International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Climate Variability And Its Local Perception And Adaptation Measures In Weliso Woreda, Ethiopia, East Africa

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Abstract: ***Climate variability (CV) is continued to cause greatest environmental, social and economic threats to mankind. Perception on the status of CV and its adaptive mechanism is the call of the day to come up with scientific recommendation for sustainable livelihood. The study assesses major features, of CV, and local perception on its features, causes, indicators and adaptation strategies in Weliso Wereda, Oromiya Regional State, Ethiopia. Three randomly selected kebeles are used where semi-structured interview with 180 sample household heads, 6 focus group discussions, 10 key informant interviews, and frequent field observations were conducted to collect primary data. Rainfall and temperature data of the last decade (from 2004 to 2013) used to understand CV. The finding of the study showed slight variability in temperature and rainfall. Local people perceived the prevalence of CV and also identified its indicators: flooding; drying up of rivers and streams, crop damage by pests; introduction of new human and animal disease; species shift to upper altitude, and introduction of new plant and animal species; rainfall variability in duration and amount; etc. They devised mechanical and biological conservation measures upon farm lands; watershed management; rain water harvest; changes in cropping pattern; growing short maturing crops; family planning and livelihood diversification as adaptation measures. Such endeavours are challenged by poverty and food insecurity, lack of access to land, water, market, finance, insurance, information, health, and agricultural technologies. This calls for improvement in agricultural production; capacity building on existing knowledge and practices of the people; training and awareness on rainwater harvesting technologies; strengthening access to social, institutional, financial, human and natural assets of livelihood, integrated watershed management, and sustainable environmental and livelihood development programmes.***

Keywords: Adaptation, Climate Variability, Livelihood, Local Perceptions, Weliso Wereda

1. Introduction

There is a worldwide consensus that global warming is a real, rapidly advancing and widespread threat facing humanity this century. Scientists continually presented evidences and tested models to substantiate this truly alarming fact (Chaudhary and Aryal, 2009). In its fourth assessment report, the Intergovernmental Panel on Climate Change (IPCC) concluded that climate variability is already happening with its multi-faceted effects on human society and the environment. Climate variability (CV) will certainly have effect on sustainable development of biodiversity, water, forests, land and oceans as well as in relation to various sectorial activities (WMO, 1992).

There are spatio-temporal variations in the vulnerability and adaptive capacity among countries, regions, economic sectors and social groups (IPCC, 2001). Africa in general and Ethiopia in particular is among the most vulnerable region to climate variability with little adaptive capacity. Climatic and ecological changes have resulted in several negative consequences on livelihood, health, economy and environment of the people in Ethiopia (Eriksson, 2006). Recurrent drought, famine and flood are the main problems that affect millions of people in the country almost every year (NMSA, 2007). The impact of climate variability is further aggravated by poverty and population pressure. Studies have shown that climate variability has potential to have several negative impacts on human welfare, natural resources and development activities in the country (IPCC, 2007).

Yet, there are indigenous knowledge and practical experiences in respond to adaptation needs. This knowledge needs to be exploited properly for better understanding and sustainable management/use being integrated and empowered with scientific and technological inputs. However, local and traditional knowledge are not well documented and structured for the benefit of policy and decision making. For example, empirical studies made about local awareness on CV are very limited in Ethiopia (Adane, 2009). Furthermore, there is little awareness of the contribution of everyday individual actions to the problem of CV (Whitmarsh, 2009) as well as lack of appropriate incentives for community involvement in conservation (Mogoka, 2001 cited in David, 2009). It has been argued that governmental and external actors need to strengthen the adaptive capacity of rural people and take advantage of already existing strategies (Agrawal and Perrin, 2008). The current study assesses CV, its local perceptions and adaptive strategies devised by smallholding farming community in Weliso Wereda, central Ethiopia.

2. Research Methodology

2.1. Description of the Study Area

The astronomical location of Weliso Wereda is from 8°16'to 9°56' N latitudes and 37°5'to 38°46'E longitudes. Its capital, Weliso town, is about 114km southwest of Addis Ababa. Its elevation ranges from 1680 to 2883masl. The average annual temperature and rainfall are about 1075mm and 19.57°C, respectively while its agro-ecological zones fall in humid (*Dega*) and sub-humid (*Wina-Dega*)

constituting about 30% and 70% of the total area, respectively (WARDO, 2013). The total land use/cover categories account for about 82767ha, of which about 86% are under both arable and cultivated land while forest land covers accounts for about 9%.

The study area is drained by a total of 11 perennial rivers and 23 streams, which may imply the presence of high potential for micro level irrigation schemes. Weliso Wereda has a total population of 144,416, and its sex ratio is 99:100 and about 96% are rural settlers. Out of the total household heads of 21,489, about 94% are male headed households and the remaining is headed by females (WARDO, 2013). The crude population density was 174.5p/km^2. Weliso Wereda is almost entirely inhabited by the Oromo ethnic group of people.

2.2. Research Design

The study area has 33kebeles, of which 3kebeles are purposively selected for the ease of the study based on accessibility, agro ecological zonation and population in the Wereda. These sample kebeles are Dase Jabo, Maru Bebeli and Chefe Mekena (Fig. 2).

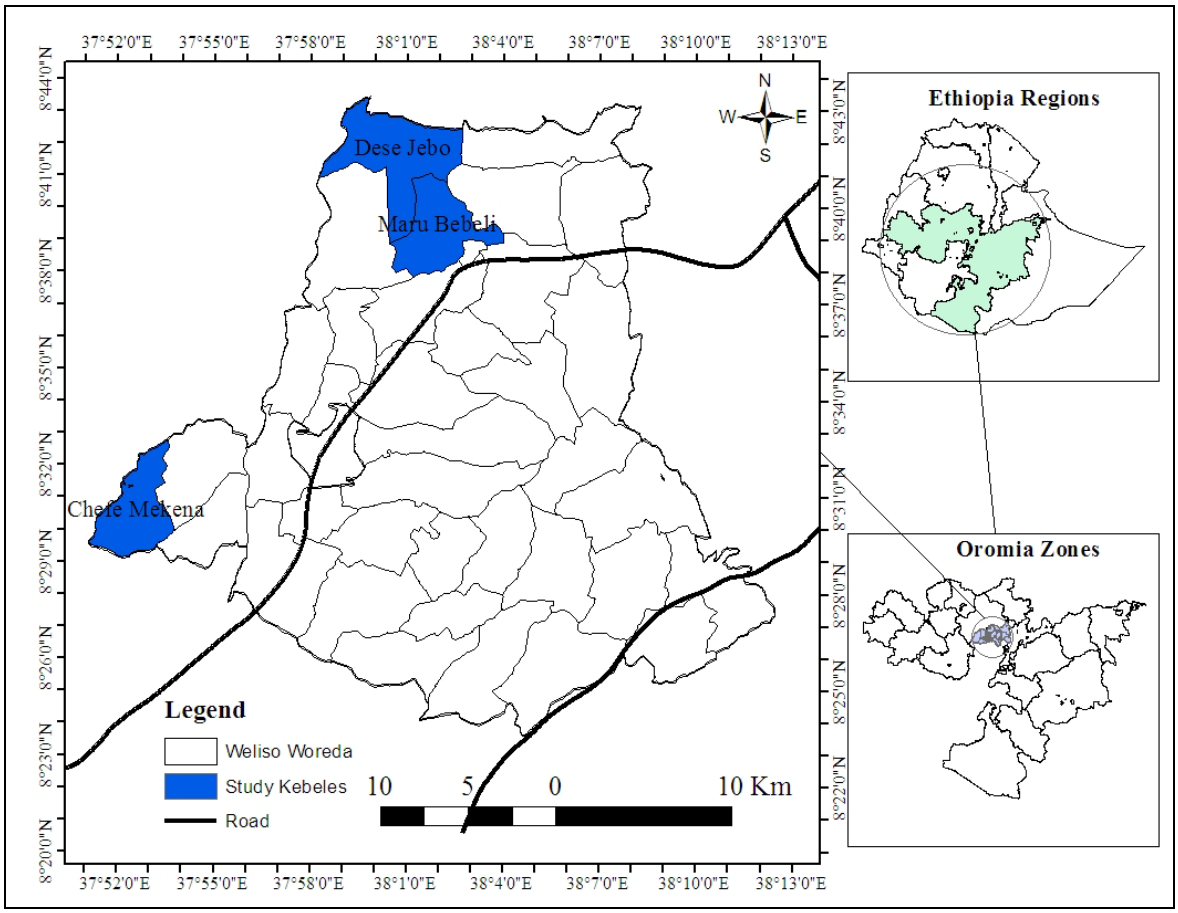


Figure 1: Map of the Study Area

Multistage stratified random sampling technique was used to select the representative sample household heads (SHHs) from the total population under the study area. The computation was determined by using simplified formula of Yamane (1967) as under:

$n=N/1+N\ (e)^2$

Where,
n = the required sample size
N= total household heads
e= expectation/marginal error, i.e., about 7%.

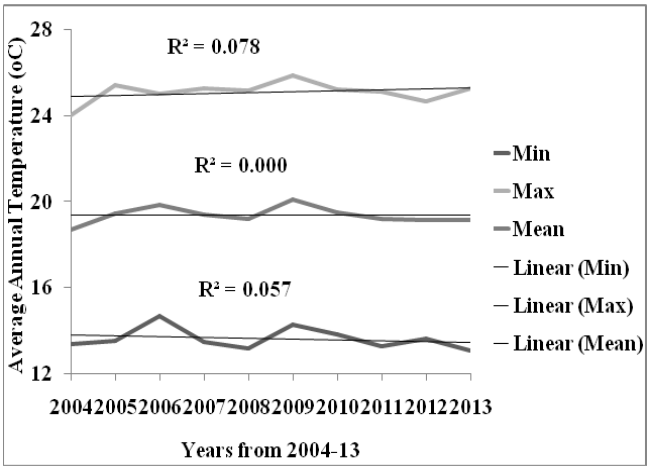
Based on the aforementioned formula, A total of 180 (12%) SHHs are selected as the sample size. Both primary and secondary data sources are used for the current study. The primary data are collected through questionnaire, scheduled interview and focused group discussion. The study used key-informant interviews with 10 community representatives and 6 FGDs. Secondary data are collected from published and unpublished documents identified from government offices, National Meteorological Service Agency, Central Statistical Agency, Haramaya and Jima University and public libraries. Monthly rainfall and maximum and minimum temperature data of 2004 to 2013 were obtained from Adama branch of the National Meteorological Service Agency. Data obtained from various sources were analyzed using descriptive statistical analysis.

3. Results and Discussion

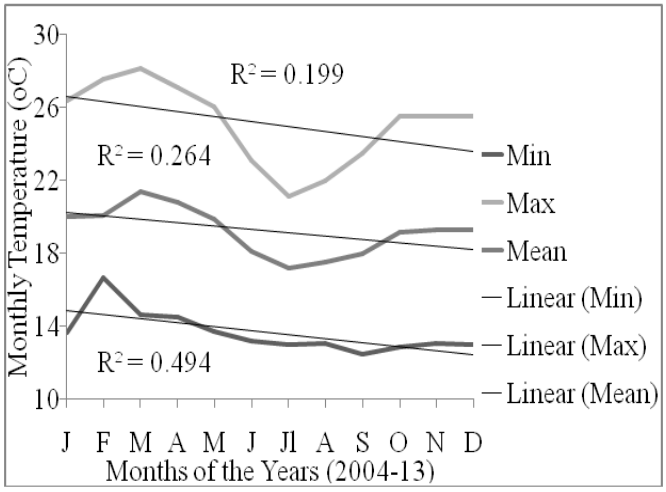
3.1. Climate Patterns of Weliso Wereda

3.1.1. Temperature Patterns

The annual and monthly temperature of the study area for the last one decade (2004-20130 are analysed. According to the annual pattern of the minimum, maximum and mean temperature of the study area, there are little/no significant variations in the case of average annual minimum and maximum temperature that can be seen from their R value below 0.5 (i.e., R= 0.28 and 0.24, respectively). Similarly, there is no significant variation in the mean annual temperature as R value equals 0 (Fig. 2).



Source: Computed based on data from NMSA.
Figure 2: Average Annual Minimum, Maximum and Mean Temperature

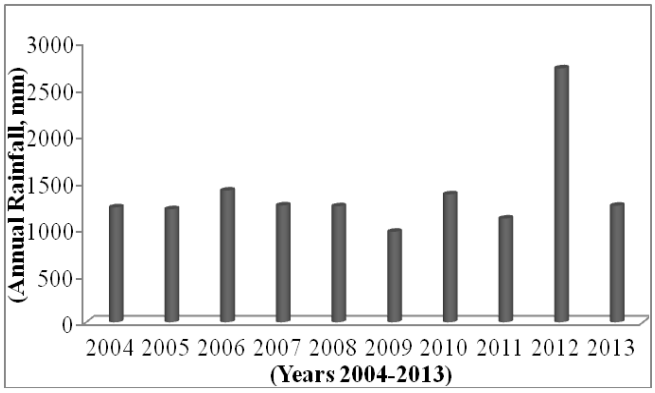


Source: Computed based on data from NMSA.
Figure 3: Average Monthly Minimum, Maximum and Mean Temperature

Conversely, there is significant variation in the monthly mean and maximum temperature for their R value equals to 0.51and 0.70, respectively (Fig.3). Likewise, the R value of the monthly minimum temperature is nearly 0.5 that also implies trend of increase. Such trend of increase in temperature in the Ethiopian highlands is also reported by Muna (2006).

3.2.2. Rainfall Patterns

The average annual rainfall of Weliso Wereda over the last one decade indicates almost uniform amount of rainfall distribution in the study area (Fig.4). The amount of annual average rainfall is closer to 1000mm, with the exception of 2,718.3mm record in 2012 and that of 2009 that received average rainfall of 950mm (Fig.4).



Source: Computed based on data from NMSA.
Figure 4: Annual Rainfall Patterns and Trends of variability

The monthly rainfall distribution in the last decade indicates prevalence of high rainfall record from April to September, constituting about 86.32% of the total amount of rainfall in the study area (Fig. 5). The monthly pattern of rainfall distribution depicts rainfall decline from October until April that clearly reflects the prevalence of seasonality of rainfall in the study area as it is also true to some of such areas in the country.

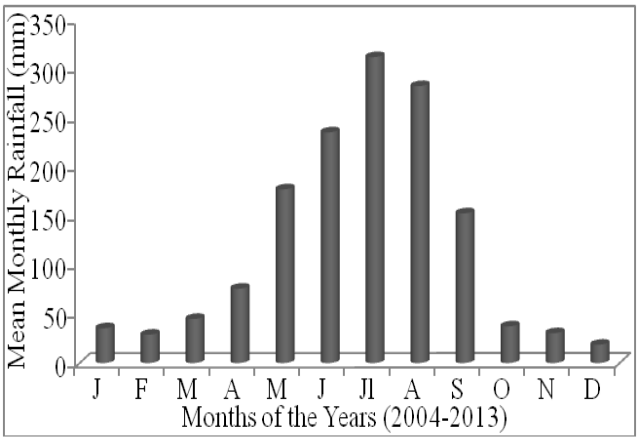


Figure 5: Mean Monthly Rainfall Pattern for the Period 2004-2013

The pattern of seasonality is determined by computing the value of rainfall concentration (RC) for each month based on the method employed by the UNFAO (1965) and adopted by Daniel (1977). According to this computation, the study area receives small rains as the RC is < 0.6 (60%) of the rainfall module and designated as dry months (ONDJFM). While April is rainy month as it received >60% of the rainfall module that made the RC= 0.64 (Table 1).

Table 1: Mean Monthly Rainfall and Rainfall Concentration (P and RC are in mm)

	J	F	M	A	M	J	Jl	A	S	O	N	D
P	35.45	28.9	44.97	75.83	177.19	235.31	312.09	282.48	152.7	29.91	24.33	5.6
RC[1]	0.3	0.25	0.38	0.64	1.51	2.01	2.67	2.41	1.3	0.26	0.21	0.05
Desg.[2]	Dry[3]	Dry[3]	Dry[3]	Rainy[4]	BRM[5]	BRH[6]	BRH[6]	BRH[6]	BRM[5]	Dry[3]	Dry[3]	Dry[3]

Source: Computed from NMSA data; **NB:** RC[1]= Rainfall concentration; Desg.[2]= Designation of the rainfall concentration in the months; Dry[3]= RC<0.6; Rainy[4]= RC>0.6; BRM[5]= Big rains with moderate concentration where RC=1.0-1.9 ; BRH[6]= Big rains with high concentration with RC= 2.0-2.9 (Based on UNFAO, 1965 cited in Daniel 1977).

In general, the other half of the years (AMJJAS) are rainy periods for the RC >0.6. Five of these six months (AMJJAS) are designated as big rainy months as their RC values $\geq$ 1.0 and receive over the rainfall module (Table 2). The study area receives big rains with moderate concentration during May and September, with the RC of 1.51 and 1.3, respectively. The RC >2.0 during the summer season (JJA) and is known for its highest concentration of big rains.

3.3. Local Perception on CV

Local Perception on climatic variation is crucial to design appropriate adaptation and coping strategies especially to those poor countries that are highly vulnerable to the impacts of CV (Whitmarsh, 2009). It is important to have an insight of peoples view on temperature and rainfall variability to dig out locally available adaptation options. Over 87.9% of the SHHs were informed (from Radio, DAs and also NGO participating there). Almost half of the SHHs reported that the major information source on CV was radio while the role played by NGOs and GOs is accounted for relatively at/below one quarter. And about 83.6% of the SHHs perceived about CV. The translated view of key informants on CV is as under:

We lived here in Weliso Wired for about 70 and 65 years. The past temperature is different from the contemporary one.
Due to increased temperature, diseases such as malaria has expanded to the highland area. Moreover, maize and Guayas introduced to our environment. This is new for us in the
more highland areas. In the case of rainfall, during past time,
the spring rainfall was starting from March but at this time starting from May.

3.3.1. Local perception of temperature variability

According to 94% of the SHHs perceived that there is increase in the temperature pattern in the study area. This seems in accordance with the trend analysis of monthly temperatures discussed in section 3.2. The indicators of temperature variability perceived by the SHHs are drying up of rivers and streams, crop damage by pests, newly introduced human and animal disease, and species shift to upper altitude, and introduction of new plant and animal species (Table 2). During FGD and key informant interview, local community representative listed additional indicators of temperature increase in Weliso wired, namely increase in water consumption, loss of biodiversity and land degradation.

Table 2: Locally Perceived Indicators of Temperature Increase (N=180)

Locally Perceived Indicators	*Frequency*	*Percent*
Drying up of river and stream	173	96
Crop Damage by pests	137	76
New human and animal disease	110	61
Species shift to upper altitude	108	60
New crop pests and animal species	59	33

Source: Field Survey, 2013.

3.3.2. Local perception on rainfall variability

Most of the participants of semi-structured interview, key informant interview and FGDs recognized and perceived the prevalence of rainfall variability in duration, intensity and distribution. About 96% of SHHs indicated increased rainfall variability in the study area. The local community perceived the shift in the beginning of spring rainfall from March to May. For instance, in 2009 spring rain started too late on June and the 2011 in May it was characterized by high distribution and sufficient amount, what goes in line with the aforementioned RC value and its designation in Table 1.

The perceived impacts of such variability in rainfall include emergence of pests and disease, interruption in crop calendar of such spring crop production as root crops and vegetables, death of livestock, etc in 2009 and 2011. In general, it affected both agricultural activities and human wellbeing. This has adversely affected in the highlands of Weliso Wired failure of the spring rain led to failure of root crops and other green vegetables production in 2009 and 2011. The survey results revealed that about 94.5% of the SHHs perceived the prevalence of impacts of climate variability in recent time. They also stated that the 2012 rainfall of Weliso Wereda was almost twice of the other years within a decade that led for flooding and land degradation especially during the summer season that affected many farm land and crop production activities along hillsides and rugged relief areas in the study area.

3.4 Local Perception on Indicators and Impacts of CV

The indicators by perceived local community were increase in loss of livestock and plant species; shortening of growing period; high rainfall variability; rise prevalence of animal and human disease; decline in agricultural yield and in availability of water in Weliso Wereda over the past 10 years (Table 3). The most common crops/plants vulnerable for climate induced pests and diseases in were enset, wheat, barley, and teff (WARDO, 2013) while climate induced health disasters were malaria, diarrhoea and typhoid, which shifted from relatively lowland to midland and highland areas, become newly introduced in to the area. Furthermore,

enset (which is the most staple food and supports the livelihood of the people of the Weliso Wereda) has continually dried up as victim of newly prevalent enset disease.

Table 3: Local Perceived Indicators of Rainfall Variability

Indicators of Rainfall Variability	*Items*	*Frequency*	*Percent*
Loss of livestock and plant species	Increased	124	69
	Decreased	56	31
Shortening of growing period	Increased	175	94
	Decreased	5	3
Rainfall comes lately and goes early	Increased	175	97
	Decreased	5	3
Decline of agricultural yields	Increased	164	91
	Decreased	16	9
Availability of water	Increased	13	7
	Decreased	167	93
Expansions of human and animal disease	Increased	171	95
	Decreased	9	5

Source: Field Survey, 2013

Under CV, small increase in temperature and variability in precipitation can result in measurable impacts on pests and diseases (Aklilu and Alebachew, 2009). Likewise, rising temperatures are changing the geographical distribution of disease vectors, through migrating to new areas and higher altitudes (for example migration of the malaria mosquito) and thereby expose large numbers of previously unexposed people to infection in the densely populated East African highlands (Boko, 2007).

3.5 Livelihood Strategies

3.5.1 Adaptive Strategies by Local Community: About 86% of SHHs engaged in numerous adaptive measures towards CV and its impacts. The major adaptation strategies devised by them reforestation, afforestation, terracing, family planning, change in cropping pattern, and growing short-maturing crops (Table 6). Mostly, the community agreed to af/reforest and terrace hilly slopes and degraded land cover using enclosure from human and livestock interventions.

Recently, rainfall in the study area has shown variability. As a result, farmers could not be certain about rainfall duration and amount from the onset to offset. According to them, even after the onset, rainfall could be heavy or light or it may stop earlier than the expected time. The farmers are aware about the type of crops planted in accordance with the characteristic (pattern) of the rain. The crops grown in the area in their decreasing order of importance include teff, wheat, barley, maize, vetch, flax, nuge, chick bean and bean (WARDO, 2013).

Table 6: Household's responses to climate variability (N=180)

Responses to Climate Variability	*Yes*		*No*	
	Freq.	*Percent*	*Freq.*	*Percent*
Reforestation	165	91.4	15	27
Aforestation	159	88.6	21	11.4
Rainwater harvest	17	9.3	163	90.7
Terracing	170	94.3	10	5.7
Family planning	143	79.3	37	20.7
Change cropping pattern	139	77.1	41	22.9
Growing short maturing crops	132	73.6	48	26.4

Source: Field survey, 2013

According to FGD participants and key informant interview, early maturing crop are planted due to shortening of growing season in the study area. For instance, spring season is shortened from three to one month. Therefore, high yield varieties of wheat, barley, beans and potato become familiar to grow during this short season. Similarly, Guayas and maize were introduced and become among the dominant crops in the middle and highland areas of the study area in response to the effects of CV. Conversely, only 90.7% of SHHs have not practised rain water harvesting (Table 6). The reason hindering from the practice were erratic nature of rainfall, increase in evapotranspiration, and low level of awareness about rainwater harvest technology. Result of FGD, key informant interview and experts also showed involvement of farmers in non-farm activities to subsidize their agricultural income. These include wage labour, petty-trading, charcoal making, firewood selling, daily labour work and temporary on-farm work in flower/horticulture farms. Moreover, CV, population growth, land scarcity and degradation, low crop productivity and lack of grazing land enforces remarkable people to migrate to Tolay (Jimma), East Shewa (Meki), Alemgena and Addis Ababa for employment and earning income.

3.5.2 Strategies by GOs and NGOs

There were some NGOs continued to work in Weliso Wereda since 2010, though not directly targeted to CV. Some of these are Green Ethiopia Agro forestry (GEA), Sustainable Land Management (SLM), Agricultural Growth Program (AGP), UNICEF and PROGIANIST. Most of their activities focus on livelihood diversification, introduction of improved agricultural inputs including empowering cultural practices, improved high yielding and early maturing crop varieties and improved bee-hives with accessories, plantation of indigenous fodder trees, shrubs, herbs and grasses along selected watersheds, improvement of rural infrastructure through construction and maintenance of rural access road, health facilities, school classrooms and farmer training centres (FTCs) and formation of Self-Help-Groups (SHGs), building hand pump water, etc. The SHGs supported by the NGOs and provided with high yield varieties and technical training and access to capital through saving and credit ventures, The NGOs also participate in Integrated Watershed Management in collaboration with the government since 2009. Despite the higher level of perception, only 80% of the respondents took remedial actions. Out of these, about 62% reported that their adaptive measures not successful. The major hindrances of effective practice of adaptation measures identified by major respondents were poverty; scarcity of water, forage/feed and land; lack of meteorological information, agricultural inputs,

and access to health, social and political institutions, and capital.

4. Conclusion

Climate variability and its perception on causes, indicators, impacts and livelihood strategies by smallholding farmers is the topic of the day. The current study identified the relatively congruence between the meteorological data processed and perception by local community on issues of CV in Weliso Wereda. Various mechanisms are devised by numerous stakeholders to adapt/cope with such variability. Despite this fact, integrated and sustainable environmental, socio-economic, institutional and political oriented modifications and development programmes needs to be strengthened towards transformation into climate-resilient livelihood and rural development.

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