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Original Research

Farmers' perception of Rainfall and Temperature Variability and Its Trends in North Mecha District, Amhara Region

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Abstract

The study evaluated local farmers' perceptions of changes in climate conditions and examined historical climatic trends over the 1987–2022 period. A cross-sectional research approach was employed, with participants selected through a multistage sampling technique. Primary data were generated from interviews, focus group discussions, and consultations with key informants-complementary secondary information obtained from agricultural offices, development agents, and the Bahir Dar Meteorological Station. Historical climate records were analyzed using Excel 2016 and XLSTAT version 16 to determine patterns, variability, and trends in climatic conditions. Rainfall fluctuations were quantified using the coefficient of variation (CV) and rainfall anomaly index (RAI). The findings indicated considerable seasonal variability in precipitation, particularly during the Bega and Belg seasons, where CV values reached 37.6% and 32.8%, respectively. Annual rainfall exhibited a decreasing tendency of 4.87 mm per year, while Kiremt rainfall declined at a rate of 3.96 mm annually. Conversely, both maximum and minimum annual temperatures showed increasing tendencies. Mean annual temperature increased significantly by approximately 0.044°C each year ($p < 0.05$). Consistent with the observed temperature increase and rainfall decline, most respondents across the agro-ecological zones perceived those temperatures had become warmer while rainfall had generally decreased. The results emphasize the importance of developing context-specific climate adaptation interventions that incorporate the socioeconomic conditions and environmental factors shaping farmers' exposure and vulnerability to climate variability.

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INTRODUCTION

The increased concentration of greenhouse gases has heightened global temperatures and altered the amount and distribution of rainfall around the world. Statistics show that the Earth's average surface temperature has increased by roughly 0.3 to 0.6 °C, while sea levels have risen by about 10 to 25 cm in the last hundred years (Yohannes *et al*., 2020). Unlike temperature, past changes in global average rainfall have been less predictable, varying by season and region (Alemayehu & Bewket, 2017; IPCC, 2021). The threats associated with global climate change and climate variability have heightened concerns among scientists.

Ethiopia's vulnerability to climate fluctuations is due to its geographical position, economic circumstances, dependence on mono and climate-sensitive sectors, high population density, severe environmental damage, fragile ecosystems, lack of national scientific data, restricted technological, financial, and institutional resources, and poor infrastructure (Fox *et al*., 2018). In light of this scenario, it is unavoidable that recurring drought, erratic rainfall patterns, and increasing temperatures pose an urgent danger to Ethiopian agriculture and food security. Moreover, climate fluctuations directly impact agricultural output and indirectly affect crops via pests, resulting in reduced water supply and increased degradation of natural resources. Ethiopia has experienced unusual variations in temperature over the last fifty years, alternating between warm, cold, and warm periods, with the hottest days notably increasing at a rate of 0.37% per decade (Atinkut & Mebrat, 2016).

Numerous studies have explored the elements affecting smallholder farmers' choice of adaptation strategies (Mamu, 2020) in the North Mecha district. Still, their study fails to adequately consider climate variability, and appropriate models were not utilized to analyze the elements affecting farmers' choices of adaptation strategies in the area examined. The North Mecha district is one of the most vulnerable areas in the West Gojjam zone of the Amhara region, Ethiopia, since farmers' agricultural output significantly depends on rainfall, which is increasingly jeopardized by climate variability. Nonetheless, research on the present adaptation methods utilized by farmers and the elements affecting their choice of adaptation tactics in the North Mecha District is fairly limited. This research aimed to comprehend farmers' perspectives on climate variability and its patterns in the North Mecha district of the West Gojjam zone, Amhara region, Ethiopia.

MATERIALS AND METHODS

The study was conducted in the North Mecha region of the West Gojjam zone, Amhara National Regional State, Ethiopia. Geographically, it is situated between latitudes 11° 20' 0'' N and 11° 30' 0'' N, and longitudes 36° 50' 0'' E to 37° 30' 0'' E. To the south lies the south Achefer district, while to the southwest is the Awi Zone. The west borders the Debub Achefer and Semien Achefer districts, the northeast adjoins Bahir Dar, and the eastern edge meets with the Yilmana Densa district. The district is situated 525 kilometers northwest of Ethiopia's capital city, Addis Ababa, and 35 kilometers southwest of Bahir Dar, the capital of Amhara (North Mecha district administrative office, 2023). The region consists of 33 Kebeles, including 3 Dega and 30 Woinadega Kebeles, with a total population of 319,306. Of this total, 159,847 (50.1%) are men and 159,459 (49.9%) are women. The district includes 57,528 households in total, consisting of 42,226 males and 10,302 females (North Mecha woreda administrative office, 2023). The area's land is split into three primary types: cultivated land, vegetated land, and barren land, with farmers primarily using cultivated land.

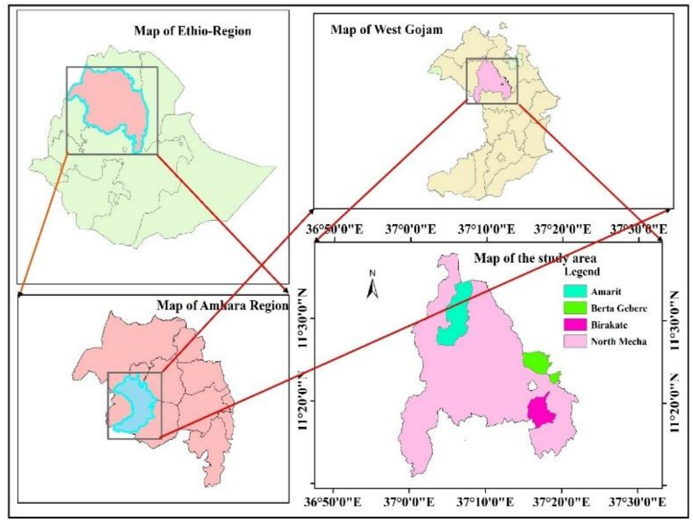


Figure 1. The study area

The North Mecha region has a single rainy season, with the primary wet period occurring from June to September. Annual precipitation varies between 1,076 mm and 1,420 mm, with July experiencing the highest rainfall and January the least. Mean temperatures fluctuate between 7.9 °C and 29.5 °C, with maximums ranging from 23.74 °C to 29.5 °C in March, while minimums dip to between 7.9 °C and 12.5 °C in January.

Research Design

A cross-sectional research design was employed to obtain socioeconomic and demographic information from sampled households through personal interviews, focus group discussions, and key informant interviews, while a longitudinal research design was utilized to gather observed monthly rainfall and temperature data from 1987 to 2022 at the Bahir Dar Meteorological Center.

Sampling Techniques and Sample Size Determination

There are 33 kebele administrations in the area. A multi-stage sampling method was used to select the sampled households in the district to gather the necessary data. First, the study area was selected purposively. Secondly, all 33 kebeles in the district was stratified into two agroecology's, midland (30 *kebeles* are *Woinadega)*, and highland (3 *kebeles* are *Dega)*. Finally, 150 total representative sample respondents were selected from all strata of selected kebeles using simple random (probability) proportional to the sampling size techniques. The number of sample households was determined using Cochran's (1977) formula at a 92% confidence interval, 5% degree of variability, and 8% level of precision.

Table 1. Computed sample Household heads of each kebeles under study.

District	Kebeles	Agroecological zone	Number of households	Sample household
North Mecha district	Berta Gebera	Woinadega	1171	49
	Amarite	Woinadega	1363	57
	Birakate	Dega	1052	44
Total			**3586**	**150**

Source: North Mecha District Agricultural Office (2023)

Data and Method of Data Collection

The primary data were collected via interviews with smallholder farmers regarding their views on rainfall and temperature fluctuations and trends, current adaptation measures, and demographic, institutional, and socioeconomic influences affecting the selection of adaptation strategies in reaction to climate variability in the research region. Secondary data were gathered from the North Mecha district administration office, agricultural offices, kebele administration office, Bahir Dar meteorological station (including a time series of rainfall and temperature data covering 36 years from 1987 to 2022), as well as published and unpublished documents among other pertinent sources.

Method of Data Analysis

This research utilized descriptive statistics, inferential statistics, and an econometric model to examine the quantitative and qualitative data gathered from the sampled households, employing STATA Version 14 software applications. Furthermore, the research employed non-parametric tests methods. Historical climate data, including monthly temperature and precipitation, were displayed using various tables and graphs, as well as metrics such as minimum and maximum values, coefficient of variation (CV), standard deviation (SD), Mann-Kendall test (ZMk), Sen's slopes test (Q), p-value, and rainfall anomaly (SRA), utilizing Microsoft Excel 2016 and XLSTAT Version 16.

Analysis of Rainfall and Temperature Variability

Coefficient of Variation (CV) is utilized to assess and compare the variability of monthly, seasonal, and annual distributions of climate variables. A greater CV signifies more variability, while a smaller CV signifies less variability. The calculation is made by taking the standard deviation of the event and dividing it by its long-term average. Standard Deviation is computed as the square root of the variance and used to check the stability of rainfall. The stability of rainfall is high when SD < 10, very high when SD is between 10-20, moderate stability when SD is in the range between 20-40, and less stable when SD > 40. The index for rainfall anomaly was utilized to determine the negative and positive variations in rainfall patterns within a specific area.

Time Series Trend Analysis

Precise and trustworthy evaluations of climate data necessitate comprehending, tackling, and supplementing the gaps in values. Consequently, prior to examining the climate data, the gaps in rainfall, maximum, and minimum temperature values in the dataset were addressed. An analysis of trends in yearly rainfall, average annual maximum temperature (Tmax), average annual minimum temperature (Tmin), along with seasonal and monthly rainfall and temperature trends, was performed using the non-parametric MK trend test (Mann, 1945; Kendall, 1948). The test statistic S of the MK test was used to detect the trend. Farmers' views on the characteristics of climate variability were defined and assessed according to the respondents' perceived level of agreement during data collection on nine aspects of climate variability: delayed start of the rainy season, premature end of the rainy season, alteration in rainfall volume, heightened occurrences of frost, increased frequency of droughts, rise in temperature, reduced rainfall volume, desiccation of ponds and streams, and crop diseases.

RESULTS AND DISCUSSION

Variability and its Trends of Climatic Variables in the Study Area

Variability of rainfall and trends in the study area: The analyzed data for yearly rainfall from 1987 to 2022 showed that the area recorded its lowest average rainfall of 1199.5 mm in 2009, while the highest average rainfall was observed at 1773.4 mm in 1999. The analyzed rainfall data showed that the area had an average of 1522.8 mm of precipitation over the past 36 years, with the variability of mean annual rainfall being 12.8%, remaining under the statistically estimated limit (CV < 20%). The distribution analysis indicated that the Kiremt and yearly rainfall data for the region are non-normally distributed at a 5% significance level. The assessed seasonal rainfall revealed that the area received average precipitation of 1145.0 mm, 136.3 mm, and 241.4 mm during Kiremt, Bega, and Belg, respectively. In 2000, the highest average rainfall of 1345.3 mm was recorded in the Kiremt season, whereas the lowest average rainfall of 896.1 mm was observed in 2020. In Belg, the highest average rainfall noted was 428.6 mm in 1989, whereas the lowest is presented in Table 2.

The average rainfall recorded was 94.1 mm in the year 2001. During the Bega season, the year 2016 recorded the highest average rainfall (234.0 mm), while the year 2012 saw the lowest average rainfall (40.0 mm). This suggested that the rainfall received during the Kiremt season exceeded that of Belg and Bega. In different instances, the analysis of seasonal rainfall's coefficient of variation indicated that Kiremt, Bega, and Belg had values of 10.3%, 37.6%, and 32.8%, respectively. This indicates that Bega and Belg experienced more variation in rainfall compared to Kiremt season rainfall. Consequently, rainfall from Belg and Bega was unreliable and not easily forecasted between 1987 and 2022. The standard deviation for Kiremt precipitation was 117.9 mm. This indicates that in the previous 36 years, the precipitation of 117.9 mm has varied by a plus or minus from the average rainfall observed in earlier years. This implies that the less stable distribution of Kiremt seasonal rainfall negatively affected the study area (Table 2).

According to NMA (2007), farmers in Ethiopia depend on the Kiremt rainfall amounts for their agricultural productivity, as slight changes in rainfall levels, duration, timing of the rainy season, and end dates greatly influence crop yields. Kiremt's total precipitation represented 75.2%, with Belg and Bega contributing 15.8% and 9%. Respectively, to the overall precipitation in the study area during the period (1987–2022), as illustrated in Table 3. This indicated that the area had the highest rainfall during the Kiremt rainy season. In the study region, average yearly precipitation levels and variability in rainfall from year to year are almost negatively correlated. The precipitation data analyzed monthly from 1987 to 2022 revealed that January (7.3mm), February (12.1mm), and December (17.1mm) had the lowest average rainfall in the region, while the highest average rainfall was recorded in July (362.3mm), with August (352.8mm), June (226.8mm), and September (203.4mm) closely behind (Table 2).

The examination of the monthly coefficient of variation showed that the precipitation during December and January had high coefficients of variation at 64.9% and 87.1%, respectively, whereas the rainfall noted in June, July, and August showed lesser variability with values of 16.3%, 10.8%, and 17.2%, respectively. The examination of the coefficient of variation revealed that in September, the rainfall exhibited moderate variability (CV = 24.7%). This variability in rainfall during September makes it inadequate for crop harvesting in the research area. September signifies the harvest season for various crops, such as beans and barley. In June, July, and August (CV < 20%), rainfall showed little variation. However, each alternate month showed considerable intra-month variability (CV > 30%) in the research area from 1987 to 2022.

Table 2. Statistics of rainfall in North Mecha District (1987-2022)

Month	Minimum	Maximum	Mean	SD	CV
Jan	0	23.9	7.3	6.4	87.1
Feb	0	27.5	12.1	6.1	50.2
Mar	0	84	29.5	18.9	64.2
Apr	12.6	231.6	87.2	49.7	57
May	25.7	234	112.6	47.3	42
June	121.1	278.9	226.5	36.9	16.3
July	295.1	447.3	362.3	39	10.8
Aug	202.1	498.7	352.8	60.7	17.2
Sep	56.4	278.8	203.4	50.3	24.7
Oct	0	178.9	77	41	53.3
Nov	11.8	89.2	34.9	14.2	40.8
Dec	2.3	43.9	17.1	11.1	64.9
Annual	1199.5	1773.4	1522.8	195	12.8
Kiremt	896.1	1345.3	1145	117.9	10.3
Bega	40	234	136.3	51.2	37.6
Belg	94.1	428.6	241.4	79.2	32.8

Based on Sen's slope values shown in Table 4, a decline in rainfall was observed during January, February, March, April, May, June, August, September, October, and December. Despite this, only June, September, and December showed a noteworthy reduction in rainfall trends at rates of -1.20mm, -2.11mm, and -2.68mm/year, respectively, in the research area, at a 5% significance level. In contrast, July and November saw an observed increase in rainfall trends. Nonetheless, only November displayed a noteworthy rise at a 5% significance level (Table 3). Sen's slope of the trend line indicated a decline in rainfall on a monthly, seasonal, and annual basis, except for July and November, which showed an upward slope. Table (2) shows the trend test for monthly rainfall in the North Mecha district, demonstrating variability in the rises and falls of monthly rainfall patterns over the past 36 years. This irregular rainfall causes water shortages and flooding for the area's rain-dependent agricultural activities, leading to problems with household food insecurity.

Table 3. Statistics of rainfall trend

Month	ZmK	Q	P-value
Jan	-1.56	-0.13	0.12
Feb	-0.98	-0.67	0.32
Mar	-0.18	-0.03	0.85
Apr	-0.91	-0.68	0.36
May	-0.11	-0.03	0.9
June	-2.03	-1.2	0.04
July	0.15	0.13	0.88
Aug	-1.38	-1.4	0.17
Sep	-2.11	-1.6	0.03
Oct	-1.46	-0.76	0.14
Nov	0.34	0.06	0.04
Dec	-2.68	-0.45	0.007
Annual	-2.93	-4.87	0.003
Kiremt	-2.04	-3.96	0.04
Bega	-1.89	-1.35	0.06
Belg	-0.89	-0.91	0.38

Note: ZMk, standardized statistics of trend test; Q, Sen Slope estimator; P-value, probability value; significant at $p<0.05$

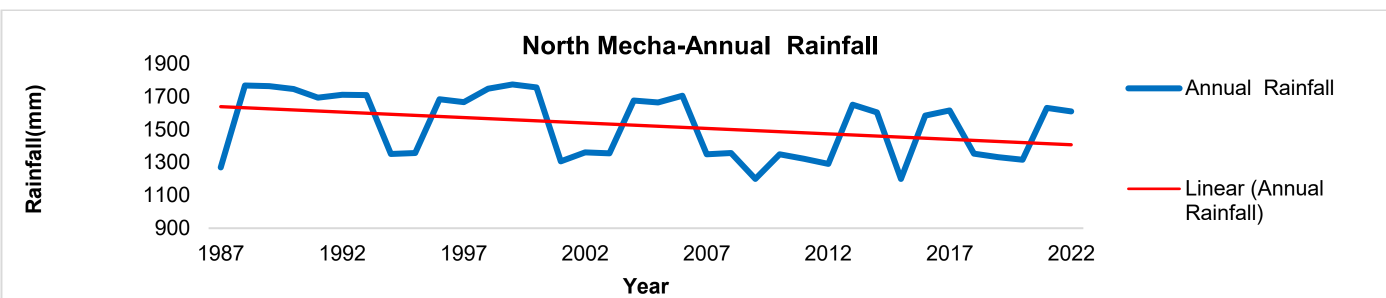
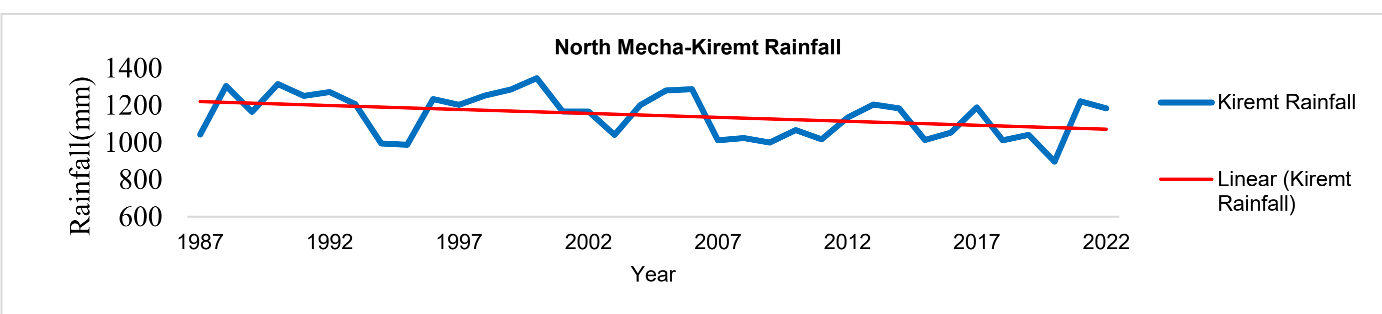


Figure 2. The trend of Annual Rainfall total from 1987-2022



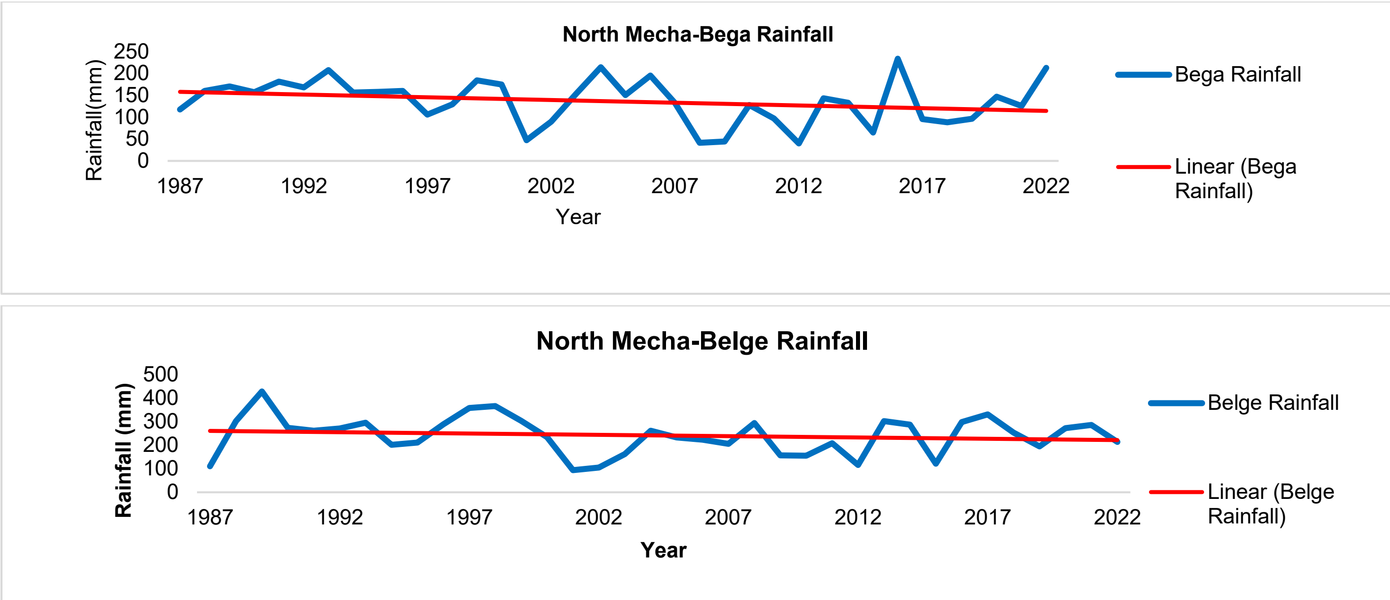


Figure 3.Trend of seasonal rainfall from 1987-2022

The precipitation anomalies (1987–2022) shown in Figure 4 exhibited inter-annual variability, with negative and positive anomalies representing 44.4% and 55.6%, respectively. The consistent rainfall anomaly over the year indicates the experienced wet conditions. The annual trends of rainfall distribution showed a deficit in precipitation compared to the long-term average during 1987–2022, 1994–1995, 2001–2002, 2003–2007, 2008–2009, 2010, 2011, 2012, 2015, 2018, 2019, and 2020. Negative rainfall deviations suggest moderate to severe aridity. Negative anomalies were observed in two years: 2009 and 2015 (5.6%), which showed extreme dryness, and one year, 1987 (2.8%), showed severe dryness. Approximately 12 years later, 1994, 1995, 2001, 2003, 2007, 2008, 2010, 2011, 2012, 2018, 2019, and 2000 (33.3%) reported moderate dryness, while a single year, 2002 (2.8%), was deemed not to have drought based on the established drought severity classifications. The results indicated that a negative anomaly (dry) existed in the study area.

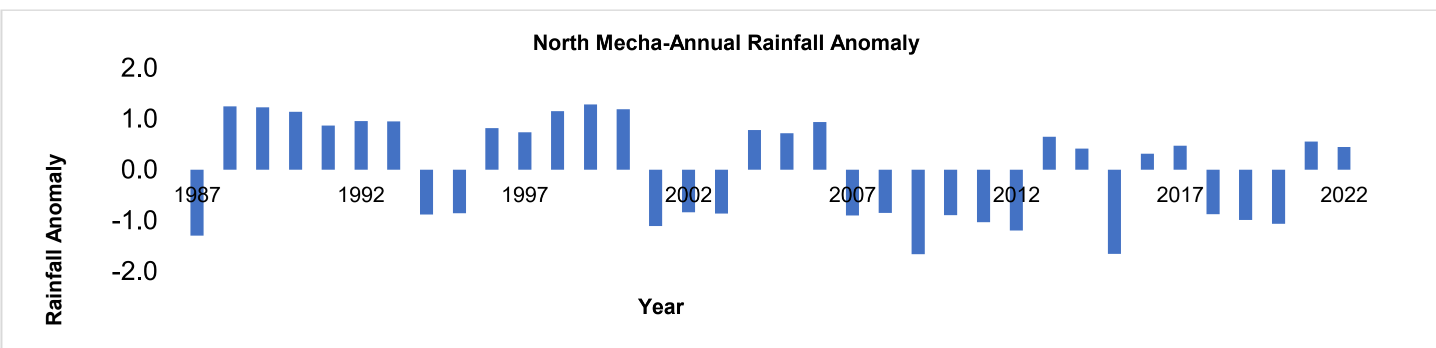


Figure 4. Annual rainfall anomaly from 1987-2022 in North Mecha district

Temperature is a key factor that influences both the weather and climate conditions of a region. The growth and yield of crops primarily depend on temperature, provided that water is abundantly available for optimal needs. Throughout the study period (1987–2022), the annual average maximum temperature in the study area fluctuated between 22.72 °C and 27.80 °C. The average annual maximum temperature in the research area was 25.15 °C, featuring a CV of 4.07% and an SD of 1.02 °C, indicating lower variability in yearly temperatures (Table 3). During the Belg season, the average maximum temperature varied between 24.74 °C and 31.26 °C, with a mean maximum temperature of 28.35 °C, an SD of 1.59 °C, and reduced variability (CV of 5.60%) (Table 4).

Table 4. Statistics of maximum temperature in North Mecha District (1987-2022)

Month	Minimum	Maximum	Mean	SD	CV
Jan	20	29.9	26.04	2.25	8.64
Feb	21.32	30.5	27.64	2.53	9.14
Mar	21.8	32.92	29.5	2.48	8.39
Apr	25.65	33.98	30.36	2.58	8.49
May	20.09	30	25.87	2.83	10.93
Jun	20	25.7	22.66	1.37	6.04
July	20.04	23.7	21.9	0.93	4.23
Aug	18.73	23.88	22.02	0.99	4.49
Sep	21.62	26.1	23.69	1.2	5.05
Oct	20.34	27.99	24.11	2.32	9.64
Nov	20	27.99	23.74	2.28	9.6
Dec	20.11	29.9	24.28	3.18	13.08
Annual	22.72	27.8	25.15	1.02	4.07
Kiremt	20.98	24.43	22.57	0.7	3.1
Bega	21.9	27.7	24.54	1.65	6.71
Belg	24.74	31.26	28.35	1.59	5.6

SD: standard deviation; CV: coefficient of variation.

Trend of maximum temperatures on an annual and monthly basis: Analysis using the Mann-Kendall trend test indicated a significant increase in the annual average maximum temperature, rising at a rate of 0.06 °C/year with a 5% significance level. The results align with Hayelom *et al*. (2017), who observed that the annual peak temperature trend has notably increased in Addis Zemen ($p < 0.05$). The trend test findings showed that in the Bega, Belg, and Kiremt seasons, the average maximum temperature is rising significantly at rates of 0.08 °C, 0.07 °C, and 0.04 °C/year, respectively (Table 5).

Table 5. Statistics of Maximum temperature trend

Month	Zmk	Q	p-value
Jan	-0.01	0	1
Feb	3.04	0.08	0.002
Mar	2.7	0.09	0.007
Apr	0.78	0.04	0.43
May	0.22	0.01	0.82
June	1.54	0.04	0.12
July	2.22	0.04	0.03
Aug	3.12	0.04	0.002
Sep	2.94	0.06	0.003
Oct	2.79	0.09	0.005
Nov	2.98	0.13	0.003
Dec	1.72	0.08	0.084
Annual	3.75	0.06	0
Kiremt	3.42	0.04	0
Bega	2.79	0.08	0.005
Belg	2.58	0.07	0.01

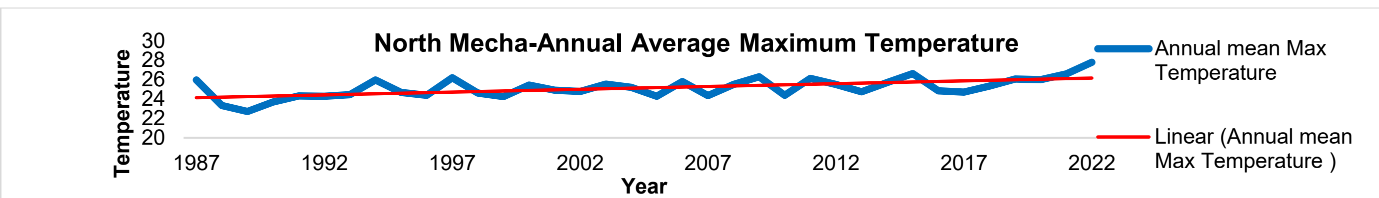


Figure 5. Annual maximum temperature trend

Annual and monthly minimum and average temperature variability

The peak monthly average minimum temperatures were recorded in April (15.80°C) and March (15.76°C), while the lowest monthly average minimum temperatures occurred in October (11.54°C), November (11.32°C), December (10.97°C), and January (12.33°C) (Table 6). The coefficient of variation for the monthly minimum temperature ranged from 3.47 °C to 11.54 °C, suggesting that all monthly minimum temperatures exhibit lower variability. Nonetheless, the lowest temperature in February shows relatively greater variability than in any other month.

Table 6. Statistics of Minimum and annual average temperature (1987-2022)

Month	Minimum	Maximum	Mean	SD	CV
Jan	9.29	14.99	12.33	1.41	11.44
Feb	11.38	16.99	14.46	1.67	11.54
Mar	12.48	18.2	15.76	1.04	6.59
Apr	14.03	17.59	15.8	0.83	5.25
May	12	16.85	14.25	1.04	7.28
June	12.66	15.01	13.93	0.69	4.94
July	12.06	14.38	13.34	0.58	4.38
Aug	12.32	14.77	13.64	0.47	3.47
Sep	9.47	15.93	13.53	1.12	8.28
Oct	9	13.89	11.54	1.22	10.55
Nov	9	13.42	11.32	1.19	10.48
Dec	8.9	13	10.97	0.74	6.75
AnnualTmin	12.52	15.09	13.4	0.5	3.74
Kiremt	11.9	14.84	13.61	0.47	3.49
Bega	10	13.33	11.54	0.71	6.13
Belg	13.11	17.1	15.07	0.79	5.21
Annual Tmean	17.92	20.98	19.28	0.65	3.35

Results from the trend test showed an increasing trend in both yearly maximum and minimum temperatures at different rates in the analyzed area. This enhances evaporation and leads to water depletion, aggravating water shortages. Moreover, rising temperatures cause a shift from long-duration cultivars to short-maturing types, leading to lower yields and quality. An increase in baseline minimum temperature leads to greater water requirements for crops due to heightened evapo-transpiration. Regarding the trend of monthly minimum temperatures, January, February, March, April, July, August, September, October, November, and December displayed an increasing pattern, while May and June revealed decreasing trends across the study area during the observed period (Table 7). The trends in minimum temperatures for each month showed no significance, except for January, February, September, and November, which were significant at a 5% level.

Table 7. Mann-Kendall statistics of the annual, seasonal, and monthly minimum temperature trend

Month	Zmk	Q	P-value
Jan	2.7	0.057	0.006
Feb	4.6	0.112	0
Mar	1.8	0.023	0.072
Apr	1.7	0.019	0.091
May	-0.5	-0.007	0.614
June	-1.4	-0.015	0.149
July	0.7	0.005	0.504
Aug	0.7	0.005	0.504
Sep	2.2	0.035	0.025
Oct	1.9	0.026	0.058
Nov	3	0.056	0.003
Dec	0.8	0.011	0.445
Annual	3.5	0.025	0
Kiremt	1.5	0.011	0
Bega	2.9	0.034	0.02
Belg	3	0.033	0.05
Annual mean Temperature	4.7	0.044	0

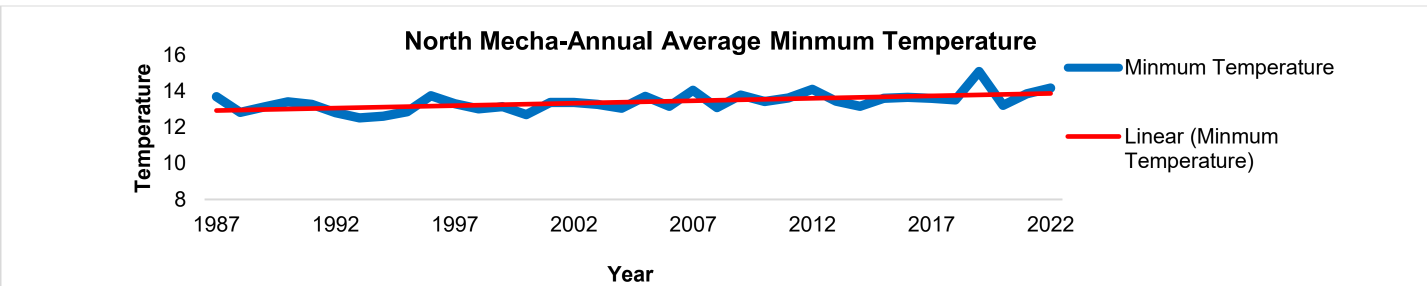


Figure 6. Annual minimum temperature trend

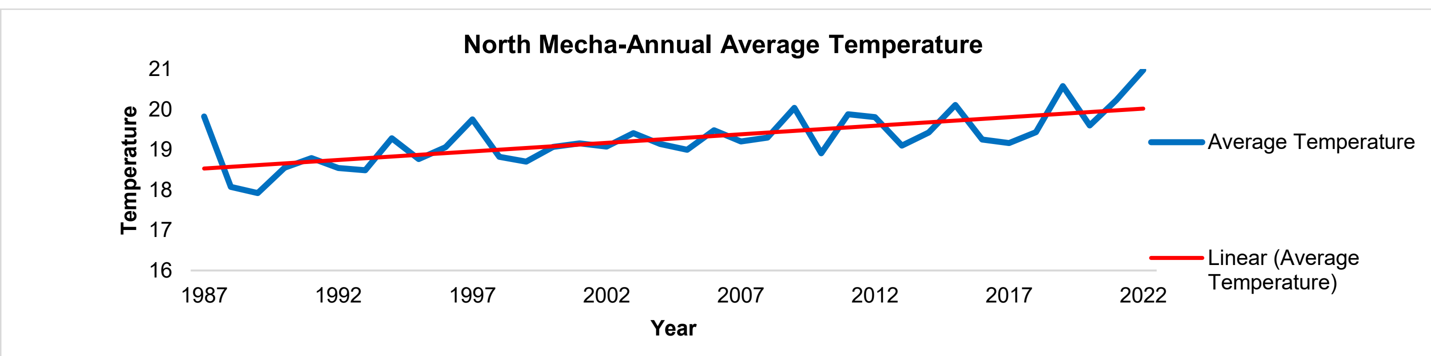


Figure 7. Annual average temperature trend

Farmers' Perception on Rainfall Variability

The results showed that 45.45% of surveyed households in Dega and 61.32% in Woinadega believed that rainfall was declining during the Kiremt (main rain) season. The results from the households surveyed showed that 54.55% of smallholder farmers in the highland (Dega) and 72.64% in the midland (Woinadega) felt that annual rainfall has steadily decreased over the last 36 years. This indicated that most respondents in each agro-ecological zone recognized the decreasing trend of rainfall in the research area over the past 36 years. However, 27.27% and 16.98% of participants from the specified agro-ecological zones acknowledged that the yearly precipitation levels increased in their area during the same period (1987–2022). Some respondents (6.82% from Dega and 5.66% from Woinadega) also thought that no changes took place in the agro-ecological zone. The other participants (11.56% from Dega and 4.72% from Woinadega) claimed they had no knowledge of the rainfall conditions in their region.

The findings indicated that 45.45% of households surveyed in Dega and 61.32% in Woinadega thought that rainfall was decreasing in the Kiremt (main rain) season, while 34.09%, 11.36%, and 9.09% of the surveyed households believed rainfall was increasing, unchanged, and were uncertain, respectively, in the Kiremt season over the past 36 years in Dega agro-ecology. In Woina dega, around 29.25%, 6.60%, and 2.83% of the households surveyed thought that rainfall was increasing, staying the same, or were uncertain during the Kiremt (main rain) season, respectively. In the Belg season, around 63.64% of participants in Dega and 69.81% in Woina dega perceived rainfall as diminishing. Nonetheless, 18.18% of respondents and 15.09% of respondents observed higher rainfall during the Dega and Woina dega seasons, respectively. The remaining 11.36% and 6.82% of sampled household heads in Dega thought that rainfall had not changed and was uncertain, respectively. In Woina dega, 10.38% of the surveyed households observed no variation in rainfall, whereas 4.72% did not recognize it during the Belg season.

Table 8. Farmers' perception of annual and seasonal rainfall Variability during the last 36 years in North Mecha district, Ethiopia (N = 150)

Climate Parameters	Perception	Dega N (%)	Woinadega N (%)
Annual rainfall	Increase	12(27.27)	18(16.98)
	Decrease	3(54.55)	77(72.64)
	No change	3(6.82)	6(5.66)
	I don't.t know	5(11.56)	5(4.72)
	-	44	106
Kiremt	Increase	15(34.09)	31(29.25)
	Decrease	20 (45.45)	65(61.32)
	No change	5(11.36)	7(6.60)
	I don.t know	4(9.09)	3(2.83)
Total N	-	44	106
Belg	Increase	8(18.18)	16(15.09)
	Decrease	28(63.64)	74(69.81)
	No change	5(11.36)	11(10.38)
	I don.t know	3(6.82)	5(4.72)
Total	-	44	106
Bega	Increase	5(11.36)	13(12.26)
	Decrease	30(68.18)	76(71.70)
	No change	6(13.64)	10(9.43)
	I don.t know	3(6.82	7(6.60)
Total	-	44	106

Source: Survey result, 2023

DISCUSSION

The findings of this study aligned with those from research by Yasuda *et al*. (2018) and Dawit *et al*. (2019), which indicated a negative correlation between rainfall variability and average annual rainfall in the Guna Tana Watershed, Upper Blue Nile Basin of Ethiopia, as well as in the Central Nile Basin. Further studies by Gebrehiwot and van der Veen (2013), Suryabhagavan (2017), and Mekonen and Berlie (2020) revealed that the Kiremt season contributes the most significant proportion (64–85%) of annual precipitation, whereas the Belg season contributes a lesser amount (5–30%) of rainfall across different areas of Ethiopia. Each alternate month showed considerable variability within the month (CV > 30%) from 1987 to 2022 in the study area, consistent with observations by Belay *et al*. (2019), who found a low CV in June, July, and August in the Beles Basin of Ethiopia.

The yearly and Kiremt rainfall showed a significant downward trend at rates of -4.87 mm/year and -3.96 mm/year, respectively, at a 5% significance level in the research area. Ademe *et al*. (2020) observed a significant reduction in rainfall during the main rainy seasons (Kiremt) in the farming region of the Ethiopian highlands. Similarly, Addisu *et al*. (2015) observed a significant downward trend in annual rainfall at the Debre Tabor, Zeghie, Hamusit, Yifag, and Maksegnit stations located in the Lake Tana Basin. In contrast to Kiremt, Bega and Belg rainfall exhibited a statistically non-significant decline in precipitation, at rates of -1.35mm and -0.91mm annually in the study area (Table 4). The declining rainfall pattern is frequently linked to severe drought conditions in the area over the past 35 years, from 1987 to 2022. This is consistent with Alemu and Bawoke (2020), who noted a negligible downward trend in the Bega.

The findings of this study aligned with those of Yasuda *et al*. (2018) and Dawit *et al*. (2019) show more variation in minimum temperature than any other month. The Mann-Kendall trend test revealed a significant increase in the total average temperature and the annual mean minimum temperature trends by 0.044 °C and 0.025 °C/year, respectively, at a 5% significance level. The result corresponds with Lemma (2016) discoveries in the western Amhara area, which showed a notable increase in the average temperature trend. Tamiru *et al*. (2015) observed an increasing trend in the average yearly minimum temperature from 1990 to 2009. Seasons indicated that trends were increasing significantly at annual rates of 0.025°C, 0.011°C, and 0.034°C, respectively. During the Belg season, the minimum temperature trend shows a statistically insignificant increase of 0.033 °C per year (Table 8). The result corresponds with the findings of Tekleab *et al*. (2013), and Dawit *et al*. (2019) who noted a significant increase in the yearly and seasonal averages of the mean minimum temperature. This shows that the yearly average maximum temperature exceeded the yearly average minimum temperature rate. This result is consistent with Shekuru *et al*. (2022), who noted that the increase in the average annual maximum temperature exceeded that of the minimum temperature.

CONCLUSION

In countries like Ethiopia, which depend heavily on rain-dependent agriculture, assessing the variations in rainfall and temperature and keeping track of their patterns are key elements for sustainable farming progress. Variations in rainfall occurred every month in the study area, suggesting that the region faced inconsistent monthly precipitation. As a result, seasonal and annual rainfall trends were inconsistent, affecting crop production. Monthly precipitation amounts are diminished, except for November and July. In particular, November demonstrated a significant increase in its rainfall pattern over the study duration (1987-2022). November plays a key role in crop harvesting; nevertheless, heavy rains this month greatly affect farmers' capacity to collect their yield. Marked declines in inter-annual rainfall variability were observed during the Kiremt season throughout the study area. In addition, seasonal rainfall was highly erratic, raising worries for rain-dependent farming. The analysis employing different statistical techniques showed significant warming trends in temperature in the study region on both an annual and seasonal basis.

Farmers in the North Mecha region noted an increase in temperature along with a decrease in rainfall. The smallholder farmer's perception of climate change aligns with the weather information from the meteorological station. Farmers' perspectives on climate variability and real climate data are essential for deepening understanding, and they are also important for achieving substantial gains in production, food independence, and sustainable development. The results of this research are crucial for local leaders as they work to adopt adaptation strategies that improve household livelihoods in the face of shifting local climate conditions. There is a chance to enhance households' knowledge and comprehension of climate factors and trends associated with climate matters in the study area.

Availability of Data and Material

The corresponding author can provide data upon reasonable request.

Conflict of Interest

The authors declare that there is no conflict of interest concerning this manuscript.

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