temperature	unpredictable	4	2.5	8	4.94	12	7.4		
	increasing	9	5.5	141	87.04	150	92.6		
	Total	13	8	149	92	162	100	11.25**	0.00
Rainfall	Decreasing	8	5	131	81	139	86		
	increasing	2	1.2	11	6.8	13	8		
	Unpredictable	3	1.8	7	4.2	10	6		
	Total	13	8	149	92	162	100	8.47**	0.01
rainfall start time	No change	8	5	2	1.2	10	6.2		
	Too late	5	3	136	84	141	87		
	Too early	0	0	11	6.8	11	6.8		
	Total	13	8	149	92	162	100	75**	0.00
Rainfall erratic nature	No change	1	0.62	53	32.72	54	33.34		
	erratic	12	7.41	96	59.26	108	66.67		
	Total	13	8	149	92	162	100	4.20**	0.04

(**, significant at 5% significant level)

Moreover decreasing nature of rainfall is also agreed with meteorological data depicted on (figure 6) that

the mean annual rainfall in Shashogo district was significantly decreasing by 4.98mm per year. In addition perception on rainfall change was also consistent with decreasing trend of *Belg* (small rainy season) rainfall by 7.06mm per year in Shashogo district during the last two and half decades. However perception on rainfall conditions during the *Meher* (summer rainy season) was not consistent with the increased conditions of *Meher* rainfall by 3.73mm per year (Figure 5).

Temperature data from NMA for Shashogo district indicated that there was a temperature increase during 1989-2013 which coincide with the local climate change perceptions (Figure 3). (Anselm *et al.,* 2011) on their field work also confirmed the increase of temperature in Ethiopia as a climate change. Farmer's perception on temperature increase and rainfall decrease was also supported by focus group discussion and key informant interview. As a result of that the FGD and KI interview participants responded that the temperature is increasing and rainfall amount is decreasing and its timing was highly unpredictable.

Over the past decades, average minimum and maximum temperatures of Ethiopia have increased by around 0.25°C and 0.1°C respectively (Tadege, 2007). Study by Tessema (2013) and Deressa (2009) in eastern Ethiopia and southern Ethiopia respectively indicated the increase in temperature over the last 20 years. (IPPC, 2001) assessment report also indicated, the temperature increase in sub-Sahara regions in the last decades. Study by Nhemachena and Hassan (2007) as well reported that, most farmers in southern African countries perceived increase of temperature and that the region faced reduced rainfall together with change s in rainfall timing and high probability of droughts. World Bank report by Maddison (2006) showed that perceptions about climate change showed that a significant number of farmers in 11 African countries including Ethiopia believe that temperature has already increased and that precipitation has declined. Study by Sharka *et al,* (2013) and Hurst et *al*, 2012) in SSA also showed that, too late rainfall and early termination and Rainfall is no longer as predictable.

4.3.2. Smallholders' Perception on Drought and Flood impacts

Different climatic extreme events are affecting livelihood strategies of smallholders' in the study area. From those extreme climatic events drought and flood incidents are very common in Shashogo district. Smallholders Perception shows that 71% and 82.1% of households perceived that there were climate induced drought and flood impacts in Shashogo district respectively. As a result of that, perception of climate change was highly associated with the prevailing drought and recurrent flood impact in the study area. In addition chi-square analysis was also used to verify the association of smallholders' perception and climate related change on drought and flood impacts. Consequently, perception on drought and flood impacts was significantly correlated with prevailing climate with impacts in the district with chi-square values of (9.334 and 4.433) and probability (P=0.000) and (P=0.035) respectively at (95%) confidence interval (table 5).

Table 5: Perception on Drought and Erosion incident

perception on drought and Flood incident							
Variables	**Response**	There is no CC Incident	%	There is CC incidence	%	χ^2	P.Value
Drought incidence	There is no Drought incidents	8	5	34	21		
	There is high Drought incidents	5	3.1	115	71		
	Total	13	8	149	92	9.33**	0.00
Flood incidence	There is flood impact	9	5.6	133	82.1		
	There is no flood incident	4	2.5	16	9.9		
	Total	13	8	149	9	4.43**	0.035

(**, significant at 5% significant level)

This shows that smallholder's perception on drought and flood impacts were important evidence that shows the change of climatic conditions of the district. Similarly the study results of Tafere (2013) in eastern Tigray and Wolaita Zones revealed that community awareness on climate change is practically high and farmers were aware enough on climate change consequences of frequent drought, temperature increase, decreasing of the rainfall, change of growing period of the crops and other climatic elements in semi-arid areas of Kenya. Climate change is not new, and many societies in developing countries have adapted to climate stressors during the past centuries and farmers move to adopt the prevailing climate change in developing countries tells us their perception towards changing climate (Mertz *et al*., 2009a).

4.3.3. Local Climate change Indicators

Almost all of the respondents had lived in the area for a long period and had an insightful knowledge about the past and current climatic conditions of an area. Accordingly temperature increase (92.5%), shortening of cropping period (80.1%), rainfall unpredictability (73.3%) and highly erratic nature of rainfall (72.6%) were reported and ranked as the most important local climate change indicators in Shashogo district. Furthermore, occurrence and frequency of drought and flood (50.6%) and (58.9%) respectively were also another important climate change indicators in the study area (Figure 4). It was generally recognized that local climate change indicators considerably indicates that the climate of Shashogo district was unpredictable.

Accordingly, households had clear awareness about climate change in the study area. Household survey results, focus group discussion and key informant interview inseparably confirmed that climatic conditions of the Shashogo district were unpredictable. Such change were perceived as prolonged drought and/or unpredictable excessive rainfall often associated with destructive flood impacts which in turn affected livelihood strategies of the households.

Assessment report on persistent humanitarian problems by UNCTSO (2003) in Hadiya zone also confirm that Shashogo district was one of the area in which food shortage manifested because of environmental and climatic problems. As study by Fentie (2013) indicated that, households lost their planted crop in Shashogo district because of periodic flood impacts which was resulted from climatic change. According to Hellmuth et al. (2007) in sub Saharan Africa (SSA) climate change and unpredictable nature of rainfall is outmost challenge for the agricultural households who were already poor.

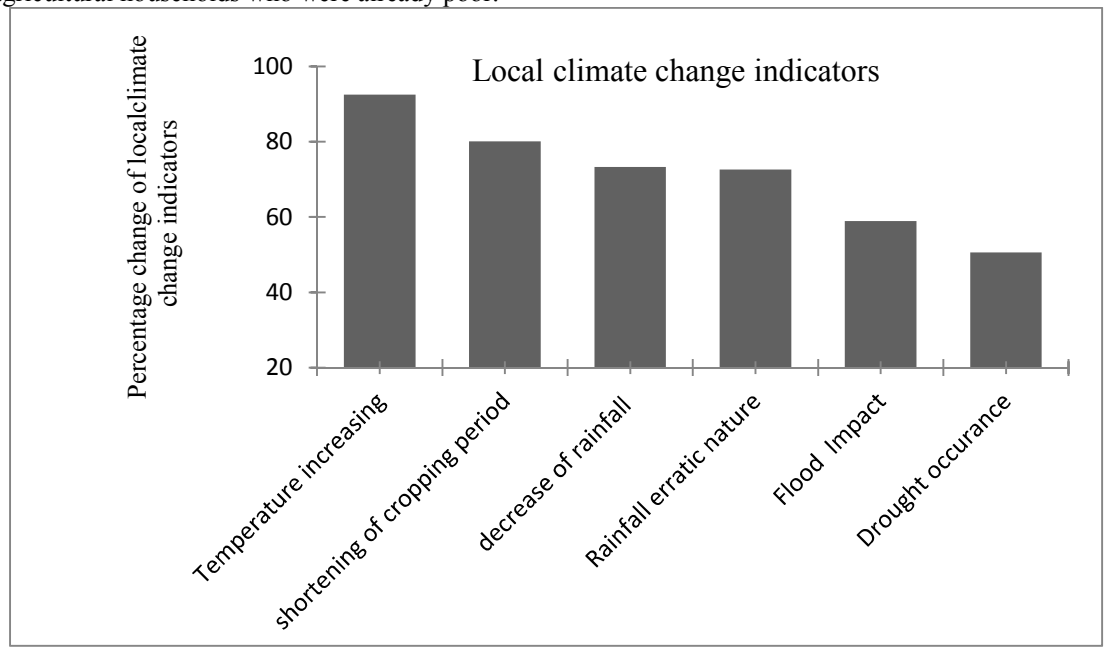

Figure 2: Proportion of Local climate change indicators

Rainfall change which resulted because of climate change affects the agricultural livelihoods and the economies of most of the African countries (Gautam, 2006). Study by Aggarwal *et al*. (2010), also evidently acknowledged various impacts of the seasonal change of rainfall in the world because its impacts are very common on the households livelihood.

4.4. Agroecology, Trends of Temperature and Rainfall

Under this section ecological characteristics and metrological data of the area were presented to see its influence on the household's livelihood strategies. Temperature and rainfall data for Shashogo district were used from Alaba meteorological station to present proximate climatic conditions of the study area. Daily rainfall and temperature data collected by the national Meteorological agency (NMA) of Ethiopian over the last 25 years (1989–2013) were used for trend analysis of temperature and rainfall of Shashogo district. Variables included on the meteorological data analysis were mean annual minimum and maximum temperature was analyzed. In addition trends and change of mean annual and seasonal rainfall conditions were analysed.

4.4.1. Ecology

Results on the (table 6) shows that 36.4% of respondents were found under midland and the remaining 63.6% of them were from low land agro-ecology. To see its influence on the households' livelihood strategies in the study area, this study used chi-square analysis. Accordingly the analysis results indicated that the chi-square value was 5.92 with the probability (P=0.05) at 95% confidence interval. This shows that there is no significant association

in agro-ecological setting and livelihood strategies in the study area. This is because of ecological setting do not resulted on significant variation of the livelihood strategies in the study area.

Table 6: Ecological variation on the household livelihood strategies

	Livelihood strategy						
Ecology	Nonfarm income	crop and livestock production	off farm activity	Total	%	χ^2	P.value
Mid land	9	41	9	59	36.4		
Low land	8	88	7	103	63.6		
Total	17	129	16	162	100	5.92	0.05

Note: (**, not significant at 5% significant level)

However (Maddison, 2006) on his study in Africa found that households in low land areas had a better probability to adopt and change livelihood strategies. This is because of that household's who live in low land areas were already experienced unpleasant climatic conditions of the low land ecological areas and they are always on adaptation move to reduce climate related impacts on their livelihood strategies.

4.4.2. Trends of temperature

Analysis of long-term temperature data indicated that, there was a significant increase in the mean annual temperature by 0.16°c per year with the year to year change of (R^2= 0.69) for the period of 1989 to 2013. In addition the mean annual maximum and minimum temperature increased by 0.097°c and 0.22°c with the year to year change of (R^2=0.79) and(R^2 = 0.54) respectively. The temperature trend analysis show that highest increase observed in the mean annual minimum temperature in the Shashogo district. This was because of high cloud cover reduced radiation and increases minimum temperature of the area. The NMA result was similar with the survey results that smallholders perception of the overall increasing of temperature in Shashogo district.

A finding of this study is also agreed with Houghton (1997) global worming brief and Lobell *et al.* (2007) climate change impact on Africa that indicated temperature increase globally and Africa which was manifested on the overall smallhold livelihood strategy and its chance of occurrence has increased during the important cropping periods.

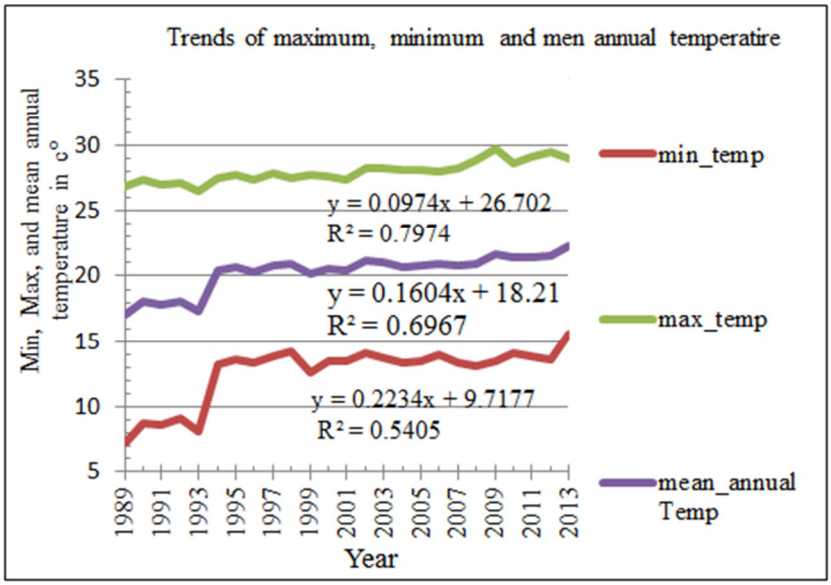

Figure 3: Trends of minimum, maximum and mean annual temperature
Source: NMA of Ethiopia, Hawassa Branch, December, 2015.

Similarly global climate change assessment of IPCC (2007) confirmed the increase of the global temperature because of increased concentration of GHGs in the atmosphere. Much of this increase is due to increase of daily minimum temperature. Increased temperature might affect the smallhold livelihood strategies negatively by increasing the risk of crop failure, reduced crop yield and reducing availability of fodder for the livestock. In the same way study by Abdul Razack Mohammed and Lee Tarpley (2011) in Texas, USA shows the impact of high temperature stress changes normal physiological process of plants.

4.4.3. Trends and Change of Rainfall

As NMA meteorological data shows that the mean annual rainfall in Shashogo district during the last 25 years was 982.9mm with its standard deviation of 156.2. The rainfall data analysis revealed that the mean annual rainfall was decreasing with 4.98mm per year with the year to year change of (R^2 =0.055) (Figure 6).

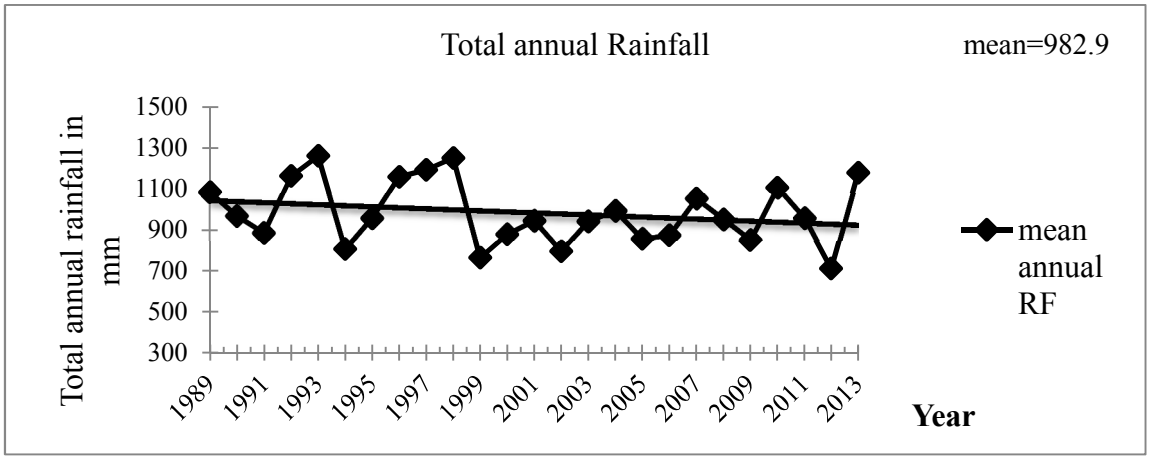

Figure 4: Trends and change of mean annual rainfall
Source: NMA of Ethiopia, Hawassa Branch, December, 2015.

4.4.3.1. Seasonal Rainfall Change

A time series rainfall data indicated that *belg* (small rainy season) which extends from February to May was decreasing and highly variable. The mean annual rainfall for *belg* season was decreasing by 7.06mm per year. In contrast to decreasing nature of *belg* season rainfall, the mean annual rainfall for the *meher* (summer season) which extends from June to September indicated an increasing trends by 3.73mm per year with its year to year change of (R^2=0.104mm) (table 7). In addition to NMA rainfall meteorological data, during the household survey and the focus group discussion, households were asked about how they perceived the general trend of rainfall on seasonal bases and they assured that the rainfall was decreasing.

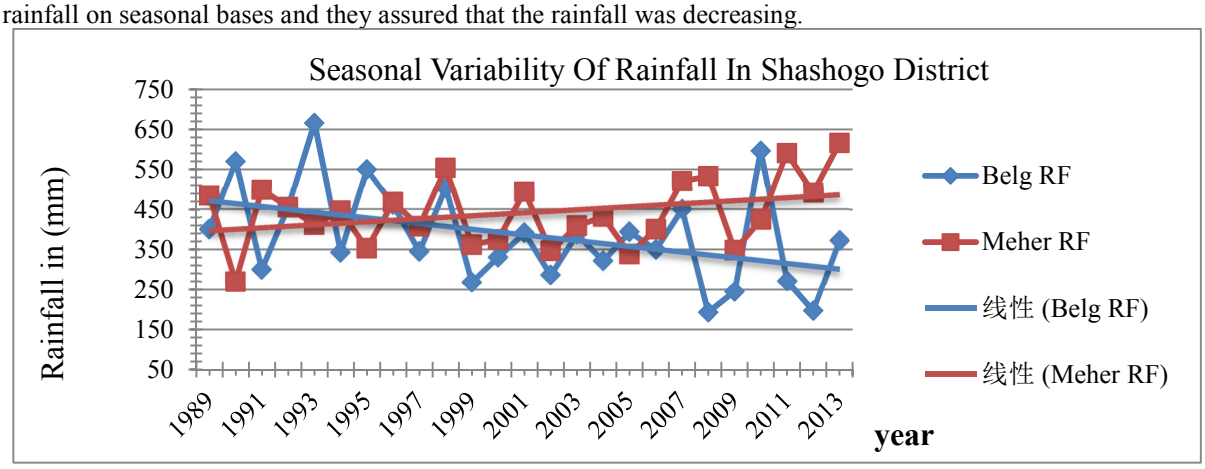

Figure 5**:** Trends and Change of Seasonal Rainfall
Source: NMA of Ethiopia, December, 2015.

Furthermore key informant interview and focus group discussers noted that, earlier trends of rainfall had been altered and the current trends also stayed mostly unpredictable. Currently rainfall is not longer falling at regular bases and this signified unpredictability in rainfall trend in the study area. (Anselm D. *et al.,* 2011) study result in Ethiopia revealed that farmers did not know about even the planting seasons of their crops. Hansen *et al;* (2004), Gautam (2006) and IPCC (2007) assessment report also signify that rainfall was highly variable and associated with frequent drought in the last decades which created poor and unreliable livelihood strategies of the households in East Africa.

4.5. Climate change Impacts on Smallholders' Livelihoods

Regarding the impacts of climate change 87.7% and 74.1 % of the respondents indicated that drought and flood respectively were the main climate change impacts severely threatening smallholds livelihood strategy in Shashogo district. In addition, food shortage and emergence of crop disease 43.2% and 28.4% respectively were reported as climate induced impacts in the study area (Figure 8). This was because of extreme climate events which affect crop production by reducing productivity; smallholders would face food shortage in the study area. Drought incident which was happening because of the early withdrawal and shortage of rainfall in the area was threatening the smallholder's livelihood. During the early withdrawal and limited rainfall conditions crops would end up its normal growth and poor productivity which in turn resulted on food shortage

In addition because of the low laying topographic nature of an area flood impact was also frequently

affecting farm lands and residential houses by causing asset damage of the smallholders. Furthermore, because of the reality of a smallholder's heavy dependence on rainfall for agricultural production in Shashogo district, climate extremes, such as drought and flood causing crop failure because of shortage of rainfall, complete damage of crops by erosion which in turn causes unreliable livelihood strategies in the area.

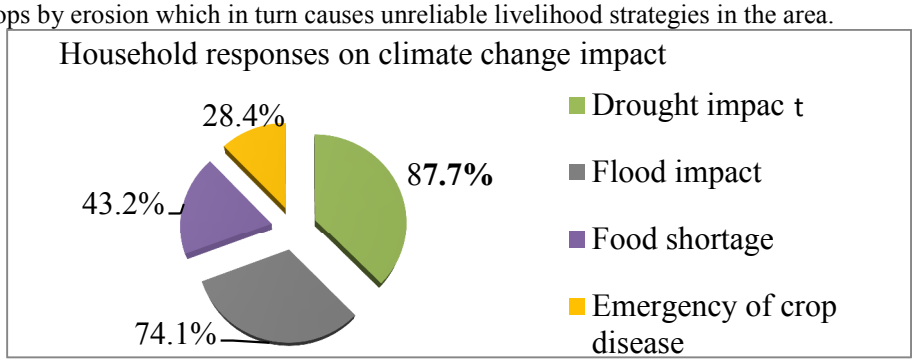

Figure 6 Proportion of household response to climate change impacts

Flood and drought impacts: the result indicates that, the problem was happening in Shashogo district causing several socio-economic problems like emergency of crop disease, incident of food shortage which let smallhold livelihood strategy at risk. Furthermore KI interview and FGD confirmed that drought and flood incidents were the recurrent problems in Shashogo district that caused loss of small hold asset and other natural resources deterioration upon which smallholds depend for their livelihood. Study by Gashaw (2013) in Shashogo district also noted that extreme flood events were increasingly frequent and severe. According to UNCTSO (2003) report, because of its geographical location, the district is one of the flood susceptible and affected areas in SNNPR's and large number of population and their assets were damaged by flood impacts during the assessment year (2002/2003). In another way study by Naumann *et al* (2013) in east Africa shows that, Ethiopia is the most affected country in the region by drought because of its geographical location and dependence on natural rainfall for agricultural production. Frequently different forms of climatic change impacts particularly temperature and rainfall change have affected agricultural systems in east Africa. Aggarwal, (2010) study in Africa confirmed that, an increase of inter-annual change caused flood and drought impacts. Furthermore UNEP (2005) signifies that drought impact was the major challenge in Africa during the period (1971-2001).

As key informant and focus group discussions, *it is difficult to think agricultural activities differently from smallholder livelihood strategies because they are entirely relied on it for their income generation. However agricultural activity is subjected to many climate change stresses. According to key informant interview and focus group discussions climate change is happening in the study area and affecting smallholder livelihood in one way or another. The main climate change impacts prevailing in the area were; Sirnekela (wilting of pepper), flooding, drought, land degradation, depletion of soil fertility and scarcity of water. In addition unpredictable nature of climatic conditions of the area is aggravating the risk of smallholder livelihood strategies which is reducing dependability of households on agriculture as a livelihood in the district. So as key informants and focus group discussers it is difficult to generalize that agriculture is effective enough to maintain smallholders' livelihood sustainably in Shashogo district.*

5.1. Conclusion

On this study households perceived that climate change is undeniable fact which is causing many impacts on the smallholder's livelihood. The household perception was also in line with trend analysis of temperature and rainfall data which verify the prevalence of climate change in Shashogo district. Furthermore local climate change also signifies the reality of climate change in the study area.

As the study results revealed that, climate change was causing multiple impacts particularly flood and drought impacts to smallholders' livelihood strategies. Regardless of its negative consequences, 87.7% and 74.1% of smallholders perceived that drought and flooding impacts respectively were the major climate change consequences. As perceived by households, food shortage 43.2% and crop disease 28.4% were also another climate change impacts on smallholder's livelihood strategies in the study area.

REFERENCE

Intergovernmental panel on climate change (IPCC). 2007. Climate Change 2007: Synthesis Report, Geneva Switzerland.

Intergovernmental panel on climate change (IPCC). 2012. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. Special Report of the Intergovernmental Panel on Climate Change (IPCC), Geneva, Switzerland.

United Nations Environmental program (UNEP). 2005. People Affected by Natural Disasters during the Period 1971–2001. UNEP report.

Etheridge, D.M., Steele, L.P., Langenfelds, R.L., Francey, R.J., Barnola, J.M. and Morgan, V.I. 2002. Natural and Anthropogenic Changes in Atmospheric Co2 over the last 1000 Years from Air in Antarctic Ice and Firn. *Geography of physical Research.*

National Research Council. 2010. Advancing the Science of Climate Change. NRC Report in Brief. *National Academies Press*, Washington, D. C.

Inter-governmental panel of climate change (IPCC). 2014. Climate change 2014: IPCC synthesis report, Cambridge university press, United Kingdom and New York, USA.

Rachel, S., Leo, P., Eva, L. and David B. 2007. Climate change, agricultural policy and poverty reduction: How much do we know? Natural resource perspectives. Overseas Development Institute (ODI).

Stern, N. 2006. 'Stern Review on the Economics of Climate Change', UK. London.

Mertz, O., Halsnæs, K., Olesen, J.E. and Rasmussen, K. 2009a. Adaptation to Climate Change in Developing Countries. *Environmental Management*, 43:743 – 752.

Regional Early Warning Response & Food Security (REWRFS). 2011. Seasonal Emergency Needs Assessment Report, SNNPR, Awassa.

Gashaw, F. 2013. Investigation of the effects of flooding on households' food availability and coping strategies. The case of Shashego district SNNPR Ethiopia. M.Sc thesis. College of Agriculture and Environmental Sciences, University of Bahir Dar, Ethiopia.

Greene, Wh. 2000. *Econometric Analysis*. Fourth Edition, Upper Saddle River, Prentice Hall, N.J.

Gbetibouo, B., Elizabeth, B.A., Deressa, T.T., Glwadys, A. and Claudia, R. 2009. An Adaptation to Climate Change in Ethiopia and South Africa. *Environmental science and Polivy*, 12:413 – 426.

Gebrehiwot, T. and Anne, V.d.V. 2013. Farm level adaptation to climate change: The Case of Farmer's in the Ethiopian Highlands. *Environmental Management,* 52:29–44.

Abaje, I.B. and Ishaya, S. 2008. Indigenous people's perception of climate change and adaptation strategies in Jema's local government area of Kaduna state, Nigeria. *Journal of Geographical and Regional Planning* 1:138–143.

Adesina, A.A. and Baidu, F. J. 1995. Farmers' perceptions and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea. West Africa, *Journal of Agricultural Economics* 13:1–9

Asfaw, A. and Admassie, A. 2004. The role of education on the adoption of chemical fertilizer under different socioeconomic environments in Ethiopia. *Journal of Agricultural Economics,* 30 (3): 215-228.

Wolf, J., Allice, I. and Bell, J. 2013. Values, climate change and implications for adaptation. Evidence from two communities in Labrador, Canada. *Global Environmental Change,* 23(2):548-562.

Jones, R.N. and Boyd, L.P. 2011. Adaptation and risk management. *Wiley Interdisciplinary Reviews, Climate Change,* (2): 296-308.

Central statistic Authority (CSA). 2007. Population and Housing Census of Ethiopia. CSA report.

Anley, Y., Bogale, A. and Haile, G. A. 2007. Adoption decision and use of intensity of soil and water conservation measures by smallholder subsistence farmers in Dedo district, Western Ethiopia. *Land Degrad Dev,* 18:289–302.

Nyangena, W. 2007. Social determinants of soil and water conservation in rural Kenya. *Environ Dev Sustain*, 10(6):745–767.

Croppenstedt, A., Demeke, M. and Meschi. M. 2003. Technology Adoption in the Presence of Constraints: The Case of Fertilizer Demand in Ethiopia. *Review of Development Economics*, 7(1): 58-70.

Nhemachena, C. and Hassan, R. 2007. Micro-Level Analysis of Farmers' Adaptation to Climate Change in Southern Africa. International Food Policy Research Institute (IFPRI), *Agricultural Economics*, Discussion Paper, No. 714, Washington, DC: 21:

Deressa, T.T., Hassan, R.M., Ringler, C., Alemu, T. and Yesuf, M. 2009. Determinants of farmers' choice of adaptation methods to climate change in the Nile basin of Ethiopia. *Glob Environ Change*, 19:248–255.

Tafere, M., Olivier, J., and Jordaan, M. 2013. Climate Change Adaptation, Opportunities and Challenges from Two Communities in Ethiopia', *Journal of Environment and Earth Science,* 2 (12).

Awraris, G. M. 2012. The impact of climate change and adaptation through agro ecological farming practices: A case study of the Konso area in Ethiopia.

Lin, N. and Yanjie, B. 1991. Getting Ahead in Urban China. *Journal of Sociology,* 97(3):657-688

Maddison, D. 2006. The perception of and adaptation to climate change in Africa', Discussion Paper No. 10, *Centre for Environmental Economics and Policy in Africa (CEEPA),* University of Pretoria, Pretoria, South Africa.

Adem, A. and Bewket, W. 2011. A Climate Change Country Assessment Report for Ethiopia: Submitted to Forum for Environment. *Epsilon International* R&D, Addis Ababa, Ethiopia.

Admassie, A., Adenew, B. and Tadege, A. 2008. Perceptions of Stakeholders on Climate Change and Adaptation Strategies in Ethiopia, *EEA Research Report,* Addis Ababa: Ethiopian Economic Association

Gecho, Y., Ayele, G., Lemma, T. and Alemu, D. 2014. Rural Household Livelihood Strategies Options and Determinants: in the Case of Wolaita Zone, Southern Ethiopia, *Journal of Social Sciences,* 3(3): 92-104.

Cranea, T.A., Roncolib, C. and Hoogenboomb, G. 2011. Adaptation to climate change and climate variability: The importance of understanding agriculture as performance.

Asfaw, S., Shiferaw, B., Simtowe, F. and Haile M. 2011. Agricultural Technology Adoption, Seed Access Constraints and Commercialization In Ethiopia. *Journal of Development and Agricultural Economics,* 3(9): 436–447.

Bryan, B.A., Kandulu, J., Deere, D.A., White, M., Frizenschaf, J. and Crossman, N.D. 2009. Adaptive management for mitigating Cryptosporidium risk in source water: A case study in an agricultural catchment in South Australia. *Journal of Environmental Management,* 90(10): 3122–3134.

Intergovernmental panel on climate change (IPCC). 2001. Climate Change 2001: Impacts, Adaptation and Vulnerability, Cambridge University Press, Cambridge, UK.

Tadege, A. 2007. Climate Change National Adaptation Programme of Action (NAPA). National Meteorological Agency (NMA) of Ethiopia, Addis Ababa, Ethiopia.

Tessema, Y.A., Chanyalew, S.A. and Getachew, S.E. 2013. Understanding the process of adaptation to climate change by small-holder farmers. The case of east Hararghe Zone, Ethiopia. *Agricultural and Food Economics*, 1:13.

Hurst, M., Jensen, N., Pedersen, S., Sharma, A. and Zambriski, J. 2012. Changing climate adaptation strategies of Boran pastoralists in southern Ethiopia. CGIAR Research Program on Climate Change, Agriculture and Food Security, (CCAFS), *Working paper No. 15,* Cali, Colombia.

United Nations country team support office (UNCTSO). 2003. Persisting humanitarian problems in SNNPR. The cases of Hadiya, kambata-tambaro, dawuro, gurage, and silte zones and Alaba special districts. Field report, SNNPR No. 7. Awassa.

Hellmuth, M.E., Moorhead, A., Thomson, M.C. and Williams, J. 2007. Climate risk management in Africa: Learning from practice. International Research Institute for Climate and Society (IRI), Columbia University, New York, USA.

Aggarwal, P.K., Baetheganb, W.E., Cooperc, P., Gommesd, R., Lee, B., Meinkef, H., Rathoreg L.S. and Sivakumarh, M.V.K. 2010. Managing Climatic Risks to Combat Land Degradation and Enhance Food Security. Key Information Needs.

Gautam, M. 2006. Managing Drought in Sub-Saharan Africa. policy perspectives. Economic Conse-quences and Policies for Mitigation, at the Gold Coast, Queensland, and Australia, Invited Paper Prepared for a Panel Session on Drought: IAAE Conference, 12–18th, August.

Houghton, J. 1997. *Global Warming: The Complete Briefing*. 2nd Ed. Cambridge University, London.

Lobell D. and Field, C. 2007. Global Scale Climate, Crop Yield Relationships and the Impact of Recent warming. Environmental Research Letter. IOP Publishing Ltd. UK.

Hansen, J.W., Dilley, M., Goddard, L., Ebrahimian, E. and Ericksen, P. 2004. Climate Variability and the Millennium Development Goal: Hunger Target. IRI Technical Report, No. 04-04.

Naumann, G., Barbosa, P., Garrote., Iglesias, A., and Vogt,J. 2013. Exploring drought vulnerability in Africa. An indicator based analysis to inform early warning systems, *Hydrol.EarthSyst.Sci.Discuss*.10:12217–12254.

United Nations Environmental program (UNEP). 2005. People Affected by Natural Disasters during the Period 1971–2001. UNEP report.