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# Assessment of Climate Variability Context and Local Farmers' Adaptation Strategies in Halaba Special Woreda, Ethiopia

Yericho Berhanu[1, *], Mulugeta Tesfa[2], Mulugeta Bekele[1]

[1]Wondo Genet College of Forestry and Natural Resources, School of Natural Resources and Environmental Studies, Hawassa University, Hawassa, Ethiopia
[2]Wondo Genet College of Forestry and Natural Resources, School of Wildlife and Ecotourism, Hawassa University, Hawassa, Ethiopia

## Email address
berhanuyericho@yahoo.com (Y. Berhanu), yerichob@gmail.com (Y. Berhanu)

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## Abstract
The main purpose of this study was to assess climate variability context and local farmers' adaptation strategies in the Halaba special Woreda (district) of southern nations and nationalities regional state of Ethiopia. The mean monthly Precipitation data of 24 years (1989 up to 2012) was collected from National Meteorological Agency and socio - economic data was collected from 184 sample respondents selected using simple random sampling techniques. The Precipitation data was analyzed by transforming into standard precipitation index. The socio - economic data was also analyzed by using descriptive statistics. The study results manifest that the district is characterized by its recurrent drought and flood occurrence for the last two decades. It was assured that 58.33% of the years under investigation were characterized by severe drought occurrence with magnitude of one to four months in each year. On the other hands, the flooding was occurred in every year with magnitude of one to four months. To escape from adverse impacts of climate variability, the local communities developed proactive and reactive adaptation strategies. Changing the growing seasons, using improved crop varieties, crop rotation, intercropping, plowing along the contour, construction of soil bunds, saving agricultural products, buying water for livestock consumption, and being the member of "Idir" are the major adaptation strategies in the area. In spite of having several local adaptation strategies, the smart adaptation strategies should be identified and scaled up.

## Keywords
Adaptation Strategies, Halaba Special Woreda, Climate Variability and Idir

## 1. Introduction

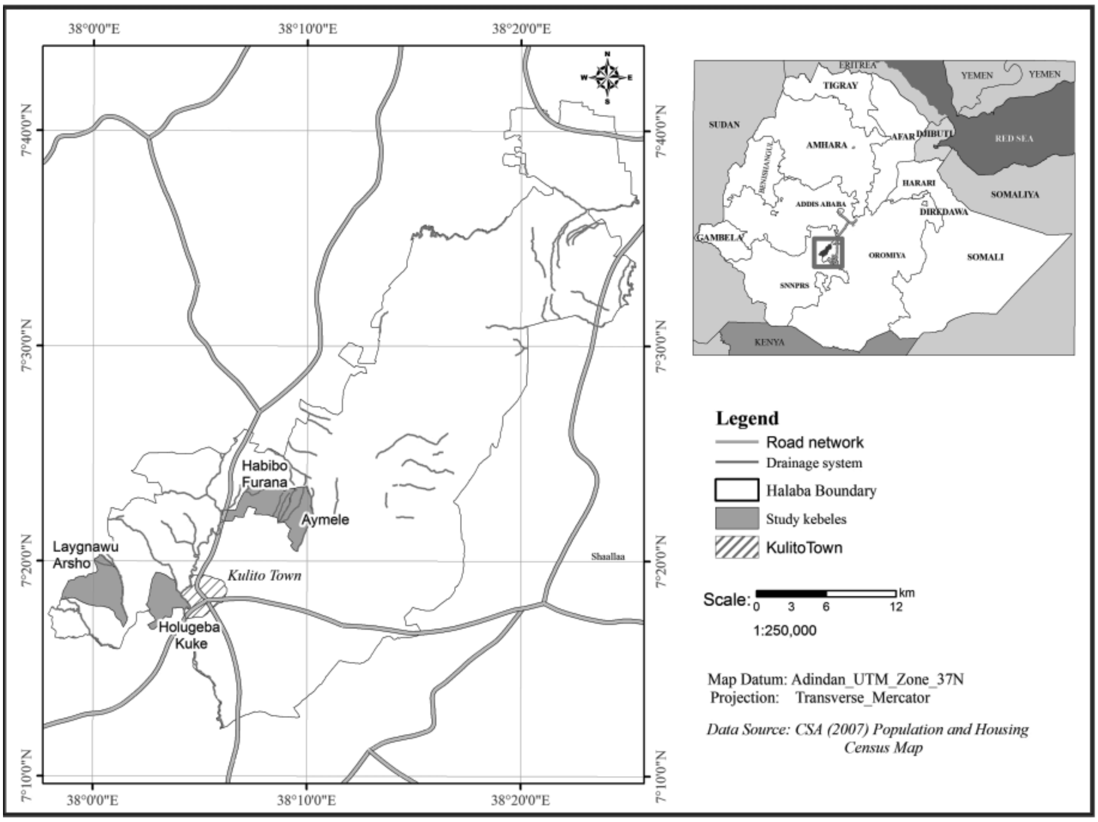
Climate variability is the common phenomenon which is manifested by the changing of the pattern of precipitation, rise and fall of temperature and recurrent occurrence of extreme events (IPCC, 2007). The two most common extreme events of climate variability are drought and flood. Drought is a normal and recurrent feature of climate that occurs almost everywhere although its features vary from region to region. In the most general sense, drought originates from a deficiency of precipitation over an extended period of time resulting in a water shortage for some activity, group, or environmental sector. Flood is often understood to indicate out-of bank flow, when the normal channel cannot convey the total water flow, which spills beyond the channel and causing damage (Kundzewicz et al., 2002).

The climate variability affects all sectors of economy and the occurrence of extreme events continues for every generation of human being (Kundzewicz et al., 2002). However, the degree of exposure to risk (vulnerability) is variable through the economy system. The agrarian society in the developing countries are highly vulnerable for adverse effects of climate variability since they are characterized by endemic poverty, poor farming system, lack of technology and infrastructures, shortage of financial resources, ecosystem degradation, complex disaster and conflicts as well as lack of skilled manpower (UNECA, 2011; Tadesse, 2010; IPCC, 2007; IPCC, 2008).

The adverse impact of climate variability in Ethiopia is significant since the political economy of country depends on rain feed agriculture (Bezabih et al., 2014; UNECA, 2011;

IPCC, 2007). Agriculture serves as a corner stone for Ethiopian economy; 50% of gross domestic product, 84% of export and 80% of job opportunity in the country relay on it. Due to its heavy reliance on rain fed agriculture, climate variability most obviously manifested in endemic, devastating droughts and floods shocks the Ethiopian economy (World Bank, 2006).

To minimize the adverse impacts of climate variability, there are two options: mitigation and adaptation. Mitigation is reduction of greenhouse emission and it is mainly the responsibility of developed countries. Adaptation is adjustment of ecological, social and economic systems in response to observed or expected climate variability through changes in the processes, practices, or structures to moderate detrimental consequences and enhance beneficial ones (Adger et al., 2005; IPCC, 2001).




Source: (CSA, 2007)

***Figure 1.*** *Map of the study area.*

Ethiopia has experiences of policy making and institutional arrangements to respond to climate variability and drought hazards for nearly half a century, on which it can build on future climate change adaptations (Aberra, 2009). Accordingly, the government of the country has been implementing integrated watershed management throughout the country. The effort of government on combating climate variability and developing sustainable agriculture is indispensible (Salehu et al., 2011).

Besides to government concern, the local communities in different parts of the country have developed several adaptation strategies for climate variability. To cope with the situation, pastoral societies in southern lowlands have long accumulated experiential local knowledge base, systems of resource management, and social networks and economic strategies (Amsalu and Adem, 2009). Changes in cropping and planting practices, reduction of consumption levels, collection of wild foods, use of inter-household transfers and loans, increased petty commodity production, temporary and permanent migration in search of employment, grain storage, sale of assets such as livestock and agricultural tools, mortgaging of land, credit from merchants and money lenders, use of early warning system, food appeal/aid are the traditional and contemporary coping mechanisms of climate variability in Ethiopia (NMA, 2007).

The existing literatures shows the empirical studies were done either at national level or in pastoral communities, while less focus is given to lowland agrarian societies of the country where rainfed agriculture is dominant (Osman and Sauerborn, 2002; Dercon, 2004; Seleshi and Zanke, 2004; NMA, 2007; Deressa et al., 2009; Deressa et al., 2008; Amsalu and Adem, 2009; Brayan et al., 2009; Edossa et al., 2009; Tesso et al., 2012; Mengistu and Haji, 2015). For instance, Seleshi and Zanke (2004) studied rainfall and rainy days at national level. Similarly, Edossa et al. (2009) investigated the drought characteristics in Awash basin at large scale. Hadgu et al. (2013) also analyzed the trend and variability of rainfall in Tigray, Northern Ethiopia. In the cases of Adaptation strategies, Brayan et al. (2009) studied the adaptation to climate change in Ethiopia and South Africa, with having 1800 Household Respondents from both countries. So far, the empirical evidence was less focused on low land agrarian societies in the country in general and in southern parts of the country in particular. So that, understanding climate variability context and local communities' adaption strategies of climate variability in agrarian societies is vital to come up with solid and concurrent management strategies in the country as well as in the region. Therefore, this study is concerned to assess the climate variability and farmers' adaptation strategies in the Halaba special Woreda (district) of southern nations and nationalities regional states of Ethiopia. Halaba is entirely lowland, where agriculture is the main stay of the economy accommodating about 87.8% of the total population as a source of employment and subsistence (SNNPR, 2011).

# 2. Materials and Methods

## 2.1. Area Description

This study is conducted in Halaba Special Woreda in SNNPR, Ethiopia. It is located in the upper rift valley region of southern central Ethiopia. Astronomically, it lies between 7.21°-7.62° North latitude and 38.05°- 38.44° East longitudes. It is situated in north eastern part of SNNPR, and it is 310 km away from Addis Ababa. It covers an area of 991 $Km^2$. It is bordered with Oromiya regional state in the east, the Siltie zone in the northwest, Hadiya and Kembata-Tembaro zones in the south and southeast (Figure 1). The mean annual temperature ranges between 17.6°C and 22.5°C, with the highest of 34.45°C and lowest of 16.42°C in January and April respectively. The topography is characterized by sloppy hills in the western half and a gradually descending to undulating plain and it is drained by intermittent streams and the river Bilate.

## 2.2. Methodology

Mean monthly precipitation data was collected from the National Meteorological Service Agency of Ethiopia for a total of 6 stations namely; Halaba-Kulito, Angacha, Durame, Hosanna, Mayokote and Shone stations which found within and nearby the study area. The study period (1989–2012) has been selected due to the availability data for all stations. The missing data were estimated by using the following formula (Das, 2009):-

$$\mathrm{P_x} = \frac{\mathrm{P_1} + \mathrm{P_2} + \mathrm{P_3} + \cdots + \mathrm{P_m}}{\mathrm{m}}$$

Where $P_x$ is the missing mean monthly precipitation, $P_1$, $P_2$, …, $P_m$ are mean monthly precipitation data recorded at m number of nearby stations.

The district comprises a total of 79 kebeles (sub districts) that show difficulty to include the entire district for investigation and hence, 4 sub districts are selected based on accessibility. The individual household from each sample sub district is selected using simple random sampling techniques. The sample size was determined by using the following formula (Cochran, 1977):-

$$n = \frac{(Z\alpha/_2)^2 * p(1-p)}{d^2}$$

Where n is the sample size needed to include the number of household. P is the proportion of households in the selected sub district and the value is 0.5 that is obtained using pilot survey. The term d is called margin of error such that the value for it is 0.07. This value is acceptable since it is less than 10%. $Z_{\alpha/2}$ is the critical value using α=0.05 and has a value 1.96.

$$n = \frac{1.96^2 * 0.5(1-0.5)}{0.07^2} = 184$$

Then proportional sample size allocation for each sub districts weighs the population for each sub district and hence$W_j$ is the proportion of the number of households in a given sub district with the total population. After calculating $W_j = \frac{N_j}{N}$ and the number of sample size in each sub district determined using the formula: $n_j = W_j * n$. The result is presented in table 1.

*Table 1. Sample size distribution based on sub districts Households.*

| Name of sub districts | Total Households ($N_j$) | Proportions ($w_j$) | Sample sizes ($n_j$) |
|---|---|---|---|
| Laygnawu Arsho | 748 | 0.303 | 56 |
| Aymele | 617 | 0.250 | 46 |
| Habibo Furana | 483 | 0.199 | 37 |
| Hulugeba Kuke | 609 | 0.247 | 45 |
| Total | 2467 | | 184 |

The socio economic data was collected from 184 households using questionnaire survey designed for this purpose. The questionnaire was pre tested on 20 selected farmers in district before the actual implementation of data collection. Besides this, data was also collected through field observation, focused group discussion and key informants interview. Field observation was focused on observation of biophysical characteristics of sub districts including land degradation, crop patterns, distribution of settlements, individual activities in the farming plots, farmers' land and water resources management practices in all sampled sub districts of the study area. Total of eight focused group discussion having 8-12 people in each group was conducted based on checklists and semi-structured questionnaires. During this session, the people or participants of focused group discussion expressed their opinions, views, feelings and perspectives about discussion points freely. Key informants interview was carried out with 4 elders, 4 local administrators and 4 experts. Identified key informants have deep deep-rooted experience and knowledge of their environment.

The collected data was analyzed by its type: Meteorological and socio economic data analysis. Meteorological data was analyzed using standard precipitation index (SPI). The SPI is developed to define and monitor drought (McKee et al., 1993). They define criteria for a drought event at a given time scale of interest for any rainfall station with historic data. The SPI is computed by fitting a probability distribution density function to the frequency distribution of precipitation summed over desired time scale. The probability function is transformed in to the standard normal distribution (Z-distribution) called SPI. In this study SPI was calculated for 1 month, 3 months and 12 months' time scale. Before calculating the SPI, the equivalent uniform depth of precipitation was computed using the following formula (Das, 2009):-

$$\overline{P} = \frac{\sum_{j=1}^{m} P_j}{m}$$

Where $\overline{P}$ is equivalent uniform depth of precipitation

$P_1, P_2, \ldots, P_m$ are mean monthly precipitation of each station and m is number of stations.

SPI is a Z-score that indicates an event far from the mean expressed standard deviation units.

$$Z = \frac{(Xi - \mu)}{\delta}$$

Where Z is SPI, xi is observed precipitation, μ is mean of precipitation and δ standard deviation

The value of SPI is categorized into different classes as indicated in table 2.

The collected socio economic data was analyzed using descriptive statistics such as frequency, percentage, mean and standard deviation. Chi square test was employed to test the significance of categorical data. Accordingly, it was employed to test the significance of adaption strategies identified in the area.

# 3. Results and Discussion

## 3.1. Drought and Flood Occurrence in Halaba District

The two extreme events of climate variability are common phenomenon for the last two decades (1989 to 2012) in Halaba district. The standard precipitation index (SPI) result indicates that the district engross different types of drought and flood (Figure 2, 3 and 4).

***Table 2.*** *Period classification based on SPI.*

| SPI classes | Period classification | SPI classes | Period classification |
|---|---|---|---|
| $SPI \le -2$ | Extremely dry | $1 < SPI \le 1.5$ | Moderately wet |
| $-2 < SPI \le -1.5$ | Severely dry | $1.5 < SPI \le 2$ | Very wet |
| $-1.5 < SPI \le -1$ | Moderately dry | $SPI > 2$ | Extremely wet |
| $-1 < SPI \le 1$ | Normal | | |

Source: McKee et al., 1993

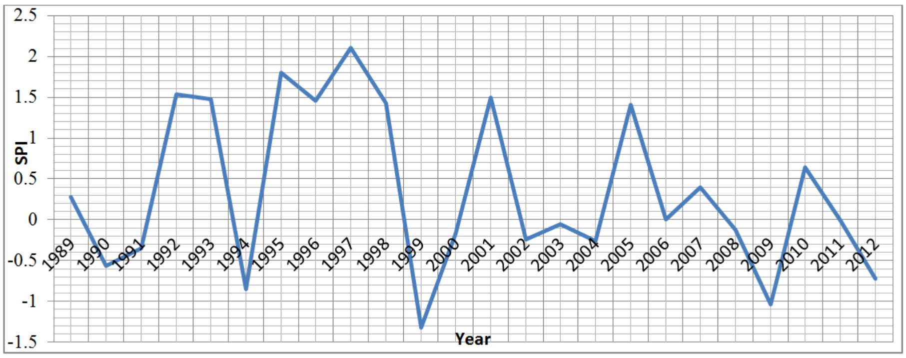



***Figure 2.*** *Twelve Monhts SPI distribution for 24 Years (1989-2012).*

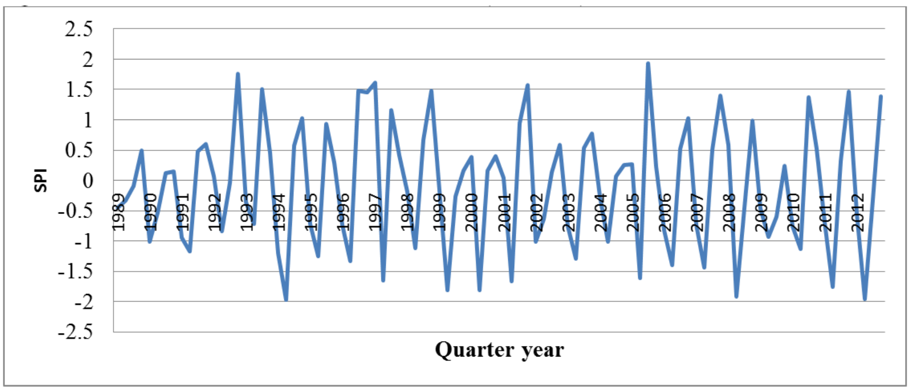



***Figure 3.*** *Three Monhts SPI distribution for 96 quarter years (1989-2012).*

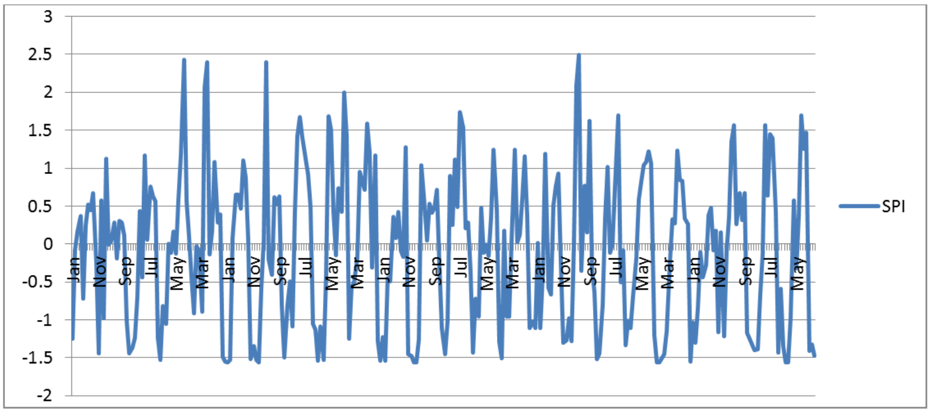


***Figure 4.*** *Monhtly SPI distribution for 288 Months (1989-2012).*

The result of SPI showed in above figures 2, 3 and 4 is summarized in table 3 as follows.

***Table 3.*** *Relative distribution of the SPI in 1 month, 3 months and 12 months time scale in the district.*

| Period category | Observed Frequencies | | | | | |
|---|---|---|---|---|---|---|
| | 12 Months | | 3 Months | | 1 Month | |
| | n | (%) | n | % | n | % |
| Extremely Dry | 24 | 0 | 96 | 0 | 288 | 0 |
| Severely Dry | 24 | 0 | 96 | 9.4[b] | 288 | 7.29[c] |
| Moderately dry | 24 | 8.34[b] | 96 | 12.5[b] | 288 | 18.75[b] |
| Nearly normal | 24 | 58.33[a] | 96 | 62.5[a] | 288 | 57.64[a] |
| Moderately wet | 24 | 16.67[b] | 96 | 4.2[b] | 288 | 10.4[c] |
| Very wet | 24 | 12.5[b] | 96 | 11.4[b] | 288 | 3.47[d] |
| Extremely wet | 24 | 4.16[b] | 96 | 0 | 288 | 2.43[d] |

Superscript letters in the table show the significant variability with 0.05 level of significance.

The 12 months (yearly) SPI result showed that out of 24 years 14(58.33%) were characterised as normal, 4(16.67%) as moderately wet, 3(12.5%) as very wet, 1(4.16%) as exteremly wet and the reamining 2(8.33%) as moderatley dryin the district (Figure1 and Table 3). The variation of SPI distribution is statistically siginifcant. Similarly, quarterly SPI result showed that the Halaba district has 62.5% normal, 12.5% modertley dry, 9.4% severly dry, 11.4% moderately wet and 4.2% very wet clamatic conditions for last two decades (Figure 3 and Table 3). The variation in the distribution is statistically siginifcant. Moreover, the monthly SPI result manifest that 58.33% of the total peroid has normal climatic condition. However, the remaining 41.67% were characterised as extreme event causing climatic conditions (dry and wet). The monthly SPI distribution is also statisitically variabile for the last two decades (Figure 3 and Table 4).

The three time scale SPI results showed the significant climate variability since 1989 up to 2012. The significance variation of SPI in 3 and 12 months is due to higher proportion of normal climatic condition, while in 1 month it is because of significant variation in all SPI distribution across period category. As presented in Table 3, out of 288 months, 26.04% were dry months including severely dry with the probability of 7.29% and moderately dry with the probability of 18.75%. The distribution of SPI within dry category is significantly variable. The data presented in figure4 shows that the severe dry condition occurred since 1991,1993,1995,1996,1997,1998,1999,2002,2005 and 2008 for one month duration(magnitude), 2000 and 2012 for two months, 2007 for three months and 1994 for four months. These show that out of 24 years, 58.33% of years were characterized by the occurrence of severe dry climatic condition with duration of one to four months (Figure4). Furthermore, moderately dry occurred every year for the last two decades. Of this, since 1995 moderately dry occurred for five months, 2010 and 2011 for four months, 1996, 1999, 2001, 2003, 2004, 2006, 2009 and 2012 for three months, 1997, 2007 and 2008 for two months and the remaining nine years for one month.

The result in figure 4 also shows that drought occurred every two years before 1993, every one year from 1993 to 1999, and every three years from 1999 to 2007 with duration (magnitude) of drought ranges one to four months in each year. Lastly, it shows the highest lag (four years) from 2008 to 2012. These evidences suggest not only drought occurrence, but also variability of the drought magnitude from year to year is common in Halaba district. This result is in line with the findings of Edossa et al. (2009) that verifies the most frequent occurrence of drought in upper and middle Awash Basin. Similarly, Hadgu et al. (2013) also found that the high rainfall variability and drought condition in Northern Ethiopia in the last decade. They also proof the high inter-annual variation rainfall in Tigray region. Moreover, the study of Tesso et al. (2012) found the high rainfall variability over the last couple of decades in North Shewa Ethiopia.

***Table 4.*** *Probability of dry and wet climatic condition occurrence by months from 1989 up to 2012.*

| Months | Months Classification | | | | | | |
|---|---|---|---|---|---|---|---|
| | Moderatey dry | Severely dry | Extremely dry | Normal | Moderatey wet | Very wet | Extremely wet |
| Jan | 41.7% | 12.5% | 4.2% | 33.3% | 4.2% | 0.0% | 4.2% |
| Oct | 37.5% | 0.0% | 8.3% | 45.8% | 8.3% | 0.0% | 0.0% |
| Nov | 58.3% | 8.3% | 4.2% | 25.0% | 4.2% | 0.0% | 0.0% |
| Dec | 45.8% | 20.8% | 4.2% | 25.0% | 0.0% | 0.0% | 4.2% |
| Feb | 29.2% | 16.7% | 0.0% | 45.8% | 4.2% | 0.0% | 4.2% |
| Mar | 8.3% | 0.0% | 0.0% | 91.7% | 0.0% | 0.0% | 0.0% |
| Apr | 0.0% | 0.0% | 4.2% | 58.3% | 25.0% | 4.2% | 8.3% |
| May | 0.0% | 0.0% | 4.2% | 66.7% | 12.5% | 12.5% | 4.2% |
| Jun | 0.0% | 0.0% | 0.0% | 91.7% | 8.3% | 0.0% | 0.0% |
| July | 0.0% | 0.0% | 0.0% | 62.5% | 25.0% | 12.5% | 0.0% |
| Aug | 0.0% | 0.0% | 0.0% | 58.3% | 33.3% | 8.3% | 0.0% |
| Sep | 0.0% | 0.0% | 0.0% | 87.5% | 8.3% | 4.2% | 0.0% |

As it can be seen in table 4, October, November, December, February and March are dry months. The probability of dry conditions occurrence in November and December are highest (70.8%) followed by January (58.4%) and February (45.9%).

The Halaba district is characterized not only by drought occurrence but also it receives very wet and extremely wet conditions which are responsible for flood occurrences for last two decades. The data presented in table 3 shows that the area receives excess rainfall for 47 months for the last two decades, which is 16.3 % of total time duration of analysis (1989 to 2012). Of this, 2.43% is characterized by extreme events of flood, 3.47% by severe flood and 10.4% by moderate flooding. The distribution of SPI within wet category is significantly variable.

The data presented in figure 4 revealed that extreme wet situation was observed in the years 1992, 1995 and 1997 for one month and in the year 1993 and 2005 for two months. Very wet condition occurred since 1996, 1997, 1998, 2005, 2006, 2010, 2011 and 2012 with duration of one month and 2001 for two months. Similarly, moderate wet was occurred since 1990, 1991, 1992, 1993, 1994, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2006, 2007, 2008, 2010, 2011 and 2012. Of these years 1996, 1997, 1998, 2003, 2004, 2011 and 2012, the duration of flood occurrence was 3, 2, 2, 2, 4, 2 and 2 months respectively, and for the rest years it was occurred for one month duration. These results show that flood occurred in the area for every year with duration ranges of one to four months. This finding is agreed with the other studies (Tesso et al., 2012; Bewket and Convey, 2007). These studies found the complex picture of rainfall variability from decade to daily time scales

The data in table 4 also shows that August, July and April are the three months that receives highest wet condition with probability of 41.6%, 37.5% and 37.5% respectively for last two decades in the district. According to the FGD and key informants interview, the area is highly affected by flooding during these wet months and it was responsible large formation of Gully in the district (Figure 5).

***Figure 5.*** *Photo of Gully formed in the study area.*

To sum up the, district receives the two extreme events of climate variability within the same year. As evidence, since 1993, 1996, 1997, 1998, 1999, 2002 and 2008 both severely dry and very wet condition were recorded in the area (Figure 4). Similarly, moderately dry and moderately wet conditions are common phenomena for last 24 years in the district.

## 3.2. Adaptation Strategies for Extreme Events of Climate Variability

The actual rainfall variability from the mean which is shown by SPI in previous sections shows the recurrent occurrence of drought and flood in the area. To escape from the negative impacts of these climate variability (drought and flood), the local communities developed several adaptation strategies (Table 5 and 6). The adopted strategies are either reactive or proactive. The focused group discussion made with local community members shows that the main purpose of climate variability adaptation strategies used in the area is to reduce the impact of flood, drought or/and both (Table 5 and 6).

## 3.3. Proactive Adaptation Strategies

The general sphere of Proactive adaptation strategies in the area is under the umbrella of watershed management; in which soil and water conservation got due focus by the community. Soil resource management through plowing along the contour, planting tree along the contour, developing soil bunds, crop rotation and intercropping were widely adopted by farmers in the area (Table 5).

***Table 5.*** *Relative frequency of the Respondents' response on proactive adaptation strategies.*

| **Proactive strategies** | **n** | **Respondents' response (%)** | | **$X^2$** | **Main purpose** |
|---|---|---|---|---|---|
| | | **Yes** | **No** | | |
| Plowing along the contour | 184 | 91.3* | 8.7 | 125.565 | Adaptation for Flood |
| Planting along the contour | 184 | 73.9* | 26.1 | 42.087 | Adaptation for Flood |
| Soil bunds | 184 | 75* | 25 | 46.000 | Adaptation for Flood |
| Crop rotation | 184 | 95.7* | 4.3 | 153.391 | Flood and drought |
| Intercropping | 184 | 69.6* | 30.4 | 28.174 | Flood and drought |
| Irrigation | 184 | 21.7 | 78.3* | 58.783 | Adaptation for Drought |
| Water harvesting | 184 | 33.7 | 66.3* | 19.565 | Adaptation for Drought |
| Using of improved crop varieties | 184 | 92.4* | 7.6 | 132.261 | Flood and drought |
| Saving of agricultural products | 184 | 67.4* | 32.6 | 22.261 | Flood and drought |
| Saving of financial capitals | 184 | 41.8 | 58.2* | 4.891 | Flood and drought |
| Member of Idir | 184 | 100* | 0 | - | Flood and drought |
| Designing of house | 184 | 19 | 81* | 70.630 | Adaptation for flood |
| Using of beds which has high height | 184 | 12 | 88* | 106.522 | Adaptation for flood |

** In the table show the significant variable at 0.05 significance level*

These approaches of climate variability adaptation strategies are the planned adaptation strategies of the country and hence, it is highly supported by the government. The rural development policy and strategies of the country is one of the verification of this and it states that the soil and water conservation and environmental protection should be considered to having great importance for agricultural development (MoFED, 2003). Moreover, the agricultural sector programme of plan on adaptation to climate change prioritized these adaption strategies as core activities to reduce the impacts of extreme events of climate variability (Salehu et al., 2011). This finding is also in line with assessment report of a community level climate risk and development project in Guduru, Oromia regional state, in which water harvesting and planting tree are used as a strategy against drought and flood (Keller, 2009). Bryan et al. (2009) also assure that the aforementioned strategies were used as climate change adaption strategies in Ethiopia. However, water harvesting is not significant in this study, while it was reported significant in other studies (Keller, 2009; Bryan et al., 2009).

Saving of available resources is also practiced in the area. The saving is focused not only on financial resources but also on physical resources. The local community save the agricultural products for *kifu ken* (days of food shortage as result of drought and flood). Besides to physical resource saving, financial resource saving has got great attention by the local community. The key informants stated that the presence of financial institutions (Commercial banks, Omo Micro finance organization) in the area helps the farmers to save their financial resource safely and hence it has great contribution for survival of the community in *kifu ken*. This result is also similar with findings of Keller (2009), which shows that reduction of expenses, saving and borrowing are strategies against drought in Guduru, Oromia regional state, Ethiopia (Keller, 2009).

One of the social institutions called *Idir (self helping social group)* which is common in the community has role in supporting the local in *kifu ken* or in the day of danger of not only climate variability but also any problems. The study of Keller (2009) assures that local group called *Idir* is active in the case of death of family member. Moreover, the communities design houses in a way that it can resist flood, and they also use long leg beds to protect themselves from runoff as proactive strategy.

### 3.4. Reactive Adaptation Strategies

***Table 6.*** *Relative frequency of the Respondents' response on Reactive adaptation Strategies.*

| **Re active strategies** | **N** | **Respondents' response (%)** | | | **Main purpose** |
|---|---|---|---|---|---|
| | | **Yes** | **No** | | |
| Borrowing Resources for food | 184 | 24 | 76* | 50.087 | Flood and drought |
| Buying water for livestock | 184 | 100* | 0 | - | Adaptation for drought |
| Selling of livestock | 184 | 70.7* | 29.3 | 31.391 | Adaptation for drought |
| Draining flood | 184 | 69* | 31 | 26.630 | Adaptation for flood |
| Changing place of residence | 184 | 35.9 | 64.1* | 14.696 | Flood and Drought |
| Using of improved crop varieties | 184 | 92.4* | 7.6 | 132.261 | Flood and Drought |
| Changing growing season/calendar | 184 | 100* | 0 | - | Flood and Drought |

** In the table show the significant variable at 0.05 significance level*

Agricultural water management is under practice in the area. The local people pay for their livestock to drink water, and it is the financial source for maintenance of water delivery infrastructures. The price of water ranges from 0.0167 to 0.05 USD per cattle per visit. Moreover, the frequency of the cattle to visit the watering point is limited twice a week.

***Figure 6.*** *Livestock at water market center and irrigation scheme in the area from left to right.*

This locally innovated practice of water management got recognition by both the local community and the officials in the district, and it guaranties sustainable uses of water infrastructure in the area. The practice of water management in agricultural land through irrigation is also practiced. However, the relative prevalence of this strategy (21.7%) is less since the area is characterized by water shortage (Table 5). This water shortage coupled with inefficient irrigation water use is challenge in the area (Figure 6).

Changing of the growing calendar and season is one of the reactive adaptation strategies in the area. The focused group discussion result shows that the growing calendar of maize starts in April first of the year. However, now a day the growing calendar starts in August due to late coming of rain. Partially, the adaptation of improved crop varieties has contributed to overcome this challenge. However, there still is gap of matching the growing calendar with full crop water requirements. Hence, there were evidences in which farmers were forced to change / postpone growing seasons for the next crop growing calendar. The FGD and key informants' interview results show that the growing calendar years such as 1991/92, 1995/96, 1999/2000, and 2004/05 was characterized with full drought and hence, farmers were forced to change growing season in these years. The findings of ATPS (2013) assures that farmers were shifted the sowing and harvesting dates of their crops as an adjustment to changing climate especially rainfall variability.

During the long duration of drought, farmers were also forced to sell their livestock for two reasons; to reduce the death of livestock and to get financial resource to buy food for their consumption. However, the lack of market for livestock was the observed challenge at the time of drought years since all of the farmers focused on selling rather than buying it.

The extreme effect of excess rain is flood and managed through draining in the area. Majority of the respondents (69%) drains the flood when it comes in excess to minimize the damages it causes such as destruction of infrastructures and prevalence of water related/borne diseases especially malaria. Furthermore, some of the respondents (35.9%) were forced to relocate the place of residence due to flood. Changing the place of residence either temporarily or permanently is reported as the major strategies in studies of ATPS (2013), while insignificant in this study.

## 4. Conclusion

Climate variability which is manifested by its extreme events of drought and flood is common phenomenon in Halaba District of SNNPR, Ethiopia. The district engrosses two extreme events of climate variability; flooding and drought in each year. The extreme events of climate variability; both drought and flood occurs at least for one month in every year and they may extend up to four months. The result assures that 58.33% of 24 years were characterized by recurrent occurrences of severe drought. The probability of drought occurrences in December is highest followed by January and February. On the other hands, all years were characterized by the occurrences of moderately wet condition and the highest probability is in August followed by July and April.

To minimize the negative impacts of climate variability, the local communities practiced both reactive and proactive adaptation strategies. As proactive adaptation strategies, planting tree and plowing the land along the contour, developing soil bunds, crop rotation, intercropping, water harvesting and irrigation were used in the district. Furthermore, being a member of social institution called *Idir*, saving agricultural products and financial resources and cultivation of improved crop varieties, designing houses in a manner to resist flood and using long leg beds are also used as proactive strategies to reduce climate variability impact in the area. As the proverbs of Ethiopian "*killing two birds with one stone"*; the aforementioned strategies uses for two purposes; for drought and flood.

Payment for livestock drinking water is locally innovated reactive adaptation strategy, and it has great contribution to control and regulate the distribution of scarce water resources. In spite of having this strategy, farmers are forced to sell their livestock during extended drought occurrence and they do this not only to solve the problem of water shortage but also to have financial resource for buying food for their survival. Changing of the growing calendar, draining of flood and changing the place of residence are reactive adaptation strategies in the area.

## Recommendation

It is advisable that the government as well as the local community should expect drought during months December, January and February, and flood during months of August, July and April in the area. This study result assures that the local communities are practicing indispensible role in climate variability management strategies. However, the best strategies were not yet identified. Hence, we recommended that the smart adaptation strategies should be identified and scaled up.

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## Abbreviations

CSA: Central Statistical Agency
IPCC: Intergovernmental panel on Climate Change
MoFED: Ministry of Finance and Economic Development
NMA: National Meteorological Agency
SNNPR: Southern Nations Nationalities and Peoples Regional state
UNICA: United Nations Economic Commission for Africa.

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