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Weather Variability in Context of Agriculture based Livelihoods of the Community in Arsi and East Shewa Zones of Oromia Region, Ethiopia

Gerishu Bati Waritu[1]
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ABSTRACT

Background: Weather variability risks are testing phenomenon in natural ecosystems influencing world to look for responsive measures, where in Ethiopia, weather variability risks were common affecting Agricultural livelihoods. However, while weather variability related disasters are critical problem in Ethiopia, location specific study is limited to summarize distinguishing conclusion about the effects.

Methods: The study was designed to determine weather variability in selected districts of Oromia region. Secondary data were collected from five weather stations located in Arsi and East shewa Zones. Descriptive statistical tools and Mann-kendall trend test were employed where primarily, trends and inter-seasonal weather variability were emphasized in context of precipitation and temperature.

Result: The results indicated a significantly decreasing trend in annual rainfall for last two decades, considerably higher for majority of the seasons in each year. Aggregately, a decline of 14.5% for highland and 12.3% for lowland were identified in annual precipitation, while annual Temperature maintain increasing trends in several scenarios. Furthermore, Mann-kendall trend test estimated sen's slopes of -1.41, -0.45 and -0.55, for pre-main season, main season and post main season respectively, indicating declining trends. These illustrates a need to establish adequate strategies to promote adopted options through sustainable programs/ projects along with locally fitted environmental policy. Therefore, policy level managers and technical leaders should readdress current policies and strategies in perspective to weather variability risks management.

Key words: Agriculture, Community, Livelihoods, Variability, Weather.

INTRODUCTION

Agricultural sector contributes significantly to economic development in many developing nations while in Ethiopia agriculture contributes 43% of GDP, provides 80% employment opportunities, generates 90% export revenues. However, since agricultural production is dependent on favorable seasonal weather conditions, any changes in climate parameters are bound to have significant impacts on farm productivity (Getahun, 2017). Again, Mendelsohn (2009) also publicized that seasonal weather variability affects the livelihood of farm communities, particularly those living in dry regions of the countries. Typically, Temesgen (2014), ascertain that weather variability are critical problems that confronting agricultural productivity, undermining natural resource sustainability in Ethiopia which compounded by inadequate adaptive capacity.

Accordingly, Ethiopian government has adopted initiatives like Climate Smart Agriculture (CSA) practices to manage climate change associated risks. However, experiences of programs and/or project have not made adequate progress to integrate climate change management options (Wagayehu, 2003). Additionally, despite widespread of climate change effects, limited efforts that have been made to identify the nature of weather variability were not sufficient to summarize distinct conclusion. Therefore, this study examines seasonal weather variability in the study communities. Contextually, the paper is organized to explain and presents weather variability based on secondary data collected from weather stations located in Arsi and East Shewa zones, representing highland and lowland agro-ecologies, respectively.

[1]Directorate of Agricultural Extension, Oromia Bureau of Agriculture P.O. Box 8770, Finfinnee/Addis Ababa, Oromia Region in Ethiopia.

Corresponding Author: Gerishu Bati Waritu, Directorate of Agricultural Extension, Oromia Bureau of Agriculture P.O. Box 8770, Finfinnee/Addis Ababa, Oromia Region in Ethiopia.
Email: gerishubati@yahoo.com
ORCID: 0009-0009-1062-6473.

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MATERIALS AND METHODS

Description of the study areas

The study Areas are located in Central Rift Valley (CRV), where environmental degradation including climate changes are common phenomenon for past several years. Specifically, this study was conducted during 2022-2024 cropping seasons in Arsi and East shewa Zones of Oromia regional state, Ethiopia. Mixed farming and agro-pastoral farming system are commonly practiced at highlands, mid and lowlands. Two districts (Bosati and Dudga) were selected from East Shewa representing lowland agro-ecology, whereas two (Hetossa and Tiyo) were selected from Arsi Zone among highland Districts.

Landscape of these zones ranges from 500-3200 masl, where highland has temperate and cold climate with altitude of 2300-3200 masl while midland has warm climate ranging from 1500-2300 masl and lowland is hot with arid land areas ranges from 500-1500 masl. There are three distinct cropping seasons, with two rainy seasons and one dry season, where short rain and main rainy seasons contribute nearly 31% and 56% of annual rainfall, respectively (World Bank Group, 2011). Specifically, East shewa Zone is located in lowland areas of the Region with sub-tropical and tropical climatic zones which characterized by dry climatic conditions. Agro-ecologically, this zone constitutes 18.7% highland, 27.5% midland and 53.8% lowland with annual rainfall of 1150 mm. Similarly, Arsi Zone characterized by four major biophysical categories (WIKIPEDIA, 2023), in which cool agro-climatic condition constitutes 2.7%, cool temperate agro-climatic zone with massifs and high plateaus about 22.7%, low plateau 49.6% and Lowland 24.9% of total surface (Tamirat *et al.*, 2019 and Adisu *et al.*, 2020).

Data collection

Primarily, secondary data of Temperature and Rainfall were collected from the National Meteorology Agency's weather stations located in the two study community, while agriculture related other seconder data were collected from Bureau of Agriculture including its different structural level. Specifically, data were obtained from Adama, Wolinchiti and Meki weather stations to represent lowland, while data from Assela and Etheya weather stations were used to represent highland agro-ecology. The data covering over 25 years (1993-2018) were categorized into five categories, where the first category (1993-1997) was established as base category (baseline) to compare the observed trends of other remaining years' categories.

Data analysis

Descriptive statistics were employed to analyze weather parameters, where the Variability in selected weather variables were explained with seasonal trends, means and standard deviations obtained from descriptive analysis. On the other hand, seasons of the years was classified into three categories, which are represented as pre-season (January, February, March and April), main season (May, June, July and August) and post main season (September, October, November and December) and comparison made between these seasons. In addition to descriptive statistics, Mann-Kendall test statistic technique was employed in which Mann-Kendall test statistic slope (S) was calculated using below equations presented by Sunny and Singh (2021).

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \text{sgn}(X_i - X_j) \qquad ....(1)$$

Where,

n= The number of data points.

X_j and X_i= Data value in time series i and j (j >i).

sgn $(X_j$-$X_i)$= The sign function.

Again, 'x' and 'x' are sequential data for i^{th} and j^{th} terms, which interpreted in below presented equation.

$$\text{Sign}(x_i - x_j) = \{+1, \text{ if } (x_i - x_j) > 1\} \qquad ....(2a)$$

$$\text{Sign}(x_i - x_j) = \{+0, \text{ if } (x_i - x_j) = 0\} \qquad ....(2b)$$

$$\text{Sign}(x_i - x_j) = \{-1, \text{ if } (x_i - x_j) < 1\} \qquad ....(2c)$$

In this regard, Sen's slope test was used to identify the nature of trend existing in time series data, where a slope estimator (m) is considered as median for all data sets for various combination. Accordingly, positive (+ve) value of slope (m) indicates an upward increasing trend while conversely negative (-ve) value indicates decreasing (downward) trend and slope (m) is calculated using the below presented equation (ibid).

$$m_i = \frac{Y_j - Y_i}{J - 1} \qquad ....(3)$$

Where,

'Y_j' and 'Y_i'= Time values at time 'j' and 'i' (j>i).

The Sen's slope estimator is the median that estimated in Mann-Kendall test package, where an individual sign takes values of positive one to negative one (1, 0, or -1), indicating increasing and increasing trends.

RESULTS AND DISCUSSION

Precipitation variability and trends

An analysis of rainfall variability was carried out based on over 25 years' data, where the result indicated tremendous seasonal variability (Table 1a and 1b). In this regard, the recorded rainfall at Adama and Wolinchiti showed decreasing tendency with a decline of 31% and 48%, respectively, during 1998-2002 cropping season. However, there were some increases in rainfalls with 42% at Meki, 43% at Adama and 37.3% at Wolinchiti stations during pre-main season of the 3rd category (2003-2007) compared with baseline category.

Furthermore, there are declining trends in annual rainfall with an average of 1%, 26% and 38% at Meki, Adama and Wolinchiti, respectively, during 5th (2013-2018) category of the years as compared to baseline. Similarly, average rainfall recorded during 5th (2013-2018) category showed decline trend at Wolinchiti station with 17.3% when compared with baseline category while others (Meki and Adama) showed an increase during main season of the 2nd (1998-2002) Category. More importantly, there are consistent decline in annual mean annual rainfall during

2013-2018 in main season and post-main seasons at lowland areas. Significant and consistent decline was identified in rainfall amount at Assela weather station, where however, there were some increases at Etheya station by 11% and 23% in main-season during 2nd (1998-2002 and 3rd (2003-2007) category seasons and declined during 4th (2008-2012) and 5th (2013-2018) category at highland areas of Tiyo and Hetossa districts. Also, there was a decline with similar percentage when compared with 3rd (2003-2007) and 4th (2008-2012) category of the years. Additionally, pronounced decline of 33.3% at Assela and 44.8% at Etheya were identified during 5th (2013-2018) category.

Comparatively, rainfall reduction was found smaller (4.9% at Assela and 10.4% at Etheya) for main season during 5th (2013-2018) category as compared to pre-season situation. Likewise, there was a similar decline in rainfall amount at Etheya weather stations (23.1%) and an increase was observed at Assela (About 9%) during 5th (2013-2018) category in context of post main season compared with baseline. Generally, summarized and presented data, declaring overall declining tendency in rainfall amount which is common phenomenon at all five locations.

On the other hand, data were categorized and summarized under two agro-ecologies (highland and

Table 1a: Annual rainfall distribution and trend.

Years category	Meki		Adama		Assela		Wolinchit		Etheya	
	Mean	Change	Mean	Change	Mean	Change	Mean	Change	Mean	Change
Pre-main season (January-April)										
1993-1997	28.7		43.0		73.2		51.8		42.2	
1998-2002	32.8	14.3	29.7	-30.9	55.7	-23.9	26.8	-48.3	46.9	11.1
2003-2007	40.7	41.8	61.3	42.6	60.6	-17.2	71.1	37.3	51.8	22.7
2008-2012	27.9	-2.8	49.7	15.6	51.6	-29.5	27.2	-47.5	26.9	-36.3
2013-2018	28.4	-1.0	31.8	-26.0	45.9	-37.3	32.0	-38.2	23.3	-44.8
Main season (May-August)										
1993-1997	97.1		141.2		149.2		137.7		125.3	
1998-2002	102.6	5.7	141.3	0.1	146.5	-1.8	112.2	-17.3	158.4	26.4
2003-2007	86.3	-11.1	130.7	-7.4	140.9	-5.6	141.3	4.1	148.3	18.4
2008-2012	133.5	37.5	158.8	12.5	144.5	-3.2	131.9	-2.8	151.6	21.0
2013-2018	88.5	-8.9	134.7	-4.6	141.8	-4.9	110.9	-18.3	112.3	-10.4
Post main season (September-December)										
1993-1997	28.3		14.2		58.0		46.7		43.7	
1998-2002	36.9	30.4	50.9	26.6	61.7	6.4	49.3	5.6	57.8	32.3
2003-2007	29.0	2.5	37.3	-7.2	55.0	-5.2	27.1	-42.0	51.8	18.5
2008-2012	31.0	9.5	46.2	14.9	57.8	-0.3	42.2	-9.6	55.0	25.9
2013-2018	27.5	-2.8	37.9	-5.7	63.3	9.1	35.2	-24.6	33.6	-23.1

Table 1b: Seasonal rainfall trend analysis.

Agro-ecology and years categories	Mean seasonality trend						Aggregated trend	
	Pre main season (January-April)		Main season (May-August)		Post main season (September-December)		Mean (mm)	Change (%)
	Mean (mm)	Change (%)	Mean (mm)	Change (%)	Mean (mm)	Change (%)		
Highland								
1993-1997	57.7		137.3		50.8		81.9	
1998-2002	51.3	-11.1	152.5	11.1	59.8	17.7	87.9	7.3
2003-2007	56.2	-2.6	144.6	5.3	53.4	-12.6	84.7	3.5
2008-2012	39.2	-32.1	148.2	7.9	56.2	5.5	81.2	-0.9
20013-2018	34.6	-40.0	127.0	-7.5	48.5	-15.2	70.0	-14.5
Lowland								
1993-1997	41.2		124.2		38.4		68	
1998-2002	29.8	-27.7	118.7	-4.4	45.7	19.0	65	-4.8
2003-2007	57.7	40.0	119.4	-3.9	31.1	-19.0	69	2.1
2008-2012	34.9	-15.3	141.4	13.8	35.5	-7.6	71	3.8
20013-2018	30.7	-25.5	114.8	-7.6	33.5	-12.8	60	-12.3

lowland) where the aggregated data presented accordingly (Table 1b). In this regard, there had been significant decline over the years in highland agro-ecology while in contrary, in lowland rainfall in pre-main season increased by 40% during 2003-2007 period while it declined in other seasons.

Importantly, significant decreasing trends were identified in mean annual rainfall for whole categories, where considerably high as 32% and 40% during 4th (2008-2012) and 5th (2013-2018), respectively were observed in pre-seasons compared with baseline. Differently, main-season rainfall in highland agro-ecology shows stable increase by 11.1%, 5.3% and 7.9% during 2nd (1998-2002), 3rd (2003-2007) and 5th (2013-2018) category, respectively. In the meanwhile, in context of highland, post main season rainfall shows decreasing trend by 12.6% and 15.2% during 3rd (2003-2007) and 5th (20013-2018) categories, respectively, while there are mounting trends during 2nd (1998-2002) by 17.7% and 4th (2008-2012) by 5.5% were observed as compared to baseline.

Furthermore, standard mean deviations and coefficient of variation were computed where the result presented in Table 1c. Significant variability was indicated by standard mean deviations ranging from 142.24 to 221.29 indicating the highest variability at almost all weather stations, where the highest mean standard deviation of 221.29 was identified for Wonlichiti and followed by Meki weather station. Whereas the smallest (142.24) mean standard deviation was observed at Assela weather station indicating relatively stable variability as compared to lowland area situation.

Additionally, slightly highest coefficient of variation (CV) has identified at Meki weather station (34%) while Wolinchiti weather station result comes second by 32% indicating significant variability. Furthermore, Mann-Kendall trend test model estimated 20.6, 32.3 and 22.41 rainfall standard deviation for pre-main season, main season and post-main season, respectively, while sen's slopes were found -16.54, 12.76 and -5.65, for Pre-main season, Main season and post main season respectively, indicating significant decreasing estimates in pre-main season and post-main season (Fig 1).

More reasonably, other findings, like Ministry of Foreign Affairs of the Netherlands (2018), affirmed that there are declining trends in precipitation in some regions of the country, where *Belg* season (February-May) and *Kiremt* (June-September) seasons rainfall have decreased by 15-20% during 1975 and 2010 cropping years. Additionally, according to World Bank Group (2011), areas receiving sufficient rainfall during *Belg* season (February-May) seasons have shrunk by 16% from year 1990 and onward; compounded by decrease in the *Kiremt* season (June-September) rainfall significantly affecting the most lowland parts of the country. These mixed trends of current study's findings are adequately consistent with several study

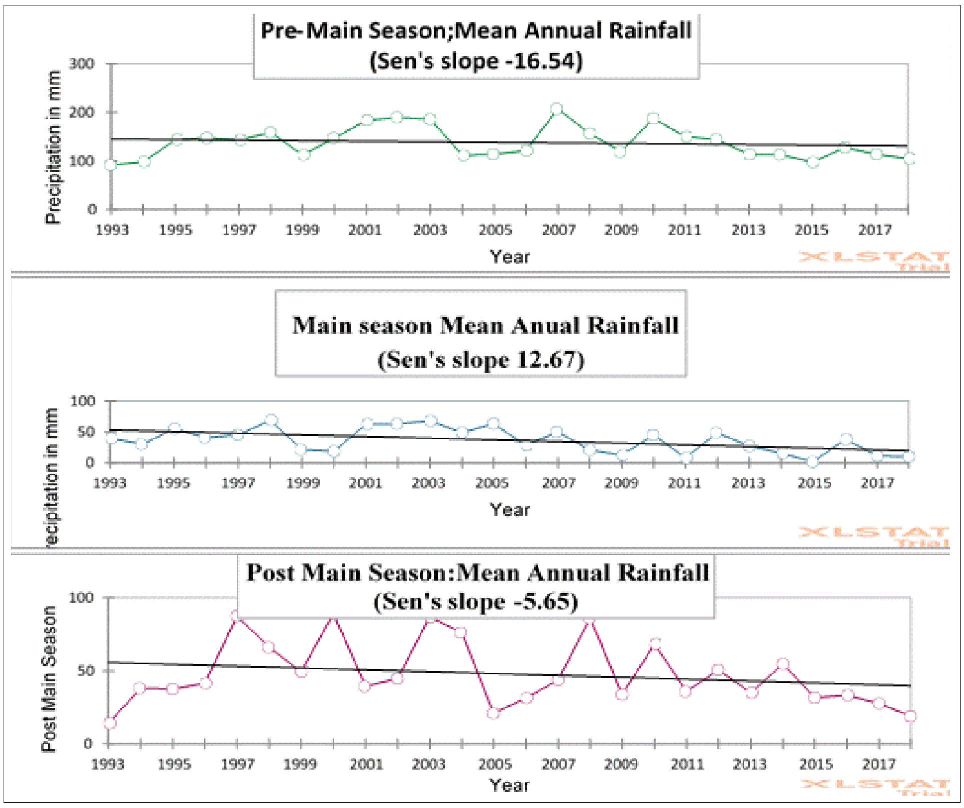

Fig 1: Mann-kendall sen's slope trend tests.

results: for instance, according to Chinedu (2023) review result, climate simulations for 2030-2070 suggest a decrease in rainfall in the western Sahel and an increase in the central-eastern Sahel, while projections of mean annual rainfall indicate an increase along the Guinea coast but a decrease further inland. This author also further stated that future precipitation patterns remain uncertain, with model estimates ranging from -30% to +30% of current levels and greater variability anticipated in the Sahel region.

Temperature variability and trends

Temperature related secondary data was analyzed using descriptive statistics and presented under this sub-section. Accordingly, annual maximum temperature increased by 1°C (3.6%), while largest 1.8°C (6.5%) changes was observed during 2008-2012 and 2013-2018 categories for pre-main season as compared to baseline for lowland agro-ecology (Table 2a).

During 1998-2002 and 2008-2012 local temperature increased by 0.9°C (3.2%) and 0.8°C (2.9%), respectively, while insignificant increases were observed during 2008-2012 as compared to 2013-2018 years' categories, in which an increase from 28.6°C to 29.6°C was identified for corresponding pre-season. In this regard, average maximum temperature variability identified for each season are quite significant (more than 1°C) when estimated from baseline category in lowland agro-ecology.

Again, maximum temperature change observed within the range of 2.9% to 6.5% compared with baseline and change is approached 1.8ºC during 5th (2013-2018) category. In similar manner, maximum temperatures were changing during consecutive three categories with an average of about 1°C, but escalated during 5th (2013-2018) category to 1.8°C (6.7%) compared to baseline for main season.

The result shows closely similar increasing and decreasing tendency as observed in pre-main season, where relatively significant change from 3.4% to 6.7% were observed for main season. Undoubtedly, moderately significant changes of smallest 1.5% to largest 5.3% were identified in maximum temperature during post-main season. Change in mean annual minimum temperature found significantly high as compared to changes identified in maximum temperatures in all seasons, where the change from baseline reached 2°C (14.3%) during pre-main season, but there is declining trend in minimum temperatures during 1998-2002 category.

In contrast to lowland agro-ecology, the result of temperature data from Assela weather station (highland agro-ecology) shows unclear tendency compared with actual expectation (Table 2b). The results indicated significant declining trends in maximum and minimum local temperature as compared to baseline category, showing different condition from several findings. Arguably, maximum local temperature shows a slight decline of about 2.9% to 5.8% during 2003-2007, 2008-2012 and 2013-2018, while an increase by 4.6% observed only during 2nd (1998-2002) category during pre-main season.

Practically, insignificant declining trends identified (0.3%) during 1998-2002, but significant 8.6% (2008-2012) and 1.7% (2013-2018) in minimum local temperature, while only 8.8% increase realized during 2003-2007 as compared to baseline during pre-main season. In summarized scenario, no significant increasing change was found in pre-main season, main season and post main season in maximum and minimum local temperature; but relatively significant increasing tendency of 5.6%, 1.1% and 5.6% were observed during post main season for consecutive categories of 2003-2007, 2008-2012 and 2013-2018 years, respectively. A steady increase of 2.2% during 2nd (1998-2008) has identified in maximum temperature during main season while minimum temperature of the areas depicts similar increasing trend by 0.9% for 2nd (1998-2002) and 5th (2013-2018) category.

According to highland results, significant decrease in maximum temperature was observed throughout whole seasons, except two situations (during 1998-2002 of pre-main season and main season). Meanwhile, post main season maximum temperature shows straight decreasing tendency, but with fluctuating magnitude of -0.5°C (2.2%), -2.2°C (9.8%), -1.6°C (7.1%) and -1°C (4.4%) during consecutive years, while only a decline of -0.5°C (5.7%) was identified in minimum local temperature during the same season.

In addition to above presented parameters, 10 years' temperature data were analyzed to find the tendency of temperature variability in summarized scenario using mean standard deviation and coefficient of variation (Table 2c). In this regard, about 0.33 mean standard deviation for Adama weather station and 0.78 for Wolinchiti weather station were observed in maximum temperature, while minimum Temperature mean standard deviation of 0.34 and 0.71 was identified, respectively, for these two stations located in lowland agro-ecology.

Relatively high mean standard deviation of 0.72 for maximum temperature and 0.60 for minimum temperature were found in highland agro-ecology, which is slightly escalated temperature variability as compared to lowland. On the other hand, highest coefficient variability (CV)

Table 1c: Rainfall variability statistics computed from 10 years (2009-2018) data.

Weather stations	Minimum	Maximum	Mean	Standard. deviation	Coefficient of variation
Adama station	558.80	1214.80	809.85	206.29	0.25
Meki station	389.70	966.80	645.05	216.51	0.34
Wolinchiti station	239.10	987.50	700.66	221.29	0.32
Assela station	796.80	1196.60	1002.38	142.24	0.14
Etheya station	498.40	1202.60	749.07	210.75	0.28

Table 2a: Temperature variability in lowland agro-ecology.

Years	Pre-main season			Main season			Post main season		
	Monthly average (°C)	Change (°C) from base years average	Change (%) from base years average	Monthly average (°C)	Change (°C) from base year average	Change (%) from base years average	Monthly average (°C)	Change (°C) from base years average	Change (%) from base years average
Maximum T									
1993-1997	27.8			26.8			26.2		
1998-2002	28.8	1.0	3.6	27.8	1.0	3.7	26.6	0.4	1.5
2003-2007	28.7	0.9	3.2	27.7	0.9	3.4	26.8	0.6	2.3
2008-2012	28.6	0.8	2.9	28.2	1.4	5.2	26.9	0.7	2.7
2013-2018	29.6	1.8	6.5	28.6	1.8	6.7	27.6	1.4	5.3
Average		1.1	3.9		1.3	4.9		0.8	3.1
Minimum T									
1993-1997	14.0			15.5			13.2		
1998-2002	11.2	-2.8	-20.0	13.4	-2.1	-13.5	10.5	-2.7	-20.5
2003-2007	14.9	0.9	6.4	16.6	1.1	7.1	14.2	1.0	7.6
2008-2012	15.1	1.1	7.9	16.8	1.3	8.4	14.3	1.1	8.3
2013-2018	16.0	2.0	14.3	17.1	1.6	10.3	14.8	1.6	12.1
Average		0.5			0.5			0.3	

Table 2b: Summary of temperature trend in highland agro-ecology.

Years	Pre-main season			Main season			Post main season		
	Monthly average	Change (°C) from base years average	Change (%) from base years average	Monthly average	Change (°C) from base years average	Change (%) from base years average	Monthly average	Change (°C) from base years average	Change (%) from base years average
Maximum T									
1993-1997 (1st)	24.0			22.3			22.5		
1998-2002 (2nd)	25.1	1.1	4.6	22.8	0.5	2.2	22.0	-0.5	-2.2
2003-2007 (3rd)	22.7	-1.3	-5.4	20.8	-1.5	-6.7	20.3	-2.2	-9.8
2008-2012 (4th)	22.6	-1.4	-5.8	21.2	-1.1	-4.9	20.9	-1.6	-7.1
2013-2018 (5th)	23.3	-0.7	-2.9	22.2	-0.1	-0.4	21.5	-1.0	-4.4
Average		-0.6	-2.5		-0.6	-2.7		-1.3	5.8
Minimum T									
1993-1997 (1st)	9.6			11.1			9.0		
1998-2002 (2nd)	9.6	-0.1	-0.3	11.2	0.1	0.9	8.5	-0.5	-5.7
2003-2007 (3rd)	10.5	0.9	8.8	10.3	-0.8	-7.2	9.5	0.5	5.6
2008-2012 (4th)	8.8	-0.8	-8.6	10.9	-0.2	-1.8	9.1	0.1	1.1
2013-2018 (5th)	9.5	-0.16	-1.7	11.2	0.1	0.9	9.5	0.5	5.6
Average		-0.04	-0.4		-0.2	-1.8		0.16	1.7

observed for Assela (6%) as compared to smallest variability coefficient (2%) for Adama weather station in minimum annual temperature, while Wolinchiti comes second to Assela in minimum temperature by 5% coefficient of variation. In this regard, maximum temperature coefficient of variation for Adama, Wolnchiti and Assela weather station are 1%, 3% and 3%, respectively. Relatively, current study findings are closely similar with several studies result reports. In this regard, Khodang and Rohith, 2025) summarized average temperature ranges between 14.04°C and 21.08°C in 2022 and 2016, respectively while maximum temperature fluctuated from 25.66°C to 32.45°C in 2022 and 2019 respectively whereas the minimum temperature fluctuated from 5.02°C in 2022 to 14.37°C during 2013 cropping seasons in Manipur; India. Additionally, the result of this study indicated varying rainfall levels in 2022 and 2018, with less rainfall in 2022 (24.71 mm) and the highest in 2018 (108.59 mm), with an average rainfall of 95.25 mm, indicating significant rainfall fluctuations situation.

Furthermore, based on aggregated annual mean temperature data of two agro-ecologies (Highland and lowland), Mann-kendall trend test model estimated 20.59, 32.31 and 22.43 mean annual temperature data standard deviation for Pre-main season, Main season and Post-main season, respectively, indicating significant seasonal variability within the seasons, while sen's slopes were found -1.41.-0.45 and -0.55, for Pre-main season, Main season and Post main season respectively, indicating declining trends in all scenario which is different from several findings and traditional assumption (Fig 2).

Furthermore, World Bank (2010) affirmed increasing trends in annual Temperature by 1.3°C during period of 1960 and 2006, with average rate of 0.28°C per decade,

Table 2c: Temperature statistics computed from 10 Years (2009-2018) weather data.

Location	Weather stations temperature	Minimum	Maximum	Mean	Standard deviation	Coefficient of variation
Lowland	Adama maximum	27.70	28.90	28.39	0.33	0.01
	Adama minimum	15.20	16.30	15.77	0.34	0.02
	Wolnchiti maximum	29.43	31.49	30.26	0.78	0.03
	Wolnchiti minimum	14.28	16.38	15.45	0.71	0.05
Highland	Assela maximum	21.20	23.50	22.08	0.72	0.03
	Assela minimum	9.30	11.30	9.90	0.60	0.06

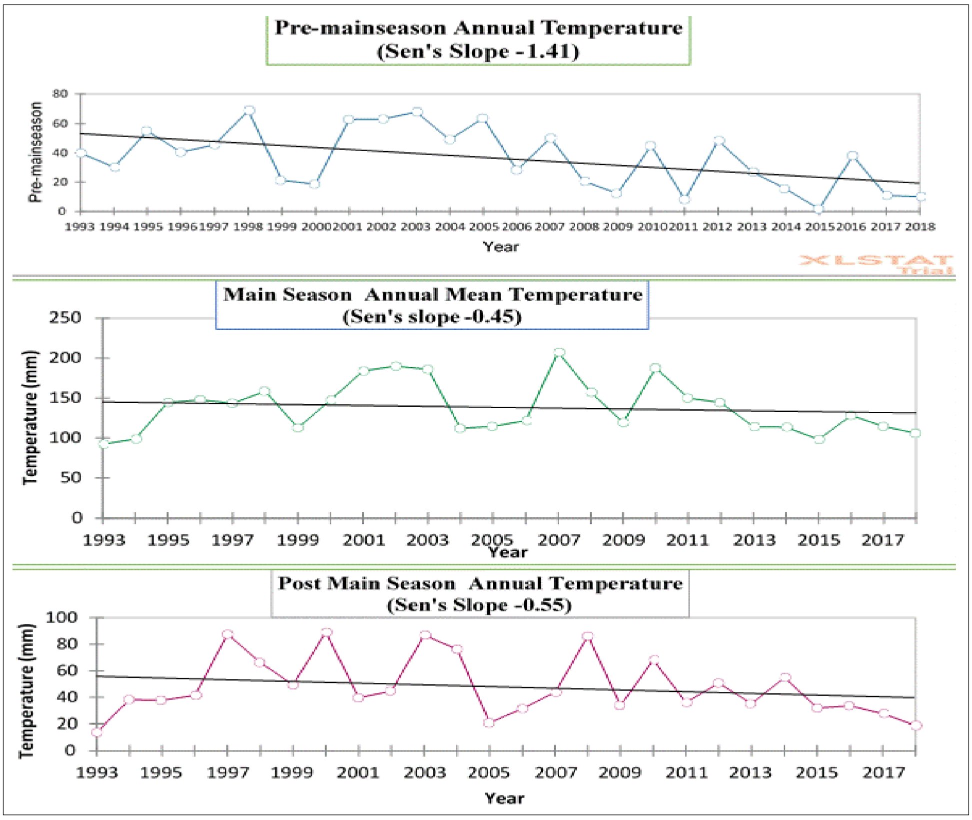

Fig 2: Mann-kendall trend tests.

while IPCC (2007) has predicted mean yearly temperature increase of 1.1°C to 3.1°C and 1.5 to 5.1°C by 2060s and 2090s, respectively, in Ethiopia which are similar with current findings in some in context of season and different in other seasons. Generally, several findings like Sivakumar *et al*. (2005), ascertained consistently closely similar weather variability and trends in context of most of the country and regions. Generally, several studies consistently revealing that variability in weather parameters significantly affect the crops productivity and livelihoods of a particular farm community. However, the study conducted by Abubakar *et al.* (2023), suggested non-significant influence of combined climate parameters (rainfall, temperature and etc) on the variations observed in palm yield. Again, weather variability affects multi-dimension of farm business: for instance; as to Valarmathi Sankaranarayanan (2025), Variation in rust intensity, ranging from 20.4% to 55.0% across different hybrids, can be attributed to weather conditions, where a one-degree Celsius reduction in maximum temperature corresponded to a 1.0%-10.1% increase in rust intensity among hybrids.

CONCLUSION AND RECOMMENDATION

The findings of this study indicated fluctuating situations within the years, between the years and seasons in annual rainfall and temperature parameters while in context of study findings, negative trends and escalating variability equally expected in the study community. It is very likely for annual temperatures to continuously increase while rainfalls decline over the next years and these changes certainly will persuade disastrous impacts on agricultural production and agriculture based livelihoods.

Additionally, extensive inter-seasonal weather variability compounded by declining trends in rainfall while significant increasing tendency identified in temperature which both have adverse consequences on farm business. These illustrates a need to establish adequate weather variability management strategies and strengthen information delivery systems to promote the adopted climate change management options among farmers through various programs/projects. Therefore, it is critically important for strategic and Technical managers to revisit and redesign existing policies, strategies and tactical measures which certainly improves prevailing environmental uncertainty that leading to livelihoods insecurity and beyond.

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Conflict of interest

The authors declare that there are no identified and acknowledged competing interests that could have appeared to influence the work reported in this paper.

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