Climate Variability and Livelihood Strategies Pursued by the Pastoral Community of the *Karrayu People,* Oromia Region, Central Ethiopia

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Abstract: Variability in seasonal rainfall and precipitation as a result of climate change has been threatening the already fragile livelihoods of pastoral communities in Ethiopia. The current study was conducted to elucidate climate variability, perception, and livelihood strategies in the *Karrayu* pastoral area of Fenatale district, in the Oromia region of the country. A semi-structured questionnaire, key informant interviews, focus group discussions were used to elicit data climate variability and livelihood strategies in the community. One hundred twenty randomly selected sample respondents were used for the study. Assessment of the climate variability was based on reports of Metehara (1968-1984) and Awash (1985-2007) Stations of the National Meteorological Service Agency and primary data collected from the area. Rainfall coefficient (RC), least square regression models (rho), standardized rainfall anomalies (SRA) and coefficient of variation (CV) were used for analysis of the data. The findings identified eight rainy months and four dry months with rainfall coefficients of > 0.6 and < 0.6, respectively. However, March, April and September had a moderate concentration (RC 1.0 - 2.0) while July and August had higher rainfall concentration (RC > 2.0). There was an increase in the maximum and annual average temperature and a decline in the minimum annual temperature from 1965-2007, which was also augmented by the perception of 66% of the respondents. The seasonal rainfall variability was significantly higher (CV ranged from 0.25 to 0.80) than the annual rainfall variability (CV = 0.18). Thus, a large proportion of *Karrayu* pastoralists perceived less water and food (76%), migrated to other areas (73%), became dependent on Participatory Safety Net Program (72%), and eked out a living by collecting and selling firewood and charcoal (57%) as major livelihood strategies. In conclusion, the results of this study have revealed that there have been such persistent increments in temperature and seasonal rainfall variability that the pastoralist community in the area has been markedly resorting to various livelihood strategies to adapt to climate variability and change. However, to complement the community efforts, integrated livelihood development mechanisms better be devised with active involvement of different stakeholders for sustainable development of the pastoral and agropastoral communities of the *Karrayu* including early warning systems, collection of reliable climate data, disaster risk reduction and risk sharing strategies to avert the risk of vulnerable groups of the community from the hazards of climate variability in particular and change in general. Likewise, further critical studies are recommended regarding trend analysis and variability of rainfall of the study area using other parameters to substantiate these findings.

Keywords: Climate Variability; *Karrayu*; Livelihood Strategies; Pastoral Community

1. Introduction

Pastoralism has a great share in national and regional economies for several poorest countries of the world. It serves as a base for local livelihoods and provides multi-directional ecological services (Nori *et al.,* 2008). Pastoral and agro-pastoral societies inhabit the arid and semi-arid environments, which are characterized by high probability of the occurrence of frequent and intense drought and flood (WISP, 2007; Birch and Grhan, 2007). Africa is one of the most vulnerable continents to climate change/variability, and 350–600 million Africans will be at risk of drought and increased water stress by 2050s IPCC (2007). The pastoral and agro-pastoral production systems are mostly vulnerable to increased climate variability (Stige *et al*., 2006; Sithole and Murewi, 2009 cited in Kgosikoma and Batisani, 2014).

Drought occurs anywhere in the world but its damage is not as severe as in Africa in general and in Ethiopia in particular (NMA, 2007). Ethiopia is very vulnerable to the harmful effects of climate extremes primarily drought and flood. Due to climate change/variability, the country has suffered from severe poverty, low adaptive capacity to drought, highly sensitive livelihood to weather, and low access to education, information, technology, and health services (Senait *et al*., 2010).

The adverse effect of climate variability and change is accelerating the already existing pastoral livelihood insecurity (Tagel and Veen, 2015). Knowledge of people's perceptions and adaptation measures are crucial to inform future actions and thereby minimize impacts of climate change. Improving resilience of communities and households to the effects of impacts of climate change

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requires understanding of the existing local practices (Smucker and Wisner, 2008).

The pastoral areas of Ethiopia cover over 60% of the total landmass inhabiting 10 million people (Beruk, 2008). These areas are known for erratic rainfall, which is usually inadequate to meet the physiological water requirements of biotic system. This phenomenon is aggravated by high temperature and strong dry winds, leading to high evapo-transpiration, which in turn accelerates water scarcity to its climax (Mesfin, 2000). There is increased frequency of meteorological drought episodes, unseasonal flash floods and outbreaks of diseases in the pastoral regions of Ethiopia (Debay, 2010). Unlike others, livestock represents a householder's source of income, savings, social status and security of pastoral community and any losses of livestock through droughts and/or flooding results in economic and social disaster at the household level (Orindi *et al.,* 2007). Hence, pastoralists are among the most vulnerable groups of society as they are increasingly being characterized by poverty, food insecurity, environmental risk, and political, economic and social marginalization (Hogg, 1997 cited in Dula, 2013).

Few local level studies have been done on climate change and variability regarding the arid and semi-arid areas of Ethiopia (Gebre *et al.,* 2013; Nega *et al.,* 2015). As there are spatio-temporal variations in the degree of climate change and variability as well as their resilience capacities, informative studies at local level are crucial for reliable data and for decision actions. The current study has been done on *Karrayu* pastoral area in Fentale district of Oromia region where there have been frequent climate-induced disasters, such as drought, flood, and resultant livelihood insecurity. The study was aimed at evaluating the trend and variability of major climatic element; assessing the perception of local pastoral community; and identifying major livelihood strategies to tackle the adverse effects of climate change and variability.

2. Materials and Methods

2.1. Descriptions of the Study Area

Karrayu area (administratively under Fentale district) is located between $8^{0}42'$ to $9^{0}00'$N latitudes and $30^{0}30'$ to $40^{0}11'$E longitudes in East Shewa Zone of Oromia, Central Ethiopia. The capital town of the district, Metehara, is located at the distance of about 200 km south east of Addis Ababa, along the Addis Ababa-Djibouti road and rail ways. The neighbours of Fentale district are the Afar Debine in the north, Arsi Oromo in the south, Awash National Park in the east, the *Ittu* in west Hararghe and the *Argoba* in the west, and Bereket and Shenkora and Minjar districts in the south west (Fig. 1). The study area is situated in tectonically active Main Ethiopian Rift (Goerner *et al.,* 2009) whose topography is characterized by flat, undulating plains, hills and mountain ridges. The altitude ranges from 900 to 2700 meters above sea level (FWARDO, 2007).

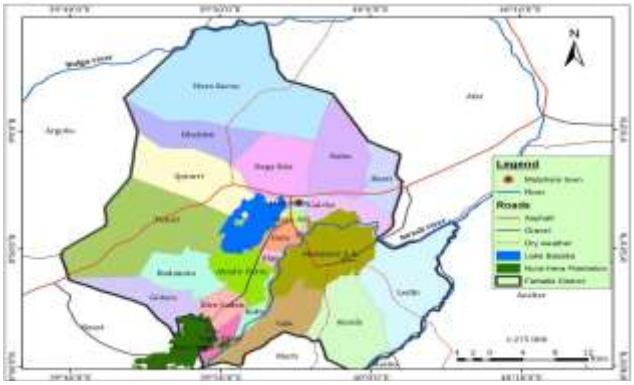


Figure 1. Location map of *Karrayu* area in Fantalle District Source: Dula, 2013.

The average monthly and annual temperatures of the area are 25^{0}C and 26^{0}C, while the average annual minimum and maximum temperatures are 17.3^{0}C and 32.5^{0}C, respectively. The highest rainfall occurs in the Ethiopian summer (*Kiremt*) season (Jun to September) followed by four to eight consecutive months (October through May) that are water deficit (Haji *et al.,* 2015). The total annual rainfall ranges between 400 and 700 mm, which is associated with semi-arid (*kolla)* agro ecological zones or dry/arid climatic areas (lower *kolla*) (Ayalew, 2001; MOA/FAO/UNDP, 1983). Awash River and Lake Beseka are the main hydrologic elements in the *Karrayu* area.

The soils in *Karrayu* area are dominated by Andosols and Leptosols, having reddish colour, silt clay to sandy loam texture, and low organic matter content. The dominant tree species are *Acacia senegali* (vernacularly known as *Burquqqee)*, *Acacia tortolis* (*Xaddacha*) and *Acacia etaica (Ajo*). Among these, *Acacia senegali* and *Acacia tortilis* are highly harvested for fuel wood and charcoal production (OIDA, 2007; FWARDO, 2007). The *Karrayu* area is a habitat of a variety of birds, fishes, crocodiles and other aquatic species from Lake Beseka and plays an important role in the wildlife ecology as it is located in the northern vicinity of Awash National Park (Eleni, 2009).

According to FWARDO (2007), the area is one of the most drought-prone areas in the East Showa Zone of Oromia region that is inhabited largely by *Karrayu* pastoralists. The total population of Fentale district was 82255, of which 53% and 47% were male and female, respectively. The rural and urban ratio of total population is about 75% and 25%, respectively (CSA, 2009). *Karrayu* has two major tribal divisions, namely, *Dullacha* and *Basso* (Haji *et al.,* 2015) and is inhibited as a single dominant group in Fentale district until the 1950s and the 1960s. Since then, *Ittu* Oromo and the Somali community continually have permanent settlements in *Karrayu* area (Ayalew, 2001). Pastoralism is the dominant livelihood base of the area, including rearing cattle, goats, sheep and camels. Agro-pastoral livelihood system began after the 1980s following the severe scarcity of feed, grazing land and water. Agro-pastoral households cultivate maize, sorghum, groundnut, and onion (FWARDO, 2007).

Climate variability is mainly manifested through decreasing trend in rainfall and increasing trend in temperature in the *Karrayu* like in other parts of the country in particular and the world at large. As a result, pastoral people inhabiting this area have suffered frequently from climate related hazards, particularly drought. The much variable climatic condition that is reflected by erratic and low rainfall amounts enhanced vulnerability of these pastoralists to climate variability and change (that require proper interventions (Dula, 2013).

2.2. Data Collection and Analysis

Three sample *kebeles*: Gelcha, Kobo, and Banti Mogassa were purposively selected based on their accessibility, vulnerability to drought and water scarcity, and representativeness of the features of pastoral and agro-pastoral livelihood system of the area. The stratified random sampling technique was used to select 120 sample respondents by taking into account their settlement, location, and wealth rank. Primary data were gathered through semi-structured questionnaire interviews, focus group discussions (FGDs), key informant interviews, and field observations. The key issues of the theme were demographic, livelihood, perception on climate variability and drought, water use and management and livelihood strategies. For the sake of showing the features of water stress and drought in association with rainfall pattern of *Karrayu* area, three seasons: *Bega* (*Bonna*), *Belg* and *Kiremt* seasons were considered. The secondary data were obtained from archives of the National Meteorological Service Agency, Fentale district, regional and national governmental and non-governmental institutions. In addition, consecutive meteorological data (1985-2007) of Awash and Metehara (1965-84) Stations were used from the National Meteorological Service Agency.

Quantitative data analysis was undertaken by using SPSS software. The rainfall variation and distribution were analyzed and interpreted on the basis of daily, monthly, seasonally and annual time duration. The number of wet days and corresponding amounts and probability of wet days were calculated by taking a daily rainfall amount of > 0.1 mm as a threshold to identify a rainy day in accordance with Bewket and Conway (2007). The probability of wet day was computed as:

$$P(w) = \frac{n}{N} \quad (1)$$

Where: P (w) = probability of wet day; n = number of wet days; N = total number of days (both wet and dry days)

Following Bewket and Conway (2007), inter-annual variability was evaluated by calculating standardized rainfall anomalies using:

$$SRA = (Pt-Pm)/\sigma \quad (2)$$

Where: SRA= Standardized Rainfall Anomaly; Pt = rainfall amount of a given period; Pm=is Long term mean rainfall over a period of consideration; σ=is standard deviation of rainfall over a period of observation.

Moreover, linear trend regression analysis, coefficient of variation, rainfall coefficients were used to quantify trends and their statistical significance, respectively; while patterns and trends of climate change and variability were presented using graphs, tables and charts.

3. Results and Discussion

3.1. Trend and Variability of Major Climatic Elements

3.1.1. Temperature Variation and Distribution

The study area experienced a decreasing average monthly minimum temperature for almost all months of a year during 1985-2007 as compared to that of 1965-1984. The least average annual minimum temperatures were recorded in December, January, and November from 1965-2007. November was the second coldest month preceding December (Fig. 2). Similarly, local community identified December as the coldest month.

The mean monthly minimum temperature for the period of 1985-2007 was relatively lower than that for the period of 1965-1984, which implies a gradual decrease in the minimum temperature. Conversely, the mean maximum monthly temperature indicates increasing trend for both periods, with the exception of the months of July and August (Fig. 2). With regard to annual linear trend, there was increase in maximum and annual average temperature for the periods of 1965-84 and 1985-2007, while a declining trend was observed in the minimum annual temperature from 1965-2007 (Table 2).

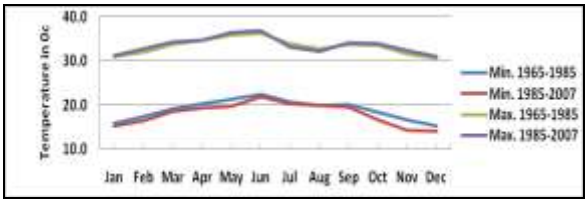


Figure 2. Mean monthly minimum and maximum temperature variation

Table 2. Annual mean, standard deviations and linear trend (LT) of minimum (Min), mean and maximum (Max) temperature (°C) variations.

Years	Annual Min.		Annual Mean		Annual Max.		Linear Trend Value		
	Mean	STD	Mean	STD	Mean	STD	Min.	Max	Mean
1965-1984	18.8	0.7	26.1	0.5	33.3	0.6	0.76	0.46	0.61
1985-2007	17.9	0.6	25.7	0.4	33.6	0.5	0.46	0.4	0.43
1965-2007	18.34	0.8	25.89	0.5	33.44	0.5	-0.11	0.12	0.01

3.1.2. Rainfall Variation and Distributions

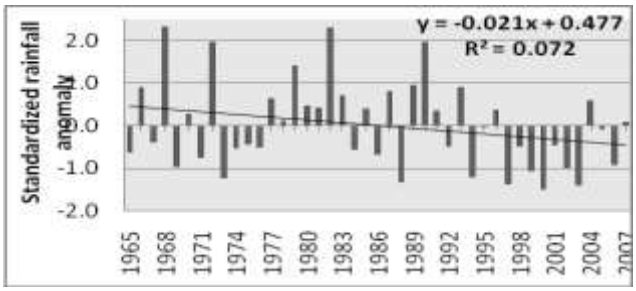
3.1.2.1. Annual and Seasonal Rainfall Variability and Trends

For the period between 1965-2007, the mean annual rainfall was 512.5 mm, with over half (58%) being received during the *Kiremt* season, followed by nearly a third (33%) being received in the *Belg* season. The rainfall of the area has a bimodal distribution (Table 3). The mean seasonal rainfall *Bega* (dry season*)* followed by *Belg* (small rainy season) indicated variability. As indicated in Fig 3 (A–D), the rainfall of annual total and all three seasons showed a decreasing trend. Likewise, the pastoralists also perceived that in the season of *Belg* (*Arfaasaa*) period alone, the rainfall showed a decreasing tend. This can also be verified by slight decrease in the mean annual rainfall during the aforementioned period by about 0.26 mm every decade. Despite this fact, the linear trend values and associated regression results showed insignificant decrease in both the seasonal and annual rainfall (as R<0.5 Table 3 and Fig 3). This seems against the report for the eastern and south eastern Ethiopia from 1982 to 2003 by Yilma and Zanke (2004) and for the Borana pastoral areas of southern Ethiopia (Wassie and Fekadu, 2015). Hence, further work is required to substantiate this fact.

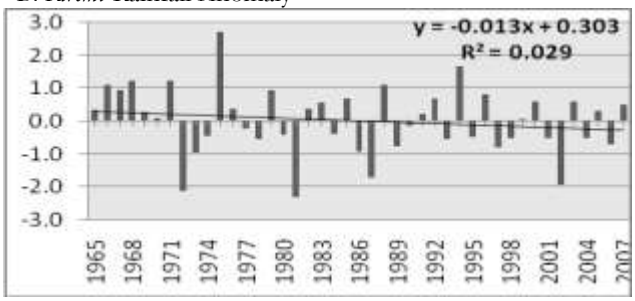
Table 3. Annual and seasonal rainfall amount and percentage and linear trend (1965 -2007).

Variables	Mean Rainfall		Decadal Linear Trend Equation	Linear Trend	Regression Trends	
	Amount (mm)	(%)			R^2	R
Kiremt	321.22	58.16	Y= -0.13x + 0.303	-0.13	0.029	0.17
Belg	184.78	33.46	Y= -0.21x + 0.477	-0.21	0.072	0.27
Bega	46.30	8.38	Y= -0.09x + 0.207	-0.09	0.014	0.19
Annual	552.3	100	Y= -0.26x + 0.507	-0.26	0.106	0.33

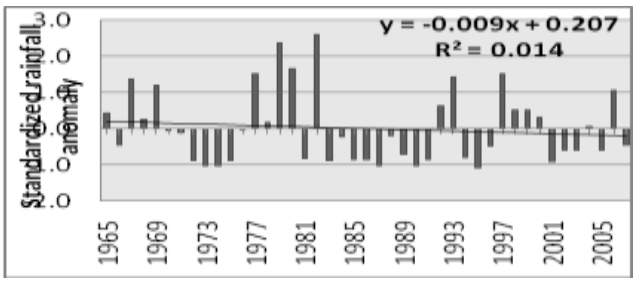
A. *Belg* Rainfall Anomaly



B. *Kiremt* Rainfall Anomaly



C. *Bega* Rainfall Anomaly



D. Annual Rainfall Anomaly

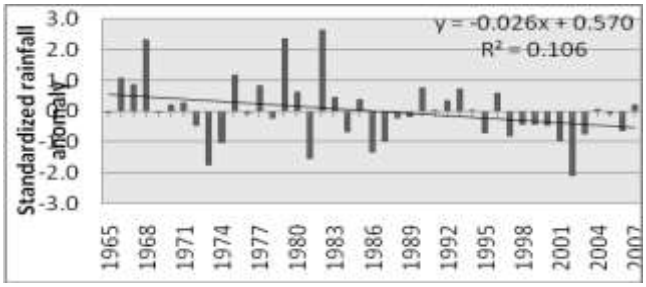


Figure 3. Annual and seasonal rainfall standardized anomalies and trends (1965 – 2007).

3.1.2.2. Monthly Rainfall

The mean monthly rainfall received in almost all months of the years from 1965 – 2007 were almost uniformly distributed among the months whereby August and July were with the highest levels (119.9mm and 117.7mm), respectively (Table 4). The annual mean total rainfalls for 1965-1984 and 1985-2007 were 598.1mm and 512.50mm, respectively (Table 4). According to the values of rainfall coefficient, eight months (Feb. through Sept.) were rainy as their RC values were > 0.6 while the remaining four months (Oct. to Jan.) were dry with rainfall coefficient (RC < 0.6). Three of the wet months (March, April and September) were with moderate concentration (as RC ranges from 1.0 to 2.0 while July and August had intense or big rainfall concentration with RC above 2.0). The monthly rainfall variability from 1965 through 2007 can be detected from the CV value (Table 4). According to Hare (1983), CV below 20% imply less variability and hence monthly rainfall

experienced very less variability. Yet, proper use of water harvesting technology should be devised to use and manage the intense rainfall of July and August. Moreover, early warning systems and integrated environmental management measures are required to minimize/avoid disaster and design possible remedial actions.

Table 4. Monthly and annual mean rainfall, coefficient of variation (CV) and rainfall coefficient (RC) for the decades 1965- 1984, 1985 -2007 and 1965- 2007.

Variables	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Period of 1965-1984													
MRF[1]	20.2	48.7	57.6	52.7	46.0	41.1	114.2	121.1	50.8	23.7	15.9	6.0	598.1
C.V.[2]	1.9	1.4	0.9	0.8	0.6	0.9	0.4	0.5	0.5	1.2	1.5	1.8	0.3
RFC.[3]	0.4	1.0	1.2	1.1	0.9	0.8	2.3	2.4	1.0	0.5	0.3	0.1	
Period of 1985- 2007													
MRF[1]	8.3	29.5	52.0	50.7	30.2	25.8	120.6	118.9	42.3	21.8	3.4	8.9	512.5
C.V.[2]	1.5	1.5	0.7	0.7	1.0	0.8	0.4	0.3	0.5	1.4	1.5	1.9	0.2
RFC.[3]	0.2	0.7	1.2	1.2	0.7	0.6	2.8	2.8	1.0	0.5	0.1	0.2	
Period of 1965-2007													
MRF[1]	13.8	38.5	54.6	51.6	37.5	32.9	117.7	119.9	46.3	22.7	9.2	7.6	552.3
C.V.[2]	2.03	1.48	0.78	0.75	0.83	0.90	0.41	0.42	0.51	1.28	1.94	1.94	0.24
RFC.[3]	0.3	0.8	1.2	1.1	0.8	0.7	2.6	2.6	1.0	0.5	0.2	0.2	

Notes: [1]MRF = Mean Rainfall; [2] CV = Coefficient of Variation; [3]RFC = Rainfall Coefficient

3.1.2.3. Amount, Variation, and Trends of Rainy Days

From the points of view of hydrology, and soil and water conservation, the duration, intensity and amount of rain that falls within a given area is very significant (Daniel, 1977). Accordingly, the mean annual number of rainy days was 84.93 with 23.27% probability of wet days. This implies that about 76.73% of the annual mean days from 1993-2007 were dry (Table 5). As stated in Hare (1983), CV < 20% are less, 20% to 30% moderate and > 30% highly variable, the number of rainy days are less variable for *Kiremt* while moderately variable for *Belg* and annual while *Bega* season has highest variability from 1993 to 2007 (Table 5). Concerning the amount of the rainy days, there was highest variability in *Bega* and *Belg* seasons as their CV was > 30% (i.e., 45% and 80%, respectively as compared to *Kiremt* seasons and annual values (with CV = 25%, and 18%, respectively (Table 5). However, CV above 25% is taken as significant value (Snedecor and Cochran, 1989) and hence it can be concluded that *Belg* and *Bega* are with significantly highest variability in amount of rainy days.

Both numbers of rainy days and amount for annual and all season's rainy days show decreasing trend and negative anomalies that was found significant at 0.05 levels for the aforementioned years (Table 5 and Fig. 5 A-D). This finding can be substantiated from the findings of Yilma and Zanke (2004) who reported that the rainy days of *Kiremt* in the eastern Ethiopia showed a significant decline (at 5% level) since 1982 compared to that of 1965-81.

Generally, the annual, seasonal and monthly and daily rainfall of the study area was characterized by reduced amounts during the study periods. Moreover, there were continued increases in the minimum and maximum temperatures of the study area. Yet, this requires proper meteorological data to come up with sound recommendations vis-a-vis climate change adaptive and coping strategies for the life and livelihood of the *Karrayu* community in particular and the region at large.

Table 5. Mean probability of wet days (W), coefficient of variation (C.V.), linear trend (LT) of number of rainy days and rainfall amount for *Belg, Bega* and *Kiremt* (1993-2007).

Periods	Number of Rainy Days				Rainfall Amount of Rainy Days			
	Mean	P(w)	C.V. (%)	LT(day/decade)	Mean	% of annual	C.V. (%)	LT (mm/decade)
Belg	21.13	17.61	28	- 0.57	141.03	27.98	45	- 0.17
Kiremt	46.60	38.20	18	- 0.60	306.67	60.85	25	- 0.32
Bega	17.2	13.98	43	-0.40	56.31	11.17	80	- 0.35
Annual	84.93	23.27	32	- 0.93	504.01	100.00	18	-0.56

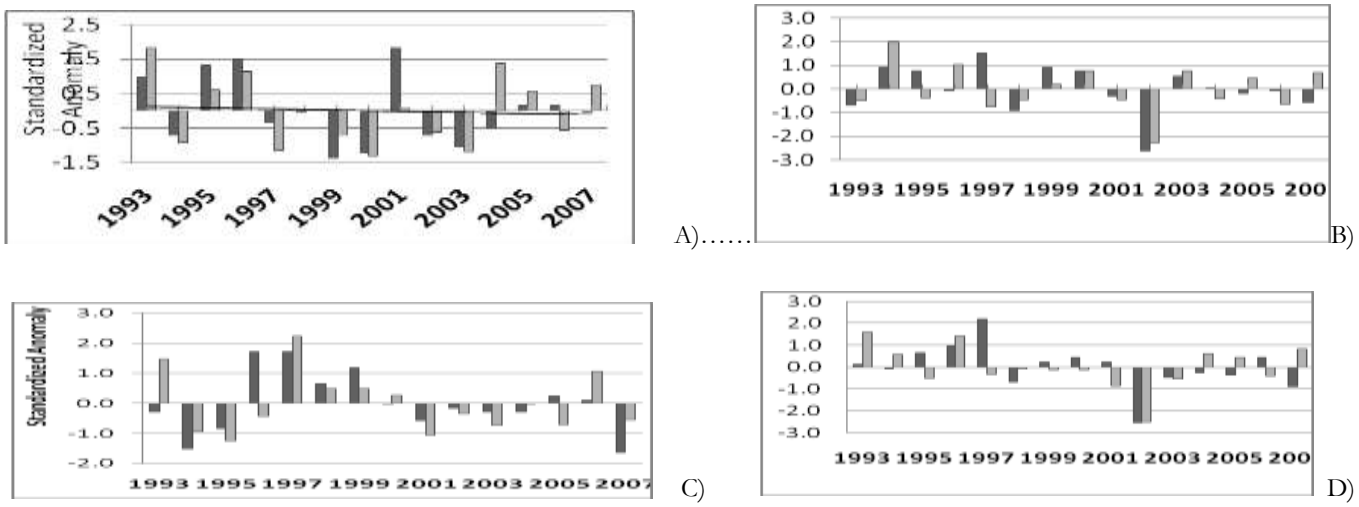


Figure. 5: Standardized seasonal and annual anomalies of number of rainy days (black bar) and rainfall amounts on wet days (white bar), (1993-2007). A) *Belg* Anomalies; B. *Kiremt* Anomalies; C. *Bega* Anomalies; D. Annual Anomalies

3.2. Pastoralists' Perception of Climate Change/Variability and Drought

As revealed in Table 6, about 68.3% and 42.5% of the respondents perceived increment in the mean maximum temperature and decrement in the mean minimum temperature, respectively. Similarly, the annual total rainfall was perceived to decrease by 65% of the respondents while about 57.5% of them indicated a decrement in rainfall variability. Moreover, nearly 2/3rd of them perceived decrease in rainfall intensity (Table 6). Furthermore, participants of FGDs and key informants' interviews indicated the presence of variations in the average temperature and rainfall. As per their perceptions, the periods of high and low temperatures were clearly known and demarcated. For instance, very high daily temperature was in June and the low temperatures were in December and January. Hence the local pastoral community is expected to adapt accordingly. But, recently there are variations in low temperature that started as of September while high temperature occurred from April through July on irregular basis and that exacerbated the resiliencies efforts of the community.

Table 6. Pastoralists' perception of temperature and rainfall variations by sample respondents.

Climatic Elements	Perceptions by Sample respondents of *Karrayu* Pastoral Community									
	Increases		No changes		Decreases		Unknown		Total	
	No	%	No	%	No	%	No	%	No	%
Max. Temperature	82	68.3	21	17.5	10	8.3	7	5.8	120	100.0
Min. Temperature	35	29.2	14	11.7	51	42.5	20	16.7	120	100.0
Rainfall Intensity	27	22.5	16	13.3	77	64.1	-	-	120	100.0
Rainfall Variation	30	25.0	16	13.3	69	57.5	5	4.2	120	100.0

In the case of rainfall during the past years, pastoralists underlined that the rainfall was relatively ample and less variable as it occurred during two rainy seasons: small rainy season (March to May) (*Arfaasa*) and big rainy season (June to September) *(Bonna)*. The former extends from March to May while the latter covers from June through September. Often, the rainfall period may extend from March to September. Within those months, the amount of rainfall was ample and harvestable in different ponds and used throughout several months. But, recently the *Karrayu* area received rainfall either in July and/or in August for only one to two months. Unlike past years, water collected and stored in ponds and surface depressions got dry up and that in turn resulted in severe water scarcity.

3.3. Livelihood Strategies by Pastoralists towards Climate Change/Variability and Drought

During drought period, pastoralists encounter shortage of food and/or finance to purchase food. The price of livestock on local market decreased and that of grain increased. In addition, the product of livestock like meat, milk, etc get deteriorated. Under such scenario, pastoralists developed numerous livelihood strategies including strategies concerning food, income, family and livestock related affairs (Table 7). This goes in accordance with Wassie and Fekadu (2015) who reported with shift from pastoral to non-pastoral livelihood activities in the *Borana* pastoral areas.

According to Table 7, over half percent of sample respondents pastoralists in the *Karrayu* area identified major livelihood coping and survival strategies to climate change and resultant drought including use of less amount of water (76%), settling around Metehara Sugar Factory (73%), dependence on Productive Safety Net Program (PSNP) (72%), decrement in amount of food consumption (64%), migration with their camels to other areas (62%), and sale of fire wood and charcoal (57%). Those livelihood strategies with least percentage of respondents include preparation of food storage devices, destocking by selling old/weak livestock, borrowing cash from 'the haves' or relatives, family splitting and migration to urban areas.

Table 7. Major livelihood strategies to climate change and variability by No. (%) respondents.

Major Livelihood Strategies		No. (%)
Coping/ Adaptive Strategies		
Food		
1	Use less amount of water	91 (75.8)
2	Eat less amount of food	77 (64.2)
3	Chewing chat	57 (47.5)
4	Borrowing food grain	52 (43.0)
5	Generating food store	18 (15.0)
Livestock		
1	Settling around Metehara Sugar Factory	87 (72.5)
2	Selling old/weak livestock before drought	46 (38.0)
Livelihood Diversification of Income		
1	Depending on Productive Safety Net Program	86 (72.0)
2	Sale fire wood and charcoal	68 (57.0)
3	Storage of butter until the price is high	57 (47.5)
4	Selling skins and hides of dead animals due to drought	54 (45.0)
5	Borrowing cash from 'the haves' or relatives	41 (34.0)
Survival Strategies		
Family		
1	Migration to other areas with their camel	74 (62.0)
2	Splitting family	39 (32.0)
3	Migration to urban areas	37 (31.0)

Note: Each option is out of 100% respondents.

As per discussion with key informants of *Fentale* district, the beneficiaries of the PSNP were identified by the representative committees selected by the community and the beneficiaries are rhetorically selected based on the degree of food-insecurity and other socio-economic criterion. Children, elders and pregnant women are given priority of getting access to the PSNP. The selected beneficiaries get access to the program during dry months (from January to June). Most of the food aid is given according to their participation in the development works identified in the area: namely, participation in public work like de-silting and digging ponds, constructing flood protection dams, road etc. Such beneficiaries are required to work 5 times per month and are given 40 birr/head/month for three months (Jan to March) and 15 kg of grain/head/month for the next three months (April to June). In most predominantly drought periods, beneficiary pastoralists in the study area rely on the PSNP during the dry period as their main coping strategies but there are numerous pitfalls in the implementation of the program as reported by Dula (2013).

As the traditional livelihood strategies have become increasingly insufficient to sustain local livelihoods during times of drought (Muller-Mahn *et al.,* 2010 cited in Dula, 2013), the importance of PSNP should be underlined here. Regarding the dependence on PSNP, it is variable among percentage of population of the pastoral communities in different *kebeles* that benefited from the program. It ranges from < 20% Haro Kersa *Kebele* to > 50% by pastoralists in Tututi, Kobo, Debiti and Dire Saden *Kebeles* (Fig.6).

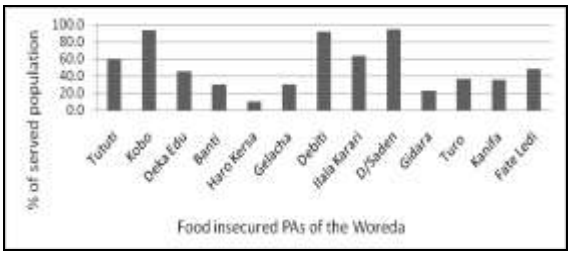


Figure 6. Percentage distribution of people served by PSNP.

According to the opinion of participants of FGDs and key informants during past years, community in *Karrayu* area relied on only livestock products like milk, meat, butter, etc. They do not have permanent settlement areas but migrate together with their cattle between "*Ona Gannaa*" (wet grazing area) and "*Ona Bona*" (dry grazing area). In olden times, there was no scarcity of grazing land and hence pastoralists did not know about farming; and culturally it was not accepted to be a farmer. But, now there is dynamism in the situation in the *Karrayu* area. Owing to all these dramatic changes since 1980s, the *Karrayu* have exercised two major livelihood modifications against recurrent drought: from mobile to sedentary and from pastoral to agro-pastoral livelihood system (this is also clearly mentioned by Dula (2013) like the one reported for Borana pastoralists by Wassie and Fekadu (2015). This is in response to the challenges faced by the pastoralists to modify their livelihoods according to the ongoing changes, to search for new alternative strategies, to diversify their livelihoods and to maintain their adaptive capacities with regard to future changes (Dula, 2013; Wassie and Fekadu, 2015).

4. Conclusion

The analysis of meteorological data of Awash and Metahara stations and the perception of pastoralists in *Karrayu* area revealed steady increments as well as decrements in the amount and patterns of temperature and rainfall, respectively. Eight distinct months of dry periods were known for water deficit and resultant drought as extreme weather events in the area. Cognizant of the climate variability and extreme weather events, the largest portions of the pastoral community perceived that numerous livelihood strategies including the use of fewer amounts of water and food, migrating to settle around Metehara Sugar

Factory, dependence on PSNP, migration with their camels to other areas, and sale of fire wood and charcoal were found to be essential to sustain the lives of humans as well as livestock.

However, to complement the community efforts, integrated livelihood development mechanisms better be devised with active involvement of different stakeholders for sustainable development of the pastoral and agropastoral communities of the *Karrayu*. These may include but not limited to early warning systems, collection of reliable climate data, disaster risk reduction and risk sharing strategies to avert the risk of vulnerable groups of the community from the hazards of climate variability in particular and change in general. Likewise, further critical studies are recommended regarding temperature and rainfall variability of the study area to substantiate the current findings and endorse very sound and applicable recommendations that can be implemented for the sustainable food, feed and water availability to the human and livestock population of *Karrayu* pastoralist area in particular and similar agroecology at large.

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