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Research Article

HOW CLIMATE CHANGE AFFECTS THE LIVELIHOOD OF RURAL HOUSEHOLDS? AN EXPLORATORY STUDY

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Abstract: *Ethiopia is one of the least developed countries in the world and affected by climatic extremes such as floods and droughts. Such events are having a negative impact on livelihoods, especially poor. The main focus of this paper is to assess the effects of climate change on rural households' livelihood particularly to assess the pattern of rainfall and temperature for three decades, to identify the factors determine the livelihood and to assess the coping strategies used by rural households. To achieve the objectives, relevant data were collected from 100 rural households from three sample villages identified through stratified sampling technique based on the agro-ecologic condition. The collected data were analysed using* descriptive and inferential statistics through *SPSS (version 23). The findings reveal that some elements of climate (temperature and rainfall) show inter annual and seasonal variability with increasing trend. The main source of income of the respondents is rain fed agriculture (62%) which is being adversely affected by unpredictable and decreasing rainfall, flood and high temperature etc. Al so women, children, elders, poor and landless were most vulnerable to the climate change. In response to this, farmers are practicing long aged coping mechanisms and adaptation strategies along with government interventions. It is recommended that increasing awareness among farmers on method of using agricultural technologies, restoring the degraded land, facilitating access to credit, diversifying source of income, building the capacity of farmers & encouraging community based adaptation strategies as the main livelihood enhancement approaches.*

***Key words**: Climate change, Livelihood, Coping mechanisms, Adaptation strategies*

Introduction

Africa has been identified as one of the continents most susceptible to the climate change such as floods and droughts. The reasons are the exposure of its population to climate variations, people's dependency on natural resources and the underdevelopment. Due to the degraded environment, food insecurity, poverty and HIV/AIDS already affected large parts of Africa (Jones and Rahman, 2007). Food and Agricultural Organization (2014) reported that food crisis has tripled in the last three decades. Agricultural production in many African countries is severely compromised where yield from rain-fed agriculture is reduced by up to 50 per cent (IPCC, 2014). Average yields of key staple crops including maize, rice, teff and wheat are projected to fall between 5 - 20 per cent by 2050 as a result of climate change. Study shows that climate change and variability have brought substantial welfare loss especially for smallholder farmers (Komba and Muchapondwa, 2018).

Ethiopia is one of the Sub-Saharan African countries dominated by subsistence farmers with less than two hectares of land (ATA, 2014). The transformation towards manufacturing and

industry oriented economy is underway. The success is determined by the productivity of smallholder farmers that account 95 per cent of the national agricultural output where 75 per cent is consumed at household level (World Bank, 2006). Agriculture is heavily dependents on rainfall, while irrigation accounts for less than 1 per cent of the total cultivated land (Di Falco et al, 2012). Agriculture is expected to play a key role in ensuring food security and overall economic development, its performance is constrained due to degradation, unreliable weather conditions and underdeveloped technology. The country's agricultural production has increased but per capita cereal yield remains stagnant (World Bank, 2010). About 16 major droughts occurred since 1980s and recently in 2015 and 2017, about 10 to 50 million people critically challenged (Alemu and Mengistu, 2019). Erosion has severely degraded 50 per cent of the highlands and reducing annual land productivity by 2 per cent (Kebede and Mesele, 2014).

High degradation, climate change/variability, decrease in grazing land and increasing food and energy demand as a result of ever-increasing population are considered as some of the development challenges in Ethiopia. The susceptibility of the country is aggravated by poor agricultural and livestock practices, a fragile and degraded natural environment, extensive poverty, limited transport and communication infrastructure, inefficient markets, changing climatic conditions, high population growth, lack of good governance, competition over scarce resources and border issues.

Shashogo district is one of the agricultural surplus producer areas and the farmers in the district practice mixed farming. Nowadays, it is characterized by fragile natural resource base, shortage of farming land and speedy deforestation which resulted in high land degradation. Since recent past, farmers were facing adverse impact of climate change on livelihood like decrease of crop and livestock production and change in the cropping pattern. So far research on cclimate change effects on households' livelihood is very limited and most of them focusedd on policy responses to climate change leaving the adaptation strategies and this study filled the gap.

Objectives

- To analyse the pattern of rainfall and temperature for the last three decades in the study area.
- To understand the causes of climate change in the study area
- To examine the effects of climate change on the livelihood of rural households.
- To identify the factors determine the livelihood of households in the study area.
- To assess the coping strategies used by the rural households due to climate change.

Methodology Adopted

To achieve the objectives, cross-sectional survey design and mixed research approaches with quantitative and qualitative methods were used. Primary data was collected from the sample respondents through face to face interview using semi-structured interview schedule. Secondary data regarding rainfall trends and temperature for three decades was collected from National Meteorological Services Agency of Ethiopia. To select the district, sample villages and households, multistage sampling procedure was followed. At the first stage, Shashogo district was selected purposely since it is prone/vulnerable to climate change. At the second stage, 36 villages in the district were stratified under three agro-ecological zones such as mid altitude, low altitude and high altitude. From each zone, one village was selected randomly as the sample study area. There are 3620 rural households are available in the selected three sample villages. To determine the sample size, the formula proposed by Singh (2007) $n = p(1-p)/SE^2$ was used with 95% confidence level. The arrived 100 sample households were distributed proportional to the villages and identified through simple random sampling. The collected data were analyzed using descriptive statistics (mean, frequencies, percentages) and inferential statistics (chi-square test, t-test and Bi-variant logistic regression and Mann-kendel trend test) through SPSS (version 23).

Model specification (Logit Model)

Choosing the appropriate statistical model was determined by the characteristics of variables that the researcher proposed to investigate. Typically, liner regression analysis model was widely used in most economic and investigation because of the availability of simple computer packages as well as the ease of interpreting the results. This data analysis was used to examine the effects climate changes on rural household livelihoods. According to Gujurati (1995), the functional formula of the Logistic regression model is presented as follows:

The logistic regression model is econometrically specified as Pidonates used to show the probability of the effects of explanatory variables on rural HH livelihood as:

Yi= 1 where exp (*Zi*) stands for the irrational number *e* to the power of *Zi.* For general logit model the following logistic regression equation has been used. The model is written as

$$P(i) = \frac{1}{1+e^{-Z(i)}} \quad \ldots\ldots (1)$$

The model also written as

$$\text{But } (1-Pi) = \frac{1}{1+e^{Z(i)}} \quad \ldots\ldots (2)$$

In fact, Zi is a linear function of *m* explanatory variables (*Xi*) and is specified as:

$Zi = \beta o + \beta 1X1 + \beta 2 X2 + \ldots\ldots\ldots\ldots + \beta mXm$ …… (3)

ß0 =is the intercept/constant and ß1, ß2.....ßm =logit parameters (slopes coefficient) to be estimated

The slope tells how the log-odds in favor of the HH livelihood as independent variables change by a unit.

Therefore, $\frac{pi}{1-pi} = \frac{1+e^{Z(i)}}{1+e^{-Z(i)}} = e^{Z(i)}$ …… (4)

The stimulus index Zi is also referred to as the log of the odds ratio in favor of Livelihood. The odds to be used can be defined as the ratios of the probability climate on HH livelihood (*Pi*) to the probability that is not (1-*Pi*).

$\frac{pi}{1-pi} = \frac{1+e^{Z(i)}}{1+e^{-Z(i)}} = e^{\beta o} + \sum_{i=1}^{m} Bixi$…… (5)

Taking the natural logarithms of the odds ratio of equation (5) was result in what is known as the logit model as indicated below:

$\ln\left(\frac{pi}{1-pi}\right) = \ln\left(e^{\beta o} + \sum_{i=1}^{m} \beta ixi\right) = Z(i)$…… (6)

If the disturbance or error term ε *is* taken into account, the logit model becomes:

$Z(i) = \beta o + \sum \beta iXi + \varepsilon$…… (7)

Dependent variable Livelihood i.e. positive and negative effects, $\beta o =$ constant Xi = determinants on rural HH livelihoods, βi = coefficients, ε = error term.

The model is estimated using the iterative Maximum Likelihood Estimation (MLE) procedure. MLE is concerned with picking parameter estimates that imply the highest probability or likelihood of having obtained the observed data. This estimation procedure yields unbiased, efficient and constant parameter estimation.

Results and Discussion

Rainfall and Temperature Pattern in the study District

Rainfall Pattern: Rainfall and temperature are important meteorological variables that determine water availability, production of crops and livestock rearing in countries where agriculture is more dependents on rainfall. The average annual rain fall in the years 1989-2019, ranges from 840mm to 1680mm. The mean annual rain fall was about 1187mm.

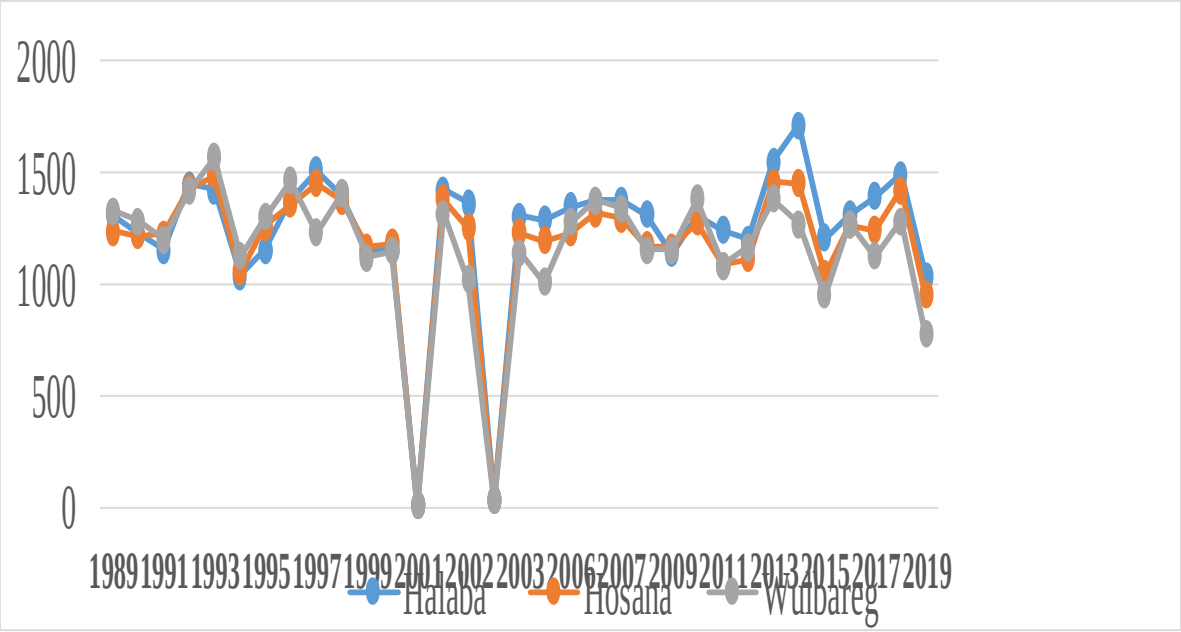

Figure 1: Mean Annual rainfall

As shown in the Figure 1, the rain fall of the district has shown inter annual variability and erratic over the past 30 years. This variability has also been indicated as a major problem for crop production. The driest year was 2010, with minimum rain fall and the wettest years were 2005-2007. Annual rain fall was below average during the years 1989 - 2019 and the district had been suffering from shortage of rainfall in the above thirteen years, while the remaining years demonstrated heavy and erratic rainfall. This is also supplemented by the focus group discussion (FGD) participants.

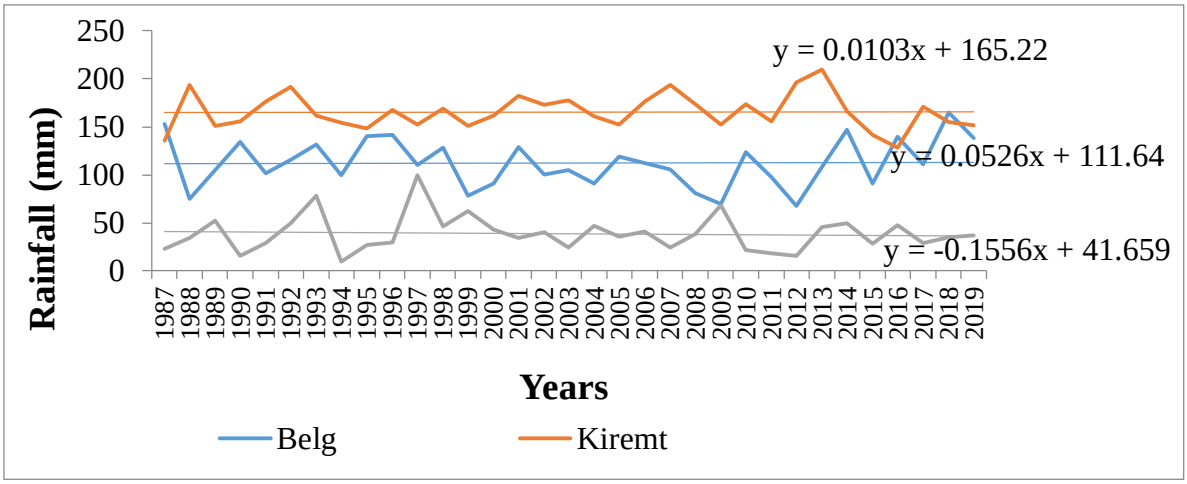

Figure 2: Average annual seasonal rainfall for last 30 years

Temperature Pattern: Climate models suggest that Ethiopia will be seen further warming in all seasons between 7°C and 23°C during 2020's and between 14°C and 29°C by 2050s (Astawsegn, 2014). The mean maximum temperature for the last thirty years ranged between

21.5 –24.2^{0}C and the mean minimum temperature ranged between 10-19.5^{0}C. The trend of temperature was increasing by minimum 2^{0}C-3^{0}C (Figure 3), this indicates that for last 30 years the area under study was affected by climatic variability which is also supported by FGD and household survey.

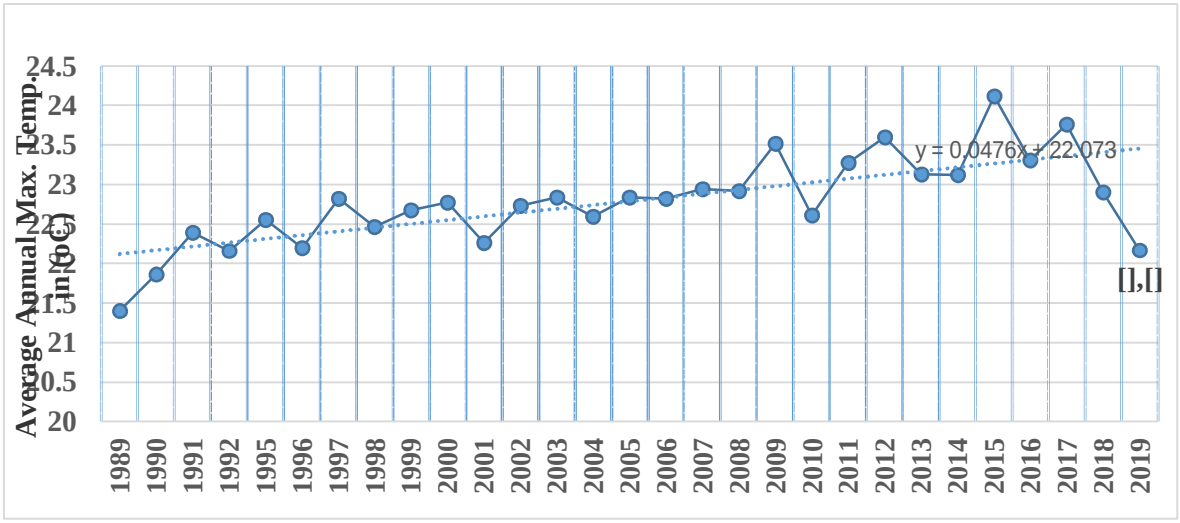

Figure 3: Average Maximum Temperature

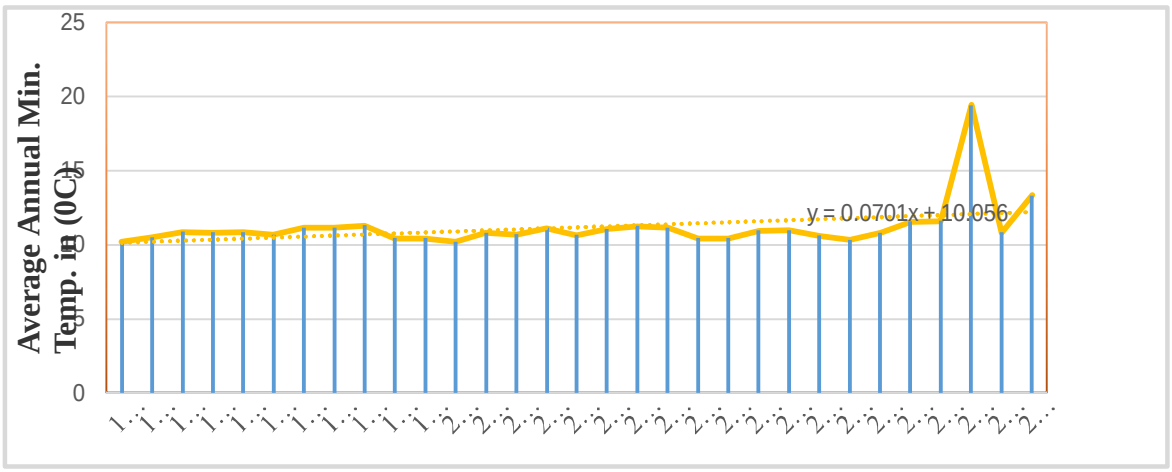

Figure 4: Average Minimum Temperature

Means of Livelihoods in the study area

Livelihood activities are the means of income for the people/community. People require a range of livelihood assets to achieve positive livelihood outcomes. Livelihood resources are the building blocks that determine livelihood activities and strategies. Since, the study area is dominated by subsistence agriculture which is the major determinant of livelihood. For the livelihood situation assessment and investigation, assets are the entry points (Devereux et al, 2003).

Table 1: Means of Livelihoods among the Respondents

Means of Livelihood		Frequency	Percent	X^2-*value*	*p-value*
1	Livestock Rearing	07	07	19.17	.004
2	Rent out land	16	16		
3	Agriculture	62	62		
4	Daily laborer	04	04		
5	Petty trade	04	04		
6	Remittance	05	05		
7	Others (Bee keeping, hand craft)	02	02		
	Total	*100*	*100*		

According to the respondents, majority (62%) dependents on agriculture/crop production, 16 per cent depends on land renting, 7 per cent engages in livestock rearing, the remaining depends on off-farm activities. The Chi-square test confirms that there is significant association between climate change and rural households' livelihood at 0.05 (P=.004) confidence level . This means, agricultural production is considered as the main source of income. Non-farm/off-farm livelihood activities are vital to supplement the income, but few sample households are engaged.

Landholding by the Respondents

Land is one of the most significant factors of agricultural production. As in most of the highlands of the country the landholding by the farmers is very small (Meskerm Abi, 2011). The average land holding size has been decreasing and is estimated as 0.5 hectares. Respondents reported that population pressure, poor land management practices, removal of vegetation and land degradation are the major causes for the reduction of farm lands. Results show that, 94 per cent of respondents has access to land for agricultural use. Moreover, majority (60%) of the respondents owned 0.25-0.5 hectares and 19 per cent have 0.75-1 hectares of farmland. FGD participants noted that the area is characterized by very small and highly fragmented landholdings.

Livestock Possession by the Respondents

Livestock contributes in several ways such as serving as a source of food, manure, income, transportation and traction power (Astawsegn Zeleke, 2013). Similar to land holding, size of livestock highly determine the income of households and who have large number of livestock, maintain better social credibility and status even at times of shock. Majority (94%) of the respondents owned different types of livestock but the productivity is very low due to

the shortage of forage, poor health services, poor breeds, poor management and marketing problems.

Respondents' experience on Climate Change

Awareness about the climate change is essential to take appropriate steps to hope up with the situation. Hence an assessment was made to understand the respondents' knowledge about the climate change for the last 20-30 years. The results indicate that 88 per cent respondents experienced climate change and the remaining (12%) not faced such experience. The focus group participants also endorsed the opinion of the respondents that ecological changes had happened in the district.

Climate Related Shocks in the Study Area

As shown in table 2, the respondents experienced different types of shocks due to the climate change in the study area. They are recurrent drought by 62 per cent of the respondents followed by erratic rainfall by 80 per cent, pest and disease for both human and animal by 53 per cent, rainfall variability by 56 per cent and occurrence of flood by 29 per cent.

Table 2: Climate Related Shocks

Types of Shocks		Frequency	Percent
1	Recurrent Drought	62	62.0
2	Erratic Rain Fall	80	80.0
3	Crop Pest and Disease (Human & animal)	53	53.0
4	Rain Fall Variability	56	56.0
5	Flood	29	29.0

Causes of Climate Change in the study area

The National Adaptation Program of Action of Ethiopia has identified the causes for climate variability and change. They are high dependence on rain fed agriculture, underdevelopment of water resources, low health service coverage, high population growth rate, low economic development, low adaptive capacity, inadequate road infrastructure in drought prone areas, weak institutions, lack of awareness, etc. In terms of livelihood approach, smallholder rain-fed farmers and pastorals are found to be the most vulnerable (UNDP, 2012).

Biophysical factors: The major biophysical problems identified by households are erratic rainfall, recurrent drought, poor soil fertility, deforestation, soil erosion, frost attack, water logging, livestock disease prevalence, as well as crop pests and diseases. Poor soil fertility, soil erosion, deforestation and rainfall shortage are the most dominant bio-physical factors making the rank from one to four in constraining livelihoods. Soil erosion or poor soil fertility are the causes for decline in crop production by 72 per cent of households. The root

cause for soil erosion is removal of natural vegetation or deforestation. It is understood from the survey, 87 per cent of the respondents reported land degradation, 65 per cent deforestation, 43 per cent loss of bio diversity, 35 per cent water and air pollution and 28 per cent reported as recurrent rainfall/ flooding are the causes of climate change.

Infrastructure and Social Factors: Access to infrastructure such as market center and roads promote livelihood diversification and agricultural intensification. Sufficient transport facilities, especially main and feeder roads that improve access to farm input and agricultural implements enhance agricultural production and productivity. According to the respondents, main causes of climate change were lack of awareness (48%) about environmental conservation and weak social capital/assets (48%).

Economic factors: The economic status has a significant role in empowering households to access income/livelihood either through production or purchase from market. The extent to which a household earns cash income matters a lot in improving agricultural activities and ensure environmental balance. The limited non cash income obtained from off farm activities like petty trade, sale of crafts, credits obtained either from private money lenders or institutions and income obtained from casual labor are limited to satisfy the cash demand. 10 per cent of the respondents reported that non accessibility of rural credit service is the root cause for climate change and 18 per cent reported that lack of accessibility of market.

Table 3: Causes of Climate Change

Causes		Frequency	Percent	t-test	P value
1	Land Degradation	87	87	15.636	.000
2	Soil Erosion/Poor soil fertility	72	72		
3	Deforestation/Desertification	65	65		
4	Loss of Biodiversity	43	43		
5	Recurrent drought / Flood	28	28		
6	Water and Air Pollution	35	35		
7	Lack of Awareness about Environmental Conservation	48	48		
8	Weak Social Capital/Assets	41	41		
9	Lack of credit service	10	10		
9	Not able to cope up the shocks	51	51		
10	Poor Administration and Management skill	21	21		
11	Poor Market accessibility	18			
12	Insufficient Technology/Infrastructure	39	39		

Institutional factors: Institutional factors identified by the households are weak extension service, weak rural organization and weak market for output. The attempts made to strengthen social ties; assist the farmers' knowledge, skill and information transfer; input

provision and self-help at times of production shortfalls and economic burden are poor. Respondents expressed that, rural organizations like farmers' service cooperatives are not well organized and even the organized one are not functional. According to the survey, poor administration and management skill reported by 20 per cent, insufficient technology/infrastructure by 39 per cent and cope the shocks easily by 51 per cent of the respondents. The t-test confirms that there is significant association between climate change and various causes at 0.05 (P=.000) significant level.

Effects of Climate Change on Rural Households' Livelihood

Climate change is probable to impact crop productivity directly but also indirectly through shifts in the geography and prevalence of agricultural pests and diseases, associated impacts on soil fertility and biological function, and associated agricultural biodiversity. The rain fed yield changes are driven by both precipitation and temperature changes; the irrigated yield effects are from temperature changes alone. As IPCC (2007) concluded, slight warming decreases yields in seasonally dry and low-latitude regions. Climate variability affects virtually all aspects of agricultural and other water-intensive activities and has impact on a large proportion of households.

Challenges of climate change on Households' Livelihood

Climatic change, natural calamities and population increase also have a tremendous impact on the livelihood. In a country like Ethiopia, fixed area of arable land is divided among many people eventually shrinking to a point where people can no longer depend on it to feed themselves.

Table 4*:* Challenges of climate change on Households' Livelihood

Major Challenges		Frequency	Percent
1	Shortage of Pasture Land	34	34.0
2	Loss of Livestock	58	58.0
3	Crop Yield Reduction	70	70.0
4	Flood	26	26.0
5	Drought	42	42.0

The shrinking of the land size per household can result in land degradation, deforestation, and increased rural poverty. Deforestation in turn, results in climate change and natural calamities, which include erratic rainfall, famine and soil erosion (Daniel Tesfaye, 2002). According to the results, 70 per cent of the sample households faced crop yield reduction, 58

per cent faced loss of livestock, 42 per cent experienced drought, 34 per cent faced shortages of pasture land and 26 per cent experienced flood.

4.6.2 Effects of climate change on water availability

Many countries of Africa are expected to be vulnerable to the impact of global climate change and sustainable water supply is a major challenge. The study also traced out the state of water sources in relation to climatic change. Accordingly, majority of the respondents (88%) reported that there were challenges of pure water. Households taking the water from pipe lines, women and children travel long distance to fetch water. Moreover, 44 per cent of sample gets water from pipe lines, 22 per cent from ponds, 20 per cent from unprotected springs, 10 per cent from protected springs and the remaining (2%) from river. This implies that most of the households are suffering from shortage of water.

Table 5: Sources of Water

Source of Water		Frequency	Percent
1	River	02	2.0
2	Ponds	22	22.0
3	Protected spring	10	10.0
4	Unprotected spring	20	20.0
5	Pipe lines	44	44.0
6	Dams water	02	2.0
	Total	*100*	*100.0*

Effects of Climate Change on Crop Yield

According to government (2011) study, by 2020 in Ethiopia, the yields from agriculture could fall by 50 per cent because of the adverse effects of climate change like rise in temperature, drought, flood, erratic rainfall and others. Climate change has been recognized by different researchers as having potentially severe impacts on livelihood and development. Being a developing country, Ethiopia's agriculture contributes about 42–45 per cent to its gross domestic product, employs more than 80 per cent of the population and generates more than 85 per cent of foreign exchange earnings. Survey results show that overwhelming number (73%) of the respondents reported the effects of climate change as a major cause for crop yield reduction while 5 per cent responded that there is an increase in crop yield. As shown on Table 6, the yield of major crops indicates fluctuating growth in spite of increasing cultivation are from year to year.

Table 6: Effects of Climate change on crop yield

Effects of Climate change on the crop yield		Frequency	Percent
1	Decrease crop yield	73	73.0
2	Increase in crop yield	5	5.0
3	No change in production	16	16.0
4	Decrease of long cycle crops	06	6.0
	Total	*100*	*100.0*

Change in Livestock possession between 2015-2020 years

Livestock plays a crucial role in supporting households in times of food shortfalls; however, the number of livestock owned per household dramatically declined during 2015-2020. That is cow (426 to144), oxen (279 to 124), donkey (179 to 92), horses (126 to 34), sheep (262 to 92) and goats (331 to 124). This is due to the shortage of grazing lands, lack of sufficient water, prevalence of animal disease and people sell the small and old animals during shocks to purchase food. The resource base such as farmland, grazing land and forests have reached their critical stage of degradation, and is the main cause for the decline of livestock.

Table 7: Change in Livestock possession between 2015-2020 years

S.N	Livestock types	Year	No.	Minimum	Maximum	Sum	Mean	Std. deviation
1	Cow	2015	94	01	10	426.00	4.53	2.308
		2020	94	01	05	144.00	1.53	1.207
2	Oxen	2015	94	01	08	279.00	2.97	1.846
		2020	94	01	03	124.00	1.32	.918
3	Donkey	2015	94	01	06	179.00	1.90	1.46
		2020	94	01	04	92.00	.98	.971
4	Horses	2015	94	01	06	126.00	1.34	1.751
		2020	94	01	02	34.00	.36	.686
5	Sheep	2015	94	01	10	262.00	2.79	2.425
		2020	94	01	07	92.00	.98	1.593
6	Goats	2015	94	01	10	331.00	3.52	2.925
		2020	94	01	07	124.00	1.32	1.773

Effects climate change on Vulnerability of Households

According to FAO (2010), the rising of temperature and variation of rainfall have direct effect on crop yields. Price fluctuation is one of the indicators that show the effect of climate change on agriculture. The primary effect of climate change on human welfare is the change in calorie availability and an increasing number of malnourished children. Climate change

likely to affects either food price or production and nutritional security, hence income disparities and vulnerable to food insecurity (Keulen et al, 1998). According to vast majority (89%) of the respondents, climate change as a major cause for shortage of water, food shortage (79%), adverse effect on drought (67%) and increase the price of commodities (56%).

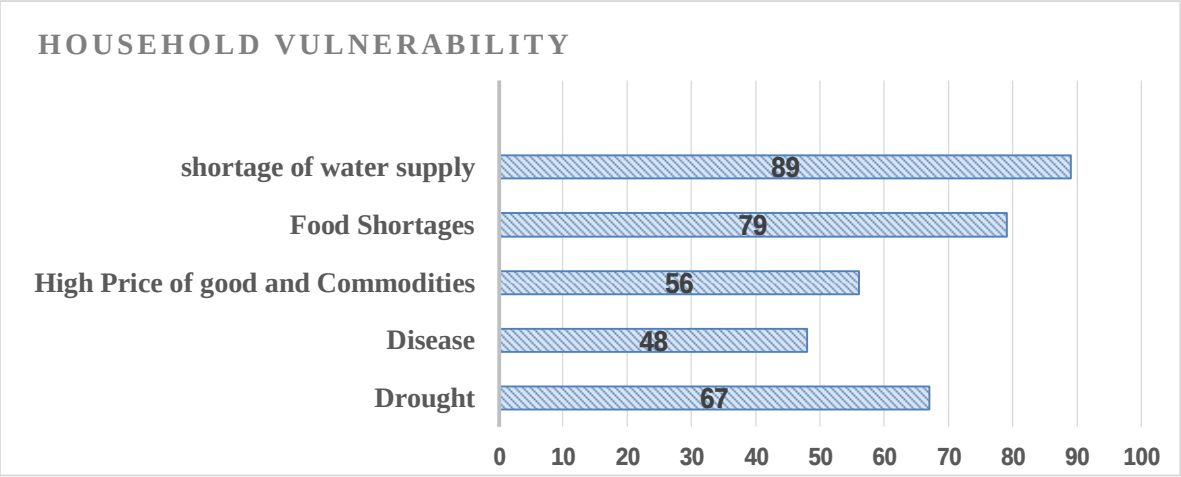

Figure 5: Vulnerability of households by climate change

Factors determine Household Livelihood (Logistic Regression Analysis)

Logistic regression analysis studies the association between a categorical dependent and a set of independent variables. As stated in the methodology, binary logistic regression model was employed to analyze the factors determine the households' livelihood due to the climate change and the results are presented in table 6. Eleven explanatory variables (sex, family size, marital status, land ownerships, awareness of the climate change and variability, educational level, institutional responsibility, poor administration, warning information, access of credit and community participation) were included in the model.

Table 8: Determinants of Households' Livelihood

Variables		B	S.E.	Wald	Sig.	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
1	Se S Sex of HHs	-.914	.913	1.002	.017*	1.401	.067	2.399
2	Family size	-.901	.513	3.079	.009*	.406	.149	1.111
3	Marital status	.783	.860	.829	.363	2.188	.405	11.80
4	Land Ownership	-18.341	13551.90	.000	.040	.000	.000	.
5	Awareness of CCV	1.675	.658	6.474	.011*	5.340	1.469	19.40
6	Education	.607	.376	2.602	.001*	1.835	.878	3.835

	Status							
7	Institutional Responsibility	1.444	1.460	.978	.000*	4.238	.242	74.19
8	Lack of Management Skill	-.453	.298	2.309	.000*	.636	.355	1.140
9	Early Warning	-3.210	1.670	3.696	.055	.040	.002	1.064
10	Access to Credits	0.387	.935	.171	.030	.679	.109	4.244
11	Community Based Measures	-20.642	8463.237	.000	.998	.000	.000	.
	Constant	38.223	15977.499	.000	.998	3.98		
Pearson X^2_{Value}						27.575	DF=11	P=0.000
-2log likelihood						45.552		
R^2						.466		

Note: *** and * Significant at 1% and 5% level

As observed in Table 8, the R^2 value is 0.566; meaning that 56.6% of households' livelihood is due to 11 variables entered in the model. The results indicate that among the 11 variables, 6 variables are significant at different probability level. They are sex of households, family size, educational status, land access, awareness of climate change institutional responsibility and poor administration/management skills.

4.8.1 Coping Mechanisms followed by the Respondents to the Climate Change

Coping mechanisms are actual responses to the crises on livelihood systems. Study findings show that 58 per cent of the respondents coping by selling livestock, 51 per cent by reducing number of meals, 43 per cent through renting land, 37 per cent by getting remittance from their relatives, 24 per cent by using loans, 12 per cent by getting aids and 9 per cent by membership in social institutions.

Table 9: Coping Mechanisms to climate change

Coping Mechanisms		Frequency	Percent
1	Reducing Number of Meals	51	51.0
2	Through loans	24	24.0
3	Getting Remittance from Relatives	37	37.0
4	Selling of Livestock	58	58.0
5	Renting of Land	43	43.0
6	Membership Socials Institution	9	9.0
7	Getting Aid	12	12.0

Coping Strategies to climate change

Coping strategies are responses to adverse events or shocks (Devereux, 2001). Results show that, an overwhelming (82%) respondents used the coping strategies like selling of weak and old animals, cattle fattening (54%), livestock stock diversification (46%), while the remaining (43%) renting land and labor works (29%) to ensure livelihoods.

Table 10: Coping Strategies to Climate Change

	Coping strategies	Frequency	Percent
1	Livestock Diversification	46	46.0
2	Seasonal migration with cattle to search water and pastures	12	12.0
3	Sale of weak and old animals	82	82.0
4	Decrease the number of livestock	22	22.0
5	Cattle fattening,	54	54.0
6	Renting land	43	43
7	Labor	29	29

Access to Credit services

During the catastrophes of food scarcity, farmers need credit services to purchase food. The outcomes of study show that, majority (90%) of the households couldn't get rural credit and only 10% got access. This clearly shows that households adaptation efforts to the changing climatic is being constrained by shortage of credit services.

4.8.3 Shared Resources and Community Responses to climate change

According to households' survey, for majority (72%) water, grazing land (18%), forest (8%) and other resources (2%) as their shared resource. This implies that there are various types of shared resources and water is the major one.

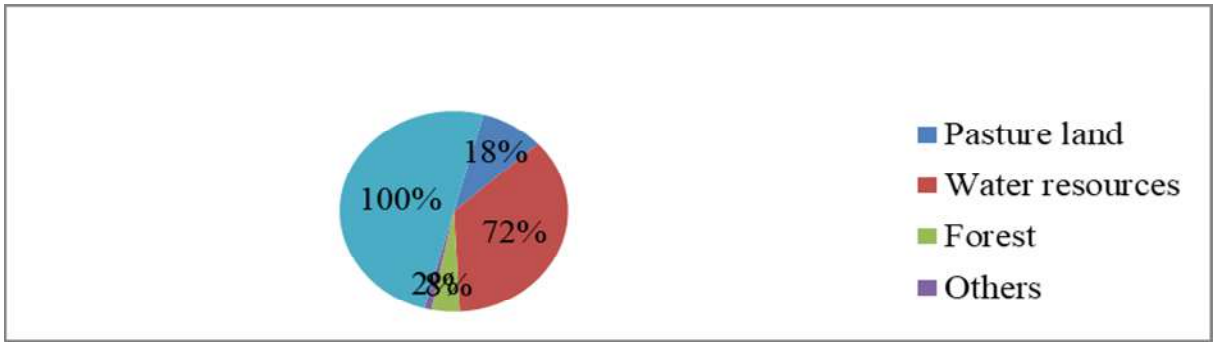

Figure 6: Community Shared Resources

Conclusion and Recommendations

The result of the study shows that, climate change is a major driver of vulnerability in the study area. The amount and timing of the rain fall in the area is variable and temperature consistently increasing from year to year which is affecting agricultural practices (crop production and livestock rearing). The livelihood problem in the study area is aggravated by ever increasing temperature, decreasing rainfall, shortage of agricultural land and degraded environment. Generally, farmers in the study area are very vulnerable and low adaptive capacity to climate change and variability. The current coping strategies used are not planned, coordinated and not sufficient too. Even though the government institutions are trying to take some intervention measures, it faces several short comings like institutional inter- connectivity, equity, efficiency etc. Based on the problems observed, following recommendations are forwarded so as to improve resilience and adaptive capacity towards climate change to improve the livelihood.

- Raising awareness about climate change effect and method of using modern agricultural technologies is imperative to increase coping and adaptive capacity of the farmers.
- Restoring the degraded ecosystem in which the local farmers depend for their livelihood, by applying, reforestation, protection of water bodies from pollution, protecting soil erosion.
- To overcome the climate risks, diversifying income sources such as bee keeping, poultry and other off farm activities other than agriculture to be undertaken.
- To minimize the effects of climate change, the young men and women should get access to credit to invest in farm and off farm activities.
- Every development plans need to be designed taking in to account the most vulnerable section of the society.
- Group based approach, which requires collective action and social capital, integrates local knowledge and emphasizes local decision making on communities' priorities and needs.
- Improved land management and soil conservation are important for the rehabilitation of natural resources and ensure the sustainability of agricultural production in the long-run which in turn would increase household food security.

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