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Investigating the Determinants of Adaptation Strategies to Climate Change: A Case of Batti District, Amhara Region, Ethiopia

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ABSTRACT

This study has sought to further understand the factors accounting for household's climate change adaptation choices by drawing on cross-sectional data in 2013 from 118 households of Batti woreda in Ethiopia. The research deploys descriptive statistics and binary logistic regression as analytical tools to arrive at the findings discussed. Drought, flooding, livestock epidemic were identified to be the dominant climate related hazards and crop rotation, diversification, changing planting dates and seasons, mixed farming, irrigation and shifting to off-farm activities were among the climate change adaptation choices, identified and investigated. The mean annual temperature was found to be increasing by 0.03°C per year and rainfall showed 2.22 mm decline rates per annum. The findings indicate that household head age ($p<0.01$, 1.076 and 1.238), total land owned ($p<0.01$, 2.809), livestock ownership ($p<0.01$, 1.308), household experience to drought ($p<0.05$, 0.152) and flooding ($p<0.01$, 2.731), household experience to crop and livestock loss ($p<0.05$, 3.359), the experience for the suitable growing seasons ($p<0.01$, 0.114, $p<0.05$, 0.153, $p<0.05$, 0.090) were found to be significant, affecting the climate change adaptation strategies. This significance highlights the need to work on these determinants to better supporting households in enhancing their adaptive capacity against their extremities.

Key words: Adaptation strategies, Batti woreda, climate change adaptation, binary logistic regression

INTRODUCTION

To date the international community has got the evidence that the earth is warming (IPCC, 2007). This increment in temperature is usually associated with declining rainfall that is impacting the food security and development efforts of countries worldwide. According to FAO (2000) the status of our world's food security depends on availability, access and utilization of food. All these facets of food security are being severely threatened by the climate extremities. The world food prices has significantly shown an unprecedented rise, climate change was identified as one of the major drivers of the reduction of yield mainly manifested in global production of wheat corn and sugar (FAO, 2008). Therefore, in many instances this food price rise is substantially driven new debates on the issues of global food security which in turn brought an impediment on the countries effort to achieve many of the prime agendas of Millennium Development Goals

(MDGs), like, to eradicate poverty and hunger in 2015. Strategies likes, adaptation, mitigation and innovative mechanism against climate change are promptly needed to save our shared climate system and achieve sustainable and equitable development by countries world-wide (Schipper, 2004). Developing countries, whereby agriculture and pastoralist are dominantly leading their economy should work on the adaptation options to address the problems of these changing climate. According to AIACC (2006) the impact of changing climate or variability worsens in tropical and sub-tropical regions whereby their economy largely relies on agriculture (arable farming) and pastoral livelihoods. Climate change witnesses itself on rainfall, soil moisture, temperature which directly affect the growth and yield of crops (Felix and Romuald, 2009).

Adaptation programming in developing countries, like Ethiopia, requires effective planning for climate change which in turn needs a fine grained study of local adaptation options, vulnerabilities, practices and preferences. The importance of adaptation as development perspective was significantly investigated in El Sava dor (Schipper, 2004). This study has identified adaptation strategies being taken by the community in response of climate extremities. Communities at the local level pursue different kinds of adaptation/coping mechanisms, inter alia, diversification of income generating mechanisms, change of growing season, assets selling etc. (Senbeta, 2009). While global models can project climate impacts and estimate costs of expected investments, developing country decision-makers also require local level researches that take a bottom-up, pro-poor perspective, integrate across sectors and reflect local stakeholders' experiences, ways of adaptation and values, in order to determine appropriate climate responses. This study provides important insights and emerging findings on the determinant factors of adaptation and institutional capacities surrounding adaptation arenas in Batti woreda, Amhara region, Ethiopia.

Amhara region, located in the northern part of Ethiopia, is subjected to a range of climate related hazards such as drought, flood and pest infestation. Agriculture is the mainstay of the economy of the regions alike the country. Majority of population (85%) livelihood relies on agriculture, 80% of the country's export is drawn from it and contributes 47% for the GDP which is very sensitive to climate extremities, indicating an area of interest (a key leverage point) for improving and designing development policy within the context of climate related hazards (Assefa *et al.*, 2008). The objective of this study was therefore to investigate the determinants of climate change adaptation choices and responses households undertake. Understanding climate related perceptions and resulting adaptation/coping strategies would help to fine tune policies and the assistances required for affected households.

METHODOLOGY

Description of the study area: The study was conducted in Batti woreda (Fig. 1) which is located in the north eastern part of Amhara, 545 km away from the capital city Bahir Dar. Batti woreda belongs to Oromia Zonal administration among the 10 zones in the region. The woreda is characterized by its recurrent drought situated in Kola agro ecological stratification of the country. Geographically, it is neighbored by Southern Wollo Zonal administration, Northern Shewa Zonal administration and Afar National Regional State. Batti woreda is bordered by Chefe Golana Dewerahmedo on the southern part and on west and northern part by Afar region on the Eastern part. Based on the 2002 Central Statistical Authority (CSA) census, the total population of the Woreda is 186,764 of which 50% are male and the remaining are females. It has also area coverage of 1,132.16 km^2. The total households in the woreda is 23,417. The woreda has 22 administrative kebeles and 3 urban kebeles.

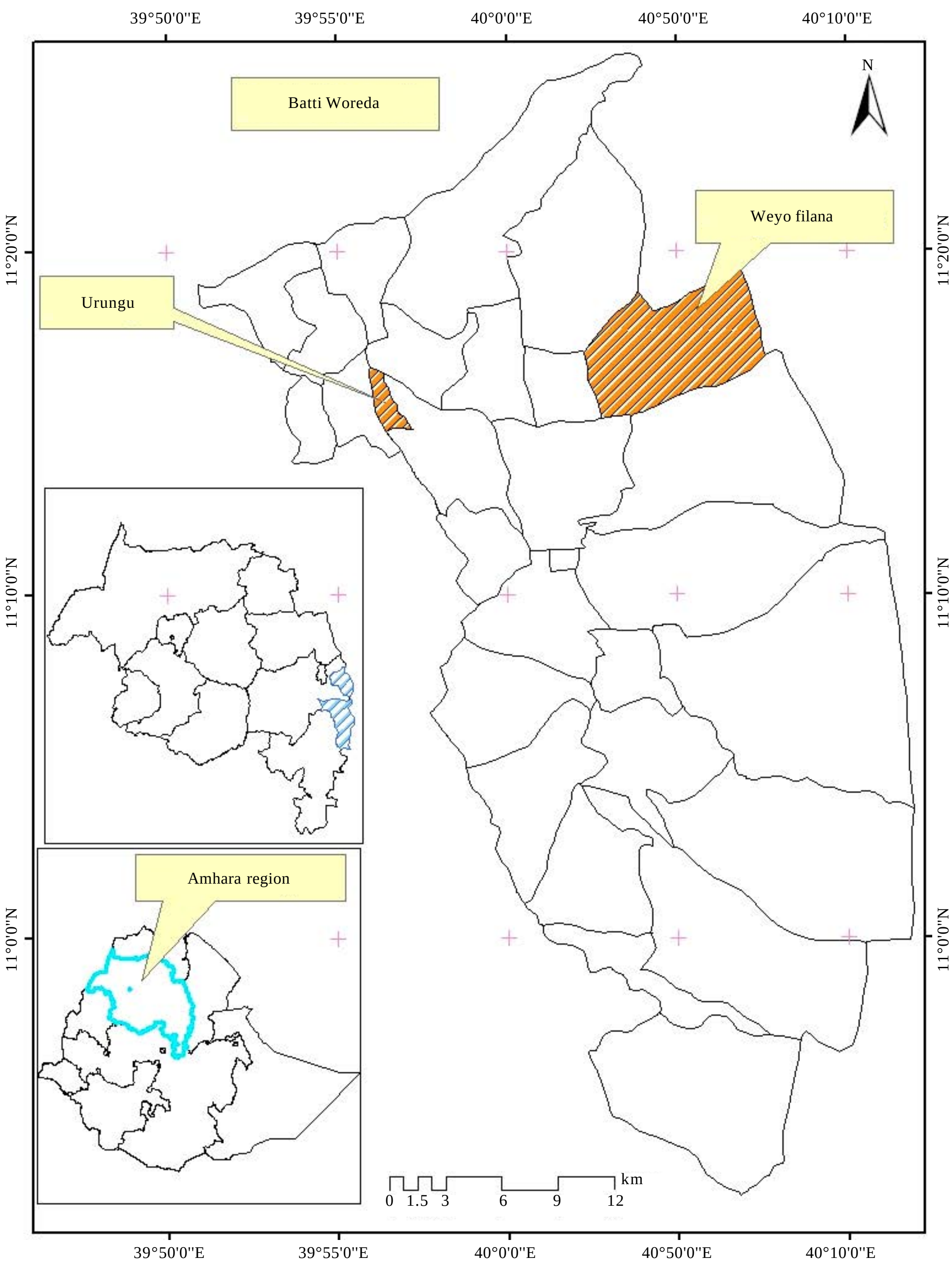

Fig. 1: Location map of the study sites

Batti wareda has the altitude ranging from 1001-2500 masl comprising an agro-ecology of majorly dominated by lowlands (below 1500 masl and traditionally called Kola (81%) of the total land and mid-altitude traditionally Woyena Dega which is between 1500-2300 mals.

Geographically, it is terrain, gorge and mountainous and have a very few amount of land plain. The annual average temperature is 26°C and has an average precipitation of 350 mm annually according to CSA in 2002 cited in Mesfin (2004). The rainfall pattern is bimodal; small rainy season (locally called belg) from mid February to end of May and long rainy season (locally called meher) from beginning June to mid September.

Like the other parts of the country, agriculture is the dominant income source with meher dominating among the growing seasons. Sorghum, teff, maize, millets, chickpea, peas and sesame are the most notable crops grown in the woreda. The woreda has got one health center, three clinics, seven health posts, five static and 32 temporary vaccination centers. With regard to education, according to Woreda Education Office (WEO) there are 21 primary schools, one senior secondary school, one preparatory and one kindergarten schools.

In this study, the smallest unit of the study was a household. Purposive sampling was used to select the woreda as well as Kebeles (smallest administration level in Ethiopia) in consultation with the concerned bodies. The researcher put criteria to select those two Kebeles, including low income community, accessibility, the status of food insecurity (one from the worst and the other among the worths), then two Kebeles were selected. The study had pre-determined 120 samples. It used systematic random sampling in which every k-th subject on a list of selected Kebele's population for inclusion in the overall sample. The "K" refers to the sampling interval and every 5th (K = 5) households. The value of K was determined by dividing the population size with the sample size.

The data and information required for the study was collected from direct and indirect sources. The primary data was collected with a structured questionnaire, administered and asked for the household heads in the community from 120 households of the two Kebeles (Woyofellana and Urungu). However, due to the intolerance missing elements with the two of household questionnaires the researcher decided to work on 118 of them. Secondary data were collected from unpublished documents, reports and meteorological station. This particular research deployed descriptive and inferential statistics analysis. Descriptive statistics were deployed to gain basic understanding of the demographic, economic, physical and social situation of the study area. A binary logistic regression model was used to see the effects of each hypothesized explanatory variables on the predicted climate change adaptation variables.

Binary Logistic regression model is described as:

$$Pi = pr(y = 1/X = xi)$$

Then the equation of the model can be written as:

$$\text{Logit}(Pi/1\text{-}Pi) = \text{Logit}(Pi) = \beta_o + \beta 1Xi \quad (1)$$

where, Pi is the probability of choosing climate change adaptation strategy and xi is predictor variable. Therefore, the parameter β_o gives the log odds of the dependent variable.

The probability of occurrence of an event relative to nonoccurrence is called odds ratio and given by:

$$Pi/(1-Pi) = \exp(\beta 0 + \beta 1xi) \quad (2)$$

Or in terms of the probability of the outcome (e.g., household choosing climate change adaptation strategies) occurring as:

$$Pi = \exp(\beta 0+\beta 1xi)/(1+\exp(\beta 0+\beta 1xi)) \quad (3)$$

Conversely the probability of the outcome not occurring is:

$$1\text{-}Pi = 1/(1+\exp(\beta 0+\beta 1xi)) \quad (4)$$

Before the data entered to the model, multicolinearity check was performed and found that it was free, model fitting was also carried out and found that the selected data certainly fit to the model.

RESULT AND DISCUSSION

Household characteristics: From 118 sampled households the average household size was found to be 6 persons with a minimum of one person and a maximum of 11 people per household. The average household size was reported to be with a standard deviation of 2.29 and variance of 5.22. About 90.7% of the respondents were married while 7% were unmarried; the remaining 2% were divorced and widowed. It is believed that marital status of household heads could have an influence on the adaptation strategies against climate related shocks. Obviously, household heads with married status shall have more stable situation in farming activities and off-farm activities and hence agricultural and non-agricultural production. Moreover, of the total sampled households majority (83.1%) were male headed households while few (16.9%) of them were women headed.

As shown in Fig. 2, the majority of the household heads included under the age interval of 33-47 followed by 18-32 taking 45 and 31%, respectively (Fig. 2) which can be generalized that people could have better understanding about the changing climate, as this demographic variable was anticipated to affect their perception. The average age was 39, of the sampled household heads, 90 years was the oldest and 18 years was the youngest. The more years they stayed, they would have greater possibility to judge the dynamic temperature and rainfall situation; hence, they could have also better climate change adaptation choices driven from their experience and age.

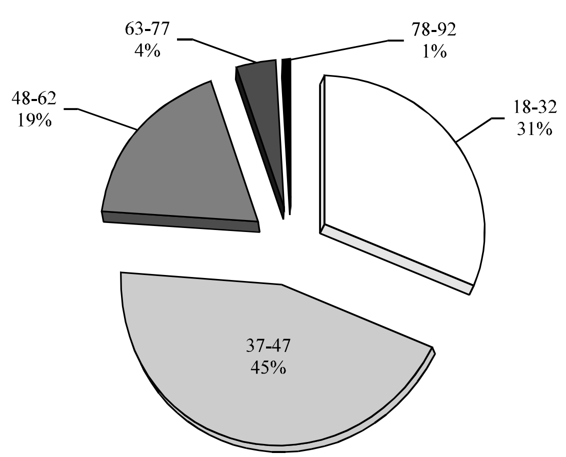

Fig. 2: Household age distribution

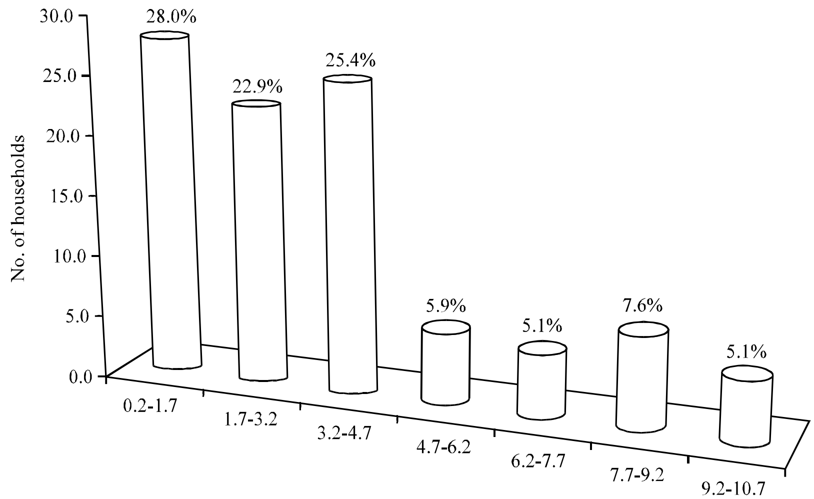

Fig. 3: Household livestock ownership (TLU)

About 75.42% of the total sampled households are literate or at least have basic education while the rest of the respondents don't write and read. Perception and adaptation to climate change is subjected to numerous understandings and information and knowledge which entirely seek respondent's level of education to interpret and use it. Therefore, adaptation is related to the ability of an individual, family and community to adjust the changes or take advantage of the threatening situation and further signifies the relevance of level of education as a basic human capital to achieve the expected adaptive capacity to the changing climate and its negative consequence (IPCC, 2007).

According to Schipper (2004), improved education and information are described as crucial factors to determine adaptive capacity and sustainable development. It is believed that households that at least have basic education are likely to be prompt enough to respond against the changing climate and are not resistant for innovative climate change adaptation technologies.

Basic information about the market distance and the time it takes to reach and the likes are vital to a comprehensive understanding of the adaptive capacity situation that could potentially contributes to appropriate design of interventions and further programming. Information on market distance and others can make households to build up their confidence of where they can sell their products and buy whatsoever. The 76% of the respondents were reported to have an access for market and 24% were otherwise. The average market distance to the market place Batti town was 17.93 and has an average of 2.5 h time long.

Figure 3 illustrates that, of the total sampled households majority (28) households own livestock in the range of 0.2-1.7, followed by 23 of them reported to have a size in the range of 1.7-3.2. The minimum, maximum, average and standard deviation of livestock holdings for the sampled households were 0.00, 10.37, 3.1 and 2.65, respectively using a standardized Tropical Livestock Unit (TLU). Livestock ownership is one of the asset households have as proxy indicator for wealth as well as better adaptive capacity in the face of climate related shocks. It is included under the productive asset in which rural households rely. These findings concur with other studies who found the same result Tafesse *et al.* (2013).

Table 1: Major climate related hazards experienced

Hazard type and response	Frequency	Percentage
Drought		
Yes	99	83.9
No	19	16.1
Flood		
Yes	58	49.2
No	60	50.8
Livestock epidemic		
Yes	95	81.4
No	23	18.6

Income is something which makes households living from whichever the source it comes. Obviously, this income is subjected to myriad of economic, social, environmental, political and institutional factors. The findings demonstrates that from the total households sampled in the woreda the average household income was reported to be 12324 with a standard deviation of 16892.9. The maximum annual income was reported to be 113,000 and 1000 is the minimum figure responded.

The already happening climate change bears exceptional dynamics on the customary hazards which the community has been experiencing since the creation of mankind. Climate change has been posing exceptional change like; drought, flooding, pest infestation, livestock and human epidemics by large. These extremities have been explained by the households themselves in the study area; as the Table 1 illustrates the most prevalent hazards is drought with 83% of the respondents have reported experienced, livestock loss follows as one of the extremities in the woreda with 81.4% respondents have reported to experience it, as livestock ownership is the basic and productive asset for the woreda, this clearly signifies as to how the happening climate variability is posing very substantial negative consequence in recent times. Moreover, households noticed negative impacts due to extreme drought conditions during the dry season, including a decrease in their production yield and the water available to their consumption as well as to their animals.

During past decades, households observed many climatic changes throughout the kebeles, from the sampled households majority (74.6%) of the respondents which are, 88 in number have noticed and believe that climate change is occurring, the respondents who were asked whether they have recognized of these changes in their life time and disagree were reported to be 30 in number taking 25.4% of the total sampled households under the study.

Households were also asked whether they have witnessed climate change or variability and in its pattern throughout their stay in the kebele (20-50 years). Moreover, they were also asked if they have been experiencing RF shortage and T°increment. From the total sampled households, almost all (97.5%) agreed on the aforementioned situations of climate change. Local peoples' past experience showed increasing warming days, erratic rainfall patterns, ecological variability, biological change and their adverse effects on human beings. More than 98% of the respondents said that warming days are increasing, rainfall pattern is unpredictable, seasons are changing, incidents of drought is increasing, wind pattern is getting warmer, decreasing water sources, wind is getting stronger, changes in flowering and fruiting time, invasion of new plant species and reduction of some indigenous plants. This result is in conenose with what IPCC (2007) claims, elders have observed and reported that there is less forest (trees) and argued that this is an indicator of warming by local households understanding. Moreover, households response is

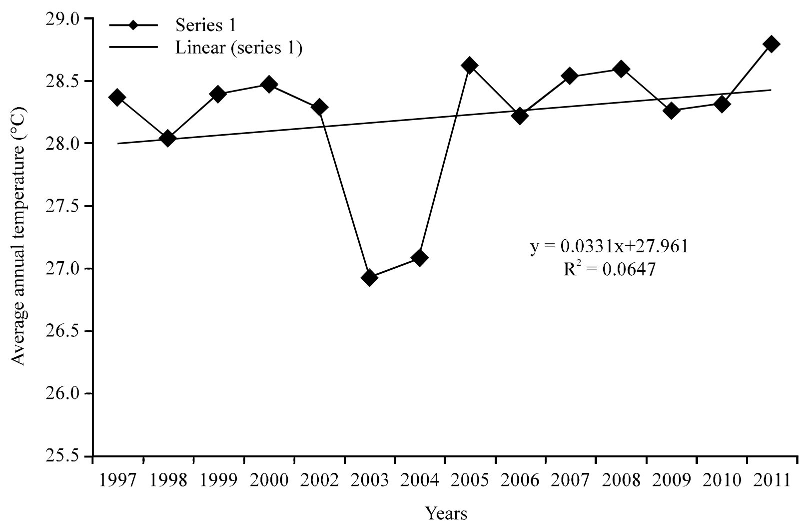

Fig. 4: Trend of average annual temperature

definitely in line with the report released by the National Metrological Services Agency (Tadege, 2001) which illustrates an increasing trend in temperature and declining trend in precipitation.

Temperature change (increase) is the direct indicator of climate change. For this study, monthly maximum and minimum temperature data was used as the climatic indicator of changing climate in the Batti woreda. Figure 4 illustrates that the mean annual temperature is in increasing at a rate of 0.03°C per year with highest temperature in the year 2011 which is nearest to national average of 0.06°C per year. The linear equation:

$$(Y = 0.03X+27.96) \text{ with } (R = 0.064)$$

Figure 4 shows the predictable increase of temperature with the year. This finding is in line with what households perceive about the change in temperature.

Rainfall is one of the principal factors indicating climate variability in any area of concern. Average annual rainfall data of 17 years was taken for the study. The average annual rainfall over the past 17 years shows a decreasing trend with erratic pattern. Average annual rainfall is decreasing at the rate of 2.22 mm per year. Even though the rainfall is in decreasing trend, the (R = 0.194) value in the Fig. 5 shows its unpredictability.

Climate change adaptation strategies reported by households

Crop rotation, diversification, changing planting dates and seasons and mixed farming: In Batti woreda crop livestock integration has come to be the alternative way of addressing the negative consequences of climate extremities. At times of climate risks households in the woreda diversifies their income sources like growing drought resistant crops so that they can cope with the water shortage and shifted to relying on livestock production which they think could need little water requirement compared to crop production. Moreover, the households sell their live stocks and buy their food at times of worse. It was reported that households in these Kebels tend to rotate types of crops when there is rainfall failure. The 46% reported of using this adaptation strategy to make their living.

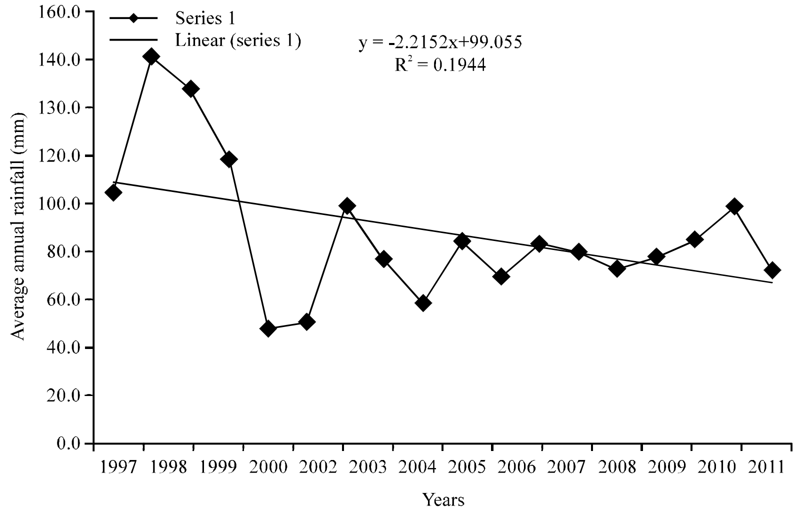

Fig. 5: Trend lines of average annual rainfall

Irrigation: Using small scale and irrigation is one of the adaptation strategies they have developed at the times of drought. They traditionally dig irrigation channels diverting the river and grow fruits and vegetables. About 42.37% households were reported to choose this climate change adaptation strategy.

Shifting to off-farm activities: Households were found to switch to off-farm activities as an adaptation strategies at times of climate related hazards and this accounts 31.36% of the total household respondents.

Correlation results interpretation

Demographic dimension: The correlation analysis deployed reported that there is a negative association between household heads age and average annual income (β = -0.189, $p<0.05$). Household heads who are aged may have less productivity as compared to their counterparts due to their insufficiency in human capital (health, physical strength etc.). Conversely, age was found to be positively associated with a climate change adaptation strategies of engaging in crop rotation, changing planting dates and crop diversification (β = 0.225, $p<0.05$); a possible explanation could be as household heads gets old they are more likely to choose this adaptation strategy to address the negative consequence of climate change. Moreover, a very encouraging and strong relation was found between household heads age their possibility of choosing shifting to off-farm activities as an adaptation strategy (β = 0.530, $p<0.01$) which has a lot to do with their possibility of being resilient against the adverse impact of climate change.

A further interesting relationship, among the demographic characteristics was household heads level of education. As it is indicated in Table 2 very strong positive relation was found between household's heads level of education and average annual income of households (β = 0.476, $p<0.01$); a positive beta coefficient clearly signifies that as the level of education increase the average annual income also increases in the same direction. This suggests that the more educated the households heads are the more they could achieve income increment. Moreover, household's heads level of education showed a positive correlation with land holdings (β = 0.286, $p<0.01$). Interestingly, this

Table 2: Correlation results of explanatory variables and adaptation strategies

Parameters	HHAGE	HHLED	AAHHI	TLAND	LIVOWNER	MFAG	HED	HEF	HECPL	HELIV	SAG	DSCCSTAY	CRPDDC	Shifting to off-farm activity	Irrigation
HHAGE															
Pearson correlation	1														
Sig. (2-tailed)															
HHLED															
Pearson correlation	-0.141	1													
Sig. (2-tailed)	0.128														
AAHHI															
Pearson correlation	-0.189*	0.476**	1												
Sig. (2-tailed)	0.040	0.000													
TLANDO															
Pearson correlation	0.080	0.286**	0.462**	1											
Sig. (2-tailed)	0.388	0.002	0.000												
LIVOWNER															
Pearson correlation	0.061	0.306**	0.496**	0.435**	1										
Sig. (2-tailed)	0.515	0.001	0.000	0.000											
MFAG															
Pearson correlation	0.103	0.260**	0.116	-0.020	-0.045	1									
Sig. (2-tailed)	0.266	0.004	0.211	0.828	0.630										
HED															
Pearson correlation	-0.165	-0.018	0.160	-0.012	0.060	-0.085	1								
Sig. (2-tailed)	0.073	0.849	0.083	0.899	0.516	0.361									
HEF															
Pearson correlation	0.124	0.029	-0.056	-0.063	0.010	0.094	-0.030	1							
Sig. (2-tailed)	0.180	0.752	0.549	0.498	0.915	0.313	0.743								
HECPL															
Pearson correlation	-0.021	-0.009	-0.100	-0.038	-0.037	0.144	0.000	0.018	1						
Sig. (2-tailed)	0.819	0.920	0.282	0.684	0.692	0.119	0.993	0.848							
HELIV															
Pearson correlation	-0.012	-0.453**	-0.207*	-0.053	-0.235*	-0.198*	0.053	-0.067	-0.072	1					
Sig. (2-tailed)	0.897	0.000	0.024	0.572	0.010	0.032	0.570	0.472	0.442						
PPACCSA															
Pearson correlation	0.095	0.017	0.065	-0.009	0.130	-0.068	-0.150	0.146	-0.126	-0.038					
Sig. (2-tailed)	0.308	0.856	0.485	0.922	0.162	0.463	0.105	0.115	0.173	0.680					

Table 2: Continue

Parameters	HHAGE	HHLED	AAHHI	TLAND	LIVOWNER	MFAG	HED	HEF	HECPL	HELIV	SAG	DSCCSTAY	CRPDDC	Shifting to off-farm activity	Irrigation
SAG															
Pearson correlation	-0.084	-0.041	-0.054	-0.151	-0.126	0.124	0.098	-0.019	0.108	0.000	1				
Sig. (2-tailed)	0.366	0.663	0.563	0.103	0.174	0.180	0.291	0.838	0.245	0.996					
DSCCSTAY															
Pearson correlation	0.090	0.006	0.054	-0.008	0.121	-0.095	-0.197*	0.168	-0.148	-0.020	-0.019	1			
Sig. (2-tailed)	0.331	0.950	0.561	0.935	0.191	0.304	0.033	0.070	0.109	0.826	0.842				
CRDCPD															
Pearson correlation	0.225*	0.068	0.088	0.096	-0.070	0.243**	0.049	-0.157	-0.181*	-0.024	0.239**	0.011	1		
Sig. (2-tailed)	0.014	0.463	0.343	0.303	0.453	0.008	0.598	0.090	0.050	0.797	0.009	0.902			
Shifting to off-farm activity															
Pearson correlation	0.530**	-0.060	0.074	0.204*	0.176	0.198*	0.086	0.033	-0.099	0.022	0.153	0.099	0.402**	1	
Sig. (2-tailed)	0.000	0.520	0.426	0.027	0.057	0.032	0.356	0.724	0.288	0.816	0.097	0.285	0.000		
Irrigation															
Pearson correlation	-0.042	0.335**	0.457**	0.409**	0.462**	0.083	0.048	-0.007	0.020	-0.284**	0.126	0.174	0.160	0.211*	1
Sig. (2-tailed)	0.655	0.000	0.000	0.000	0.000	0.373	0.609	0.942	0.826	0.002	0.174	0.060	0.084	0.022	

demographic variable is highly correlated with livestock ownership (β = 0.306, $p<0.01$) and more expectedly negatively correlated (β = -0.453, $p<0.01$) with livestock loss due to any hazard (may be climate related hazard), this could be attributed to the level of awareness about livestock rearing and management. Similarly level of education has also a positive association with market access across the sampled households (β = 0.260, $p<0.01$) this could also be esteemed from the access for market information. Besides, as it is illustrated in Table 2 household's level of education was found to be positively related with the decision of choosing irrigation as an adaptation strategy by rural households (β = 0.335, $p<0.01$). An increment in their level of education shown an increase in their possibility of choosing irrigation, this could in turn possibly be resulted from their knowledge of advantages of irrigation technologies and their purpose as an alternative of income sources.

Economic dimension: The major variables discussed under this dimension are: Average annual income, households land holding, livestock ownership and market access. These are the variables hypothesized to have an influence on households' climate change adaptive capacity. The correlation analysis results are presented: Income was hypothesized as a very determining factor for climate adaptation capacity, this study confirmed that average annual income of the sampled households has shown a very strong relationship (β = 0.462, $p<0.01$) with total land owned, livestock ownership (β = 0.496, $p<0.01$). Conversely, average annual income found to be negatively related with household's livestock loss (β = -0.207, $p<0.01$). Average annual income by households showed a very strong positive relationship with the household's decision to purse irrigation as an adaptation strategy in the face of changing climate change.

As the Table 2 illustrates, total land holding by households, as an economic variable has shown a strong positive relationship with livestock ownership (β = 0.435, $p<0.01$). This variable showed a positive relationship with shifting to off-farm activities as an adaptation strategy (β = 0.204, $p<0.05$). Land holding has a positive relationship with choosing irrigation as a climate change adaptation strategy (β = 0.409, $p<0.01$).

Alike in many Ethiopian rural households, livestock ownership is one the indicators of wealth in batti woreda. Quite expectedly, this variable showed negative relationship with livestock loss (β = -0.235, $p<0.05$) and very strong positive relationship with irrigation as climate adaptation strategy among farmers (β = 0.462, $p<0.01$).

Market access: This indicator have appeared to negatively correlated (β = -0.198, $p<0.05$) with livestock loss due climate related epidemics; this could show the importance of information to take decisions in advance against some epidemics. Moreover, household's market also showed a very strong positive relationship (β = 0.243, $p<0.01$) with their decision of making crop rotation, diversification, changing planting dates and seasons and (β = 0.198, $p<0.05$) shifting to off-farm activity as climate adaptation strategies. Inline to this finding, Tessema *et al.* (2013) found that market access influence adaptation choices made by small holder farmers.

Households experience to drought hazard was also found to be negatively correlated with households experience and witness about the prevalence of climate change in their life time (β = -0.197, $p<0.05$). Moreover, household experience to crop loss also showed negative correlation (β = -0.181, $p\leq 0.05$) with crop rotation, diversification and changing planting dates and seasons among those climate change adaptation choices. As it is indicated in Table 2 households' experience to livestock loss showed strong negative correlation (β = -0.284, $p<0.01$) with irrigation as climate change adaptation choice.

Table 3: Results of binary logistic regression model for climate change adaptation strategies determining factors

Independent variables	Crop rotation, diversification, changing planting dates and seasons and mixed farming				Irrigation				Shifting to off-farm activities			
	B	SE	Sig.	Odd ratio	B	SE	Sig.	Odd ratio	B	SE	Sig.	Odd ratio
HHAGE	0.073	0.024	0.003	1.076	0.002	0.029	0.936	1.002	0.214	0.047	0.000	1.238
AAHHI	0.000	0.000	0.633	1.000	0.000	0.000	0.030	1.000	0.000	0.000	0.718	1.000
TLANDO	0.280	0.309	0.365	1.322	1.033	0.386	0.007	2.809	0.617	0.403	0.126	1.853
LIVOWNER	-0.177	0.104	0.087	0.837	0.269	0.122	0.028	1.308	0.076	0.113	0.503	1.079
HHLED	-0.400	0.654	0.541	0.671	-0.169	0.759	0.824	0.845	0.502	0.817	0.539	1.651
MFAG	-1.074	0.535	0.045	0.342	-0.371	0.676	0.584	0.690	-1.340	0.673	0.046	0.262
HED	-0.363	0.664	0.584	0.695	-0.228	0.784	0.771	0.796	-1.881	0.966	0.051	0.152
HEF	1.005	0.487	0.039	2.731	0.077	0.565	0.891	1.080	0.336	0.592	0.570	1.399
HECPL	1.212	0.491	0.014	3.359	-0.446	0.598	0.456	0.640	0.815	0.587	0.165	2.259
HELIV	0.039	0.530	0.941	1.040	1.139	0.667	0.088	3.123	-0.500	0.669	0.455	0.607
PPCCDIS	2.014	1.356	0.138	7.491	-2.911	1.943	0.134	0.054	1.700	1.402	0.225	5.474
SAG	-2.175	0.809	0.007	0.114	-1.879	0.760	0.013	0.153	-2.406	1.007	0.017	0.090

*,**,***Significant at 10, 5 and 1%, respectively

Household's perception to climate change was appeared to be positively related (β = 0.185, p<0.05) with irrigation as climate change adaptation choice people make against the happening climate change. The more people are aware about the prevalence of climate change; they may take early decisions against it, like engaging in irrigation. Households experience for the most appropriate growing meher was found to be very strongly related with crop rotation, diversification and changing planting dates and seasons as climate change adaptation strategy. A positive sign clearly entails the more frequent they experience the aforementioned season the more they make their decision of crop rotation, diversification and changing planting dates and seasons against perceived and potential adverse impacts of climate change.

Model result discussion: The hypothesized explanatory variables affecting the dependent variables in the study were entered into binary logistic regression model to see their individual and aggregate impact on the climate change adaptation choice households make in the woredas. As it is clearly illustrated in Table 3, Most of the explanatory variables found significant similar with the priori expectations.

Household head age as a continuous variable was used as a potential proxy variable for production (crop production, livestock and off-farm) and was hypothesized to affect the income generation capability and knowledge of the households. Therefore, more experienced households' shall have better adaptive capacity and awareness against climate change. As the age of the household head increases, He/She is expected to acquire more experience in weather forecasting and that helps to increase the likelihood of practicing different adaptation strategies to climate change (Deressa and Hassan, 2009; Tazeze *et al.,* 2012). Elders and experienced farmers significantly increase the chance of the aforementioned strategies at p<0.01. Therefore, a unit increase in their age increases the likelihood of choosing crop rotation, diversification and changing planting dates and shifting to off-farm activities by 1.076 and 1.238, respectively.

Total land owned: Land holding at the household level is a continuous variable defined to affect almost all of the intermediate variables and the dependent variable. Land ownership was hypothesized to affect households as to what and how the livelihood strategy they pursue to achieve food security at any level. Therefore, it was anticipated that land owned by households would positively affect the household income and adaptation strategies they might choose.

Land is one of the natural assets households have to make use of it as source many different livelihood activities at the community level. Land ownership has a positive and significant impact on the likelihood of using irrigation as a climate change adaptation strategy at $p<0.01$. The increment in the land holding of households causes their probability of engaging in other mode of production like, irrigation, to address the adverse impacts the changing climate. The findings clearly demonstrate the importance of having land so that farmers could produce using irrigation. Similarly, Hassan and Nhemachena (2008) reported the importance having land for using irrigation as climate change adaptation strategy. In contrary to this finding, Deressa and Hassan (2009) found land holding not to be significantly affecting the choices of any of climate change adaptation strategies.

Livestock ownership: Livestock rearing is among the major livelihood activities carried out in most parts of the country which diversifies household's livelihood strategies to enhance their ability to with stand the climate related shocks. Livestock production is a sector taken as a source of income drawn from sale of livestock and their products. Hence, this variable was hypothesized to have a positive influence on household's climate change adaptation choices in the face of climate related hazards. Livestock ownership, among the farmers, is believed to be a proxy indicator for wealth as well as for better adaptive capacity in the face of climate related shocks. It is repeatedly cited in a lot of evidences that livestock ownership is included under the productive asset in which rural households rely on. Livestock plays pivotal role in serving as a store of value, source of traction and provision of manure required for soil fertility maintenance (Yirga, 2007). With this end, livestock ownership among households was found to be significant for irrigation as an adaptation choice with a significance value of $p<0.05$ which is the same as the priori expectation. A positive sign on its coefficients clearly illustrates that the more households own livestock as productive asset results in better adaptation choices like the aforementioned strategies. This could be further explained as the more livestock households own they are likely to have better financial source helping them in creating other source of livelihood like petty trading and other small business as an alternative means of income. The result implies that for each unit increase in the households' livestock ownership the odds of selecting irrigation as climate change adaptation strategy increased by 1.308. In similar fashion, the result offered by Tazeze *et al*. (2012) suggested that livestock ownership is among the factors influencing household's decision to adapt.

Household experience to flooding: Households vulnerability is measured by their ability to cope/adapt with the exposure to the risks posed by climate related shocks like flooding followed by total crop loss, forage loss and epidemic are repeatedly cited as the major negative consequences drawn from its prevalence (Tango International Inc., 2006). Flooding is the most dangerous hydro-metrological hazards currently caused by the changing climate the study area is experiencing. There has been enough evidence to support the priori expectation that when households experience extreme calamities like flooding there is a significant impact on the likelihood of using crop rotation, diversification and changing planting dates and seasons for being resilient against the negative consequence of flooding. The present study shows a positive and significant relationship at $p<0.05$.

Crop loss experience: When farmers experience crop loss due to climate related hazards, there we have got enough evidence to support that they will be using crop rotation, diversification and changing planting dates as an adaptation option. These households have got the indigenous knowledge and experience of the aforementioned strategy when crop loss has occurred. Table 3 illustrates a significance of $p<0.05$. The more crop losses they experience the more they will be changing their way of production, the evidence was supported by the odd ratio of 3.359.

Household experience to drought: As it was clearly discussed, drought is the most prevalent climate change related hazard in the woreda attributed to the shortage of rainfall. In line with the prior expectation households experience was found to be one of the determining variables affecting household's adaptation choice. A unit increase in their experience causes a downward change in their decision of changing into other off-farm activities. A negative **β**-coefficient signifies that these households are less likely to be engaged in this adaptation strategy when drought hits. A possible explanation could be that these households are likely to choose other options to sustain life in the drought conditions.

Suitable season for agriculture: In line with the hypothesis made these explanatory variable was found to be significant at $p<0.01$. This implies that as framers in the district get the most suitable growing season meher with adequate rainfall there is evidence that they are less likely to choose crop rotation, diversification and changing planting dates and seasons as climate change adaptation strategy. The more frequent they get meher season (which is suitable in their case) the less they will choose this adaptation strategy. Besides, as households experience meher season there is enough evidence to support that they get engaged neither irrigation nor shifting to off-farm activities as an adaptation strategy. The finding are supported with $p<0.05$ significance level and showed 0.153 and 0.090 odd ratio, respectively. In similar fashion, Mudzonga (2011) argued that information about suitable season for agriculture affects farmers' adaptation choice.

CONCLUSION

This study deployed descriptive statistics, correlation analysis and binary logistic regression to investigate the determinant factors affecting household's climate change adaptation choices. A total of 12 explanatory variables were entered to the model to see their impact on the choices of either of crop rotation, diversification and changing planting dates and seasons, using irrigation and shifting to off-farm activities.

All the specific objectives were met, firstly, one of a specific objective of this study was to identify the most pressing climate related shocks and existing adaptation strategies: Drought, flooding, livestock epidemic were indentified to be the most dominant type of climate related shocks in the woreda. Moreover, the major climate change adaptation strategies identified were crop rotation, diversification, changing planting dates and seasons, mixed farming, irrigation and shifting to off-farm activities. Secondly, as far as the relationship between explanatory variables and to the DV is concerned; the result clarifies the evidence that almost all of the IV has associations with each other and to the adaptation choices. Thirdly, the researcher did set out to answer the objective of understanding the effects of households characteristics, livelihoods assets,climate related hazards and losses related and market access on households adaptation choices/strategies" and hence household head age, average annual household income, total land holdings, livestock ownership, market access, household's experience to drought and flooding hazards, households experience to crop and livestock losses and seasons appropriate for growing were found significant at 1 and 5% level of significance.

Based on the results of this study, several suggestions can be made as to how rural households can be actively participated in actual climate change adaptation choices; therefore, the findings suggest that an adjustment in each one of the significant variables can significantly influence the probability of making any kind of climate change adaptation choices. Generally, Adaptive measures to climate change will need active and sustained efforts of the government, donor agencies and individuals in the woreda.

This study offers a number of insights into the overall national and world wide efforts in mainstreaming climate change adaptation measures and as such has interesting implications for policy makers seeking to implement measures that might increase the adaptive capacity among rural households. Thus, although this study is based on local data from Batti woreda, the results are indeed applicable to large rural parts of the country. Moreover, the study has shown that households who have no those significant contributors required are more likely to suffer severe and negative consequences from the changing climate. Hence, the need for local authorities to pay particular attention to these vulnerable populations when designing policies and programs and for local police units to consider the specific problems of these extremities when preparing their intervention and development plans. The findings indicate that household's livelihood strategies are climate sensitive and they are less likely to participate in other strategies in the face of climate extremities. Moreover, the role played by certain determinants of climate change adaptive capacity was found to be lacking in a lot of households in the study area. Consequently, authorities need to adopt a specific adaptation policy in line with the needs of the local people.

This study also reports evidence of the fact that households' livestock ownership, average annual income and related factors can increase household's adaptive capacity. This suggests that measures designed to fight climate change challenges should focus on enhancing these influential factors and should also take into consideration the impact on the undesired outcomes of some adaptation choices. Finally, the research highlights the need for mainstreaming climate change adaptation choices targeting those households and climate sensitive source of livelihoods which are extraordinarily vulnerable to the impacts of climate change. Likewise, particular attention should be given to the older age groups, women and child as they are the ones most likely to suffer the most severe climate extremities consequences. It would be also further important to suggest other empirical studies in this field of competence so that other gaps will be addressed.

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