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Original Research

# Assessing Local Farmers' Perception of Climate Change in Nejdo District, West Wollega West Oromia, Ethiopia

Debela Asefa[1], Getinet Kebede[2] and Dessalegn Worku[3*]

[1]Leta Sibu District, Agricultural Office, West Wollega, Oromia, Ethiopia

[2]Department of Geography and Environmental Study, Faculty of Social Science, Nekemte Campus, Wollega University

[3]Department of Natural Resource Management, Faculty of Resource Management and Economics, Shambu Campus, Wollega University

## Abstract

*This study investigates the influence of watershed management on climate change adaptation in the Nedjo District, West Wollega Zone, Oromia Regional State, Ethiopia. Employing a mixed-methods approach, the study combined quantitative data collection through household surveys, analyzed using SPSS version 26, with qualitative methods such as focus group discussions and key informant interviews. Meteorological data (1991-2021) from the National Meteorological Agency (NMA) was analyzed using XLSTAT 2015, specifically employing the Mann-Kendall trend test for analyzing rainfall and temperature trends. The findings reveal that 57.12% of the respondents are aware of climate change, with 55.93% perceiving changes in rainfall patterns and 65.25% observing changes in temperature, corroborated by the meteorological data analysis, which showed an increasing trend in annual rainfall and significant increases in both maximum and minimum temperatures. The study also identified a gender disparity in participation in watershed management activities, with male respondents comprising 82% of the total sample. The study concludes by recommending the strengthening of climate information dissemination, the promotion of climate-smart agricultural practices, addressing gender disparities, and the enhancement of local governance for effective climate change adaptation.*



## Article Information

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***Corresponding Author:**
**E-mail:**
dessuworku@gmail.com

## INTRODUCTION

Global climate change is a challenge and a threat to humanity's future in this century (IPCC, 2014). The poorest and most vulnerable populations are being pushed faster than they can react. The deteriorated state of the watershed and its consequences on reducing its ability to sustain local livelihoods are directly related to the heightened susceptibility to drought and food insecurity. On the other hand, protected and well-managed watersheds have a variety of beneficial benefits for local economies, the environment, and people's quality of life (FAO, 2014). Growth and development are impacted by climate change in ways such as altered agricultural production, water availability, upkeep of road infrastructure, and extreme weather occurrences. Extreme weather events like storms, floods, tropical cyclones, and droughts are common in eastern Africa and can have disastrous effects on infrastructure, agriculture, human health, and many other important socioeconomic sectors (IPCC, 2014). The extensive degradation of soil, water, and biodiversity along with the rural population's heavy reliance on rain-fed agricultural production for food security and livelihoods compound the effects of climate-related shocks on the functioning of agricultural systems (FAO, 2014). Furthermore, during the past few decades, the sub-region's climate has been more variable, and there has been a rise in the frequency and severity of climate hazards, particularly drought. Effective measures for adapting to climate change can be supported by good watershed management, which can also support better land and water quality (FAO, 2014).

Ethiopia faces significant vulnerabilities to the adverse effects of climate change due to several interrelated factors. These include its diverse topography, geographic location, heavy reliance on rain-fed agriculture, underdeveloped water resources, rapid population growth, low economic development, inadequate road infrastructure in drought-prone areas, and weak institutions coupled with low adaptive capacity (Dejene, 2018). Within this context, Oromia, one of Ethiopia's regional states, experiences extreme climate variability. Climate change is anticipated to further increase the frequency and severity of natural disasters and extreme weather events in the region. The existing social and economic challenges may exacerbate the impacts of these extreme events, particularly for communities that depend on resources vulnerable to climate change (ONRS, 2011). There is little doubt that soil erosion in the research area contributes to a loss in soil fertility, lower agricultural yields, and socioeconomic difficulties due to farmers' limited ability to adjust. Watershed management and climate change adaptation have been used as options by sustainable land management projects in Nedjo district Agar Genasi watershed project from (2013 to 2018) for five years in order to strengthen farmers' capacity for adaptation. The initiative strengthens farmers' ability to adjust Assessing and recognizing adaptation potential, the degree to which adaptation strategies are adopted, and which adaptation methods contribute to family income are all necessary to make watershed management for climate change adaptation function as a source of revenue for the farmers (Melaku et al, 2017). Nevertheless, no evaluation has been done on the role that WSM plays in the Agar Genasi watershed's climate change adaptation methods, the effect that watershed management techniques have on household farmers' revenue or their regional adaption plans. Therefore, the status of WM's climate adaption techniques has not been researched in the study region, which is the other portion of Ethiopia. The impact and adaption strategies in the WS intervention were thus the main focus of this investigation. Furthermore, the study evaluated the trends in climate change, the degree of awareness regarding climate change, and the understanding that local adaptation is a good place to start when strengthening local people's ability to adapt to climatic variability and change. In order to evaluate the effects of community-based watershed management on temperature and rainfall trends, this study analyzed the variability and trend of temperature and rainfall in Nejdo District, West Wollega, and West Oromia, Ethiopia.

## Materials and Methods

### Location of study area

The study was carried out in the Nedjo District, which is roughly 498 km west of Finfinnee and 72 km from Ghimbi. It is situated between 9030'0" and 9040'0" North and 35030'0" and 35040'0" East. According to the Nedjo district administrative office (2022), the district borders the Benishanguli Gumuzi Region in the north, Jarso District in the south, Boji Dirmaji District in the east, and Leta Sibu District in the west. There are ten micro watersheds in the district.

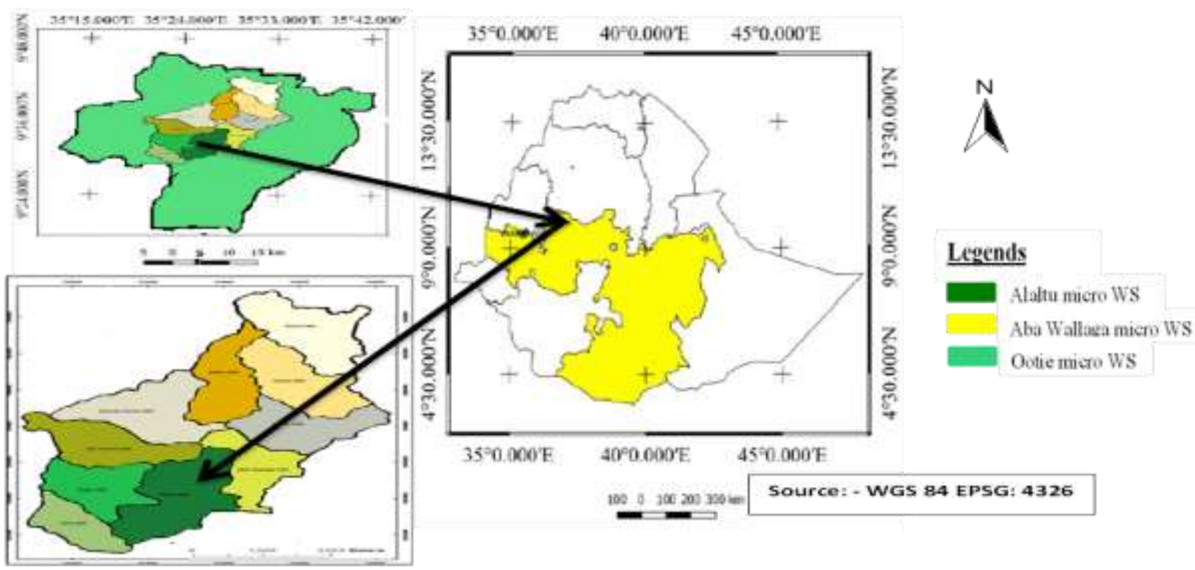


**Fig 1.** Map of the study area

### Climate

The region is made up of 1% Dega and 99% Wayina Dega. Its typical mean annual rainfall varies from 415 mm to 11.5 mm, and its annual temperature spans from 180 c to 280 c (Nedjo Meteorology Center, 2022)

### Vegetation and Wildlife

The most humid area of the district, with mean annual rainfall exceeding 1300 mm and elevations ranging from 1300 to 2500 masl, is home to broadleaf forests. This forest includes the following species: Cupressus lusitanica, Cordia Africana, Europaea, eucalyptus camaldulensis, Albizia gummifera, Grevillea robusta, Sesbania sesban, Leucaena leucocephala, and fruits such as Mangifera indica and Carica papaya. The district's common climatic climax vegetation types are grasslands and wetlands (marshes and swamps) (Nedjo District Agricultural Offices, 2022).

The area has tremendous potential for wildlife resources in the forests. The typical wildlife found in the degraded forest includes hyenas, antelope, tortoises, leopards, and others (Nedjo District Agricultural offices, 2022).

**Research Design and Approaches**

This research design used a survey method and questionnaire to conduct an explanatory and descriptive type of study. The techniques of purposive sampling were chosen. This is due to the fact that the study needs an explanation of how families are responding to current environmental issues.

The goal of the study was to explore the characteristics of watershed management practices for climate change adaptation in the designated study region using a mixed methodology, which combines qualitative and quantitative research methods. The term "mixed-methods research" refers to a research methodology that combines quantitative and qualitative approaches which allow researchers to leverage the strengths of both methods: quantitative techniques provide objective numerical data for statistical analysis, while qualitative methods offer insights into subjective attitudes, perceptions, and behaviors. (Kothari, 2004).

**Sampling Technique and Sample Size**

Sample households were chosen in two phases using the multi-stage sampling approach. Nedjo district was specifically chosen in the first phase based on the existence of watershed management. The Nedjo district, the study region, has 10 micro watershed management systems. In order to reflect the Watershed Management for Climate Change Adaptation systems in the study area, three micro watersheds Aba Wallaga, Qotie, and Alaltu were specifically chosen in the second stage. A small number of development agents, kebeles administrators, and agricultural office specialists were used in the study for key informant interviews, as well as communities of micro watershed committees. A total of 606 head farmers' households were utilized as the population from each micro watershed that was chosen, and 237 samples of HH were randomly picked using the probability proportional to size (PPS) sampling approach. To determine the required sample size at a 95% confidence level, the following formula was used:

$$n \frac{Z^2.p.q.N}{e^2(N-1)+Z^2pq} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.1$$

Where n = sample size; z = degree of confidence as value for selected alpha level; p = precision of the household head, which is the expected proportion of samples; q = 1−p or variability value that is subtracted from the precision of household head; N = Total Household Head size; and e = acceptable/margin of error. The numbers of sample HHs heads were determined using Kothari, (2004) formula at marginal error (5%). To determine the sample size, a multi-stage sampling approach was employed:

Stage I: Nedjo District was chosen as the study area.
Stage II: Three micro-watersheds within the district were purposively selected. Stage III: Rural household heads were randomly sampled using a simple random sampling technique. Stage IV: Finally, 237 sample households were selected for data collection.

As a result, the constant value for z at the 95% significance level is 1.96. A study by Mengistu (2014) found that the expected share of all household heads was over 75%, making accuracy (0.75) and variability (0.25) acceptable. There are 606 total household heads in the study locations, and the computation indicates that the acceptable error is (0.05).

$$n = \frac{(1.96)^2 x\ 0.75x0.25x606}{(0.05)^2(606-1)(1.96)^2 x\ 0.75x0.25} \dots\dots\dots\dots\dots\dots.2$$

$\mathbf{n} =$ Respondents

195 samples HHs were selected for the study from the total lists of micro watershed management using simple random sampling methods. The formula for proportional allocation from the stratum/Community-Based Watershed Management is:

$$\boldsymbol{K = \frac{nxPi}{N}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.3$$

Where; k= sample household respondents in each micro WM, n= is the sample size selected from three micro WS in this case 237 households, $P_{i=}$ is the household included from the stratum/micro Watershed. N =Total households in the three Micro watershed managements (Abba Wallaga, Qotie, and Aleltu). Accordingly

| Kebeles | Total HH | Sampling n of each kebele | Actual sample size of each kebele |
|---|---|---|---|
| Abba Wallaga | 92 | n=92×237/606 | 75 |
| Qotie | 238 | n=238×237/606 | 93 |
| Aleltu | 276 | n=276×237/606 | 108 |
| Total | 237 | | 236 |

**Sources of Data and Data Collection Method**

The primary source of information about watershed management techniques for climate change adaptation came from HHs farmers. Field observation, interviews, focus groups, and household surveys/questionnaires were used to gather it. Published books from libraries and the internet, unpublished records at the "kebele" and "wereda" levels, different reports, District Agricultural offices, and stockholders in the study areas were all sources of secondary data. To determine the climate change/variability patterns of the research area, secondary data, such as time series rainfall and temperature of 30 (1991-2021) years' data, were gathered from the National Meteorological Agency (NMA, 2021) Asossa branch.

**Data Collection Instruments**

Personal observation was used by the researchers to gather data about community-based watershed management and farmers' current efforts to adapt to climate change in the study area. However, focus group discussions (FGDs) were held in each of the three micro watershed managements that were chosen. To that end, three focus group discussions (FGDs) with ten participants were set up in each of the chosen watershed sites. These 10 participants included women, DAs, youth leaders, elder farmers, watershed management committee members, and local elders. The status, contribution, impacts, and choices for adaptation on watershed management practices for climate change adaptation were the data acquired through focus group discussions. Furthermore, knowledgeable individuals are aware of the study region, understand the consequences of WM techniques on farmers' income before and after the implementation of the watershed management project, and its adaptive implications.

As a result, six important informants' local elders, specialists from the district agricultural office, kebele administrators, and development agents were questioned for this specific study. In the end, a questionnaire with both closed- and open-ended questions was created for the purpose of identifying problems and establishing goals. In order to minimize bias, a survey and questionnaire were selected for 236 houses or 32% of all the households in the three WS. This allowed participants to express their opinions anonymously.The primary components of the survey would comprise data on household demographics, farmers' ability to adapt, and practical perceptions and awareness of climate change

**Data Analysis**

**Trend analysis**

The 30 years (1991-2021) of Rainfall and temperature data were analyzed by XLSTAT 2015 software to see the trends through the taken periods. Hence, to describe a trend of a time series Mann-Kendall trend test was used to see whether there is a trend or not. Mann- Kendall statistics (S) is one of the non-parametric statistical tests used for detecting trends of climatic variables. The Mann–Kendall (MK), commonly known as Kendall's statistic, is a non-parametric test used for trend analysis. Mann (1945) first used this test and Kendall (1975) derived the test statistic distribution. The normalized Z-score for the significance test and the Mann-Kendall test were utilized to identify the trend. If a time series value is higher, a score of +1 is given; if it is lower, a score of -1 is given. The Mann-Kendall statistic, which measures the overall score for the time-series data, is then compared to a critical number to determine if there is an increasing, decreasing, or no trend in the rainfall. Allow X1, X2, X3,... Where Xj represents the data point at time J, and Xn represents n data points (monthly). The Mann-Kendall statistics (S) are then provided by. $S=\sum_{i=1}^{n-1}\sum_{j=i+1}^{n} Sgn(X - \bar{X})$

Where $X_i$ and $X_j$ are the values of sequence i, j; n is the length of the time series and

$$\text{sgn}(S) = \begin{bmatrix} 1 \ if\ S > 0 \\ 0 \ if\ S = 0 \\ -1 \ if S < 0 \end{bmatrix}$$

A positive value of S indicates an upward trend and a negative value indicates a downward trend. The statistical S is approximately normal distribution when n > 10. The mean of S is zero and the variance can be calculated as follows:

$$Var(S) = \frac{n(n-1)(2n+5) - \sum_{j=1}^{m} t_i(t_i-1)(2t_i+5)}{18}$$

When n is the number of data points, m is the number of tied groups each with $t_i$ tied observations. A set of data that has the same value is a tied group. The standardized test statistic ($Z_{MK}$) is calculated as: The mean of S is zero and the standardized test statistic (Z) is calculated as:

$$Z_{mk} = \begin{bmatrix} \frac{S-1}{\sqrt{Var(S)}}, & S > 0 \\ 0 & S = 0 \\ \frac{S+1}{\sqrt{Var(S)}}, & S < 0 \end{bmatrix}$$

Therefore, in a two-sided trends test, if the null hypothesis is accepted at the significance level (α), it should be accepted. Zmk is the Mann-Kendall test statistic, which has a typical normal distribution with mean 0 and variance 1. A positive value of Zmk indicates an upward trend, whereas a negative value suggests a downward trend. In a two-sided trend test, if -Z1<α/2 ≤ Zmk ≤ Z1-α/2, where α is the significance level that denotes the trend strength, then the null hypothesis of no trend Ho is accepted.

**Socio-economic data analysis**

All of the information gathered from the chosen households, the focus group discussion, and the key informant interview was entered into the MS Excel and the Statistical Package for Social Science (SPSS version-26) computer programs. Using the proper techniques for each analysis, the qualitative and quantitative data that were acquired through data collection methods were examined. The quantitative data was analyzed using descriptive statistics, including mean, percentages, minimum, maximum, variance, standard deviation, and frequency. To further summarize and show the results, tables, ratios, charts, graphs, and histograms were employed. Farmers' fields were found to have significantly numerous correlations at the 5% level of significance using a one-sample T-test analysis. While the explanatory framework was used to examine the home survey results for the impact of community-based watershed management on climate change adaptation, the variables' differences and relationships were also evaluated.

## 2. Results and Discussions

**Demographic Characteristics of the Respondents**

The analysis reveals a significant gender disparity in participation in watershed management activities across the study areas. Male respondents comprised 82% of the total sample, indicating their dominant involvement in agricultural and watershed-related tasks, while female respondents accounted for only 18%. This pattern underscores the gendered division of labor within the study region.

**Table 1:** Number of Respondents and Populations of Study Area

| Sex | Study area | | | | Total%of sex |
|---|---|---|---|---|---|
| | Aba Wallaga | Qotie | Alaltu | Total | |
| Male | 32 | 74 | 88 | 194 | 82 |
| Female | 12 | 16 | 15 | 43 | 18 |
| Total | 44 | 90 | 103 | 236 | 100 |

The likelihood of someone being impacted increases with household size. However, according to Cutter et al. (2003) reported in Meaza (2014), larger homes represent important social networks and manpower, which may be useful in emergency situations. While the majority of smallholder farmers possess small plots of land where they are unable to cultivate enough crops to maintain their livelihood, a minority of them own huge plots of land where they can grow enough crops. A large family may not be able to provide for all of the necessities of raising children, which would compromise their welfare. The results of this study are in opposition to those of earlier research, which demonstrates that family planning helps achieve the nation's sustainable development goals and guarantees that some children will assist parents in meeting their children's fundamental needs.

**Age Structure and Marital Status**

**Table 2:** Age Distribution of Respondents

| Age Group (Years) | Number of Respondents | Percentage (%) |
|---|---|---|
| 21–30 | 97 | 41.1 |
| 31–40 | 78 | 33.1 |
| 41–50 | 43 | 18.2 |
| Above 50 | 18 | 7.6 |
| **Total** | **236** | **100** |

The table illustrates the age distribution of respondents, showing that the largest proportion (41.1%) falls within the 21–30 age group, followed by 33.1% in the 31–40 age group. Respondents aged 41–50 comprise 18.2%, and those above 50 account for 7.6%. The cumulative percentage indicates that the majority (74.2%) of respondents are under 40 years, suggesting that younger and middle-aged individuals are predominantly engaged in the studied activities, likely due to their physical fitness and active participation in labor-intensive tasks

In addition to the age distribution of the respondents, the table shows that 87.7% of participants are married, 8.5% are divorced, and 3.8% are widowed. The high proportion of married individuals suggests a stable community structure, which may positively influence participation in watershed management and conservation activities

**Table 3:** marital status of the respondents.

| Marital Status | Count | Percentage |
|---|---|---|
| Married | 207 | 87.7 |
| Divorced | 20 | 8.5 |
| Widowed | 9 | 3.8 |
| Total | 236 | 100 |

**Family Size**

Four categories of family types were used to define the size of the families in the surveyed households: 20.5% had fewer than three families, 39% had three to five families, 33.3% said they had six to seven families, and 7.2% had more than seven families (Figure 6). Specifics of the outcomes, given that labor-intensive technologies are more likely to be adopted by households with larger family sizes. Consequently, compared to households with smaller families, those with larger families in our study benefited from the use of watershed management techniques.

**Table 4:** Family size of the respondents

| Family Size Range | Number of Households | Percentage of Total |
|---|---|---|
| 1-2 persons | 90 | 38.1% |
| 3 persons | 50 | 21.2% |
| 4-5 persons | 70 | 29.7% |
| 6-7 persons | 16 | 6.8% |
| 8 or more persons | 10 | 4.2% |
| Total | 236 | 100 |

The provided data reveals a diverse range of household sizes within the community. Households with 1-2 persons constitute the largest segment, comprising 38.1% of the total. Following closely are households with 4-5 persons (29.7%) and those with 3 persons (21.2%). Smaller proportions are observed in households with 6-7 persons (6.8%) and those with 8 or more persons (4.2%). This suggested that respondents who were of a generally productive age engaged with the watershed management system. The results of research by Croppenstedt et al. (2003) and Deressa et al. (2009) corroborate these conclusions, showing a favorable correlation between household size and adoption of climate change adaptation or agricultural technology.

**Literacy status of HHs**

The data reveals that a significant portion of the population has limited formal education. Illiteracy and low levels of literacy (Read & Write) account for a combined 53.39% of the population. While a considerable number have completed grades 1-4 (20.34%), the percentage of individuals with higher education levels (Grade 5-8, Grade 9-12, >12) is relatively low.

**Table 5:** literacy status of the respondents

| Literacy Status | Total | Percentage |
|---|---|---|
| Illiterate | 65 | 27.54 |
| Read & Write | 61 | 25.85 |
| Grade 1-4 | 48 | 20.34 |
| Grade 5-8 | 45 | 19.07 |
| Grade 9-12 | 10 | 4.24 |
| >12 | 7 | 2.97 |
| Total | 236 | 100 |

**Respondents' perception of climate change and Variability**

In accordance with the survey, 236 head farmers of households were asked to provide suggestions regarding patterns of temperature and rainfall over the previous 30 years. Of these, approximately 95% agreed that there has been a change in the climate, 3% disagreed, and 2% were unsure of the issue (Table 2). Madison (2006) defines awareness as the capacity of an individual to prevent change that would occur if action were not done

**Table 6:** Respondents' perception on climate change and Variability

| No | Questions | Scale | Freq. | Percentage |
|---|---|---|---|---|
| 1 | Are you aware that the climate is changing? | Yes | 135 | 57.12% |
| | | No | 85 | 36.02% |
| | | Not sure | 17 | 7.20% |
| | | Total | 236 | 100.00% |
| 2 | Do you think that there is a long period's change in rainfall of the study area? | Yes | 132 | 55.93% |
| | | No | 79 | 33.47% |
| | | Not sure | 25 | 10.60% |
| | | Total | 236 | 100.00% |
| 3 | Do you think that there is a long period temperature change in the study area? | Yes | 154 | 65.25% |
| | | No | 69 | 29.24% |
| | | Not sure | 13 | 5.51% |
| | | Total | 236 | 100.00% |

The survey results highlight varying levels of awareness and perceptions of climate change in the study area. A majority of respondents (57.12%) recognized the phenomenon of climate change, with 36.02% expressing a lack of awareness and 7.20% uncertain. When it comes to long-term changes in rainfall patterns, over half of the participants (55.93%) perceived significant alterations, while 33.47% disagreed, and 10.60% were unsure. In terms of temperature changes, a notable 65.25% observed long-term shifts, whereas 29.24% disagreed, and 5.51% were uncertain. These findings suggest a widespread recognition of climate change, especially in relation to temperature shifts, within the study area.

Regarding sources of climate change information, the data reveals a diverse range of channels. A plurality (44.92%) receive information from extension services, indicating their significant role in climate knowledge dissemination. Training programs (21.61%) and media sources (26.69%) also contribute substantially to respondents' understanding of climate. Information from local government (kebele) officials, while less prevalent (6.78%), still plays a role in shaping climate awareness within the community.

**Table7:** Respondents' Source of Information on Climate

| Source of information | Number of Respondents | Percentage (%) |
|---|---|---|
| From Extension... | 106 | 44.92 |
| Training | 51 | 21.61 |
| From media... | 63 | 26.69 |
| From kebele... | 16 | 6.78 |
| **Total** | **236** | **100.00** |

### Mann-Kendall trend analysis of rainfall and Temperature

### Analysis of Rainfall data over Nedjo District

Rainfall abnormalities were evident in the 30-year meteorological data of the site. Nedjo district is home to one of the meteorological information stations, which most likely covers the Aba Wallaga, Qotie, and Alaltu micro watersheds. The research region is situated between 1600 and 2250 meters above sea level, and according to Nedjo Agricultural Office (2022), it has high temperatures, plenty of sunshine, and a monomodal distribution of rainfall. The district experiences 1350 to 1600 mm of annual precipitation, with a monomodal distribution that lasts from June to October during the major rainy season and brief showers from March to May. The region's average minimum, average, and maximum temperatures are 120°C, 190°C, and 260°C, respectively.

The pattern of rainfall in the Nedjo district has shifted in both quantity and frequency. According to the monthly rainfall data over the past 30 years, July had the highest average total rainfall (296.66 mm), followed by August (291.0 mm), June (287.0 mm), and September (251.4 mm) during the period of 1992 to 2021. The average total yearly rainfall for the 30 years (1992–2021) that the Nedjo district's meteorological data received from NMA showed was 1546.6mm. The National Meteorological Service Agency's climatic data indicated that there was an irregular rainfall distribution from 1992 to 2021. 1993, 1995, 1997, 1999, 2008, 2010, 2012, to 2016 and 2018–2021 had an increase in rainfall.

Rainfall totals for 2013 were the most ever recorded with 1792.4 mm, while 2001 had the lowest at 1134.5 mm. However, the trend study revealed that the amount of rainfall decreased in 1992, 1994, 1996, 2000–2002, and 2009 (NMA, 2022). This suggests that rainfall varied greatly between 1992 and 2021.

Sen's estimator and the Mann-Kendall (MK) trend test were used to look into the possibility of long-term change for the temperature and rainfall indices. Based on monthly and annual rainfall data in the Agar Genasi watershed from 1992 to 2021, the MK test from the p-value and trend from Sen's slope (β) estimation was computed. The findings are shown in Table 3.

**Table 8:** Annual rainfall trend using MK and Sen's slope data (1992 to 2021)

| Variable | MK | SS | Z-Value | Trend Evaluation (α=0.05) |
|---|---|---|---|---|
| Mean annual RF | 116 | 0.556 | 2.16 | Increasing |

***Source**: Data from NMA, (2022)*

Table 8 makes it clear that there is a statistically significant growing trend in the annual RF, with an increment of 7.47 mm per year or 74.7 mm per decade. In addition, the Sen's slope showed an increase in yearly rainfall of 0.556 mm. These results are consistent with those of Duhan and Payday (2013), who observed a non-significant trend in yearly rainfall for the whole state of Madhya Pradesh between 1901 and 2002.

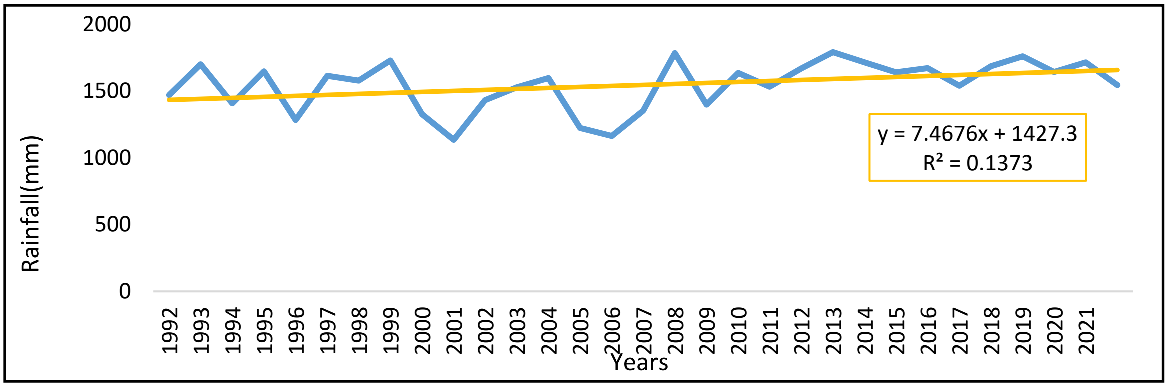


**Figure 2**: Annual rainfall trend (1991 - 2021)

The rainfall data analysis was made on annual basis, but farmers' perception is related to rainfall (cropping) seasons as their main concern is whether it is sufficient for crops to grow or not. The study has assured that the total amount of annual rainfall was in an increasing trend, with rainfall seasons uneven distribution (Figure 9), causing extreme events such as flood hazards and rainfall seasons getting shorter (late start and early cessation) and some time with heavy torrential and erratic rainfall. The majority of farmers have perceived.

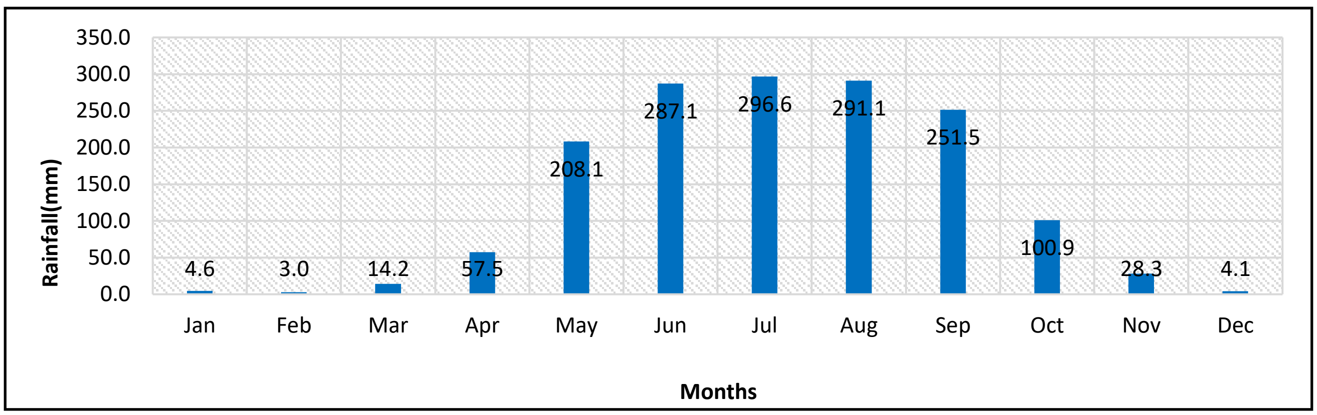


**Figure 3:** Long-term Average monthly rainfall (1991 – 2021)

that rainfall was increasing in the study area and the analysis of the amount of Seasonal and monthly rainfall data over 30 years has shown an increasing trend with visible variability. The region experiences unimodal monthly rainfall, which peaks in the months of June, July, and August, as seen in Figure 10. The results align with the perceptions of the polled households, who concurred that the area experiences its largest monthly rainfall during the months of June, July, and August, or during the whole summer season. Conversely, the data acquired from KII and FGD confirmed the authenticity of the same source. In addition, FGD participants assessed the area's climate change indicators in relation to the duration of the rainy season, its early and late onset and cessation dates, its scarcity of rivers, its deficiency in soil moisture, and its intensity and quantity.

"Climate change/variability has been well experienced for the past thirty years," according to the KII. The field was to be plowed and left in the sun throughout the generally dry and sunny month of May during the normal "Belg" rainy season, which formerly spanned from February to mid-April. April marks the beginning of the "Meher" season, which concludes in September with a few showers in October. 2013 saw excessive rainfall during the "Meher" season, which was exceptional or unheard of.

**Temperature analysis of Nedjo District from 1991-2021**

The highest average maximum temperature of the district was recorded in the months of March (31.5 OC) and April (39.2 OC) over the observed data of Nedjo district ranging from 1992 to 2022, respectively, during the last 30 years monthly maximum temperature data observed (Annex 6, table 2 and 3). August had the lowest recorded average maximum temperature (21.1OC). In particular, the pattern of rising maximum temperatures is in line with the trends and projections of Ethiopia's climate change and the general global climate changes that have been steadily growing over time (NMA, 2022).

In addition, the data over the previous 30 years indicates a trend toward an increase in Nedjo's maximum temperature, which was also consistent with the opinions of the local households polled. But occasionally, the temperature has dropped, which, as some surveyed households and FGD participants believed, had resulted in frost and had an impact on crop productivity. Thus, the examination of the maximum temperature trend and the majority of farmers' perceptions of the long-term temperature are consistent with the examination of meteorological temperature data (NMA, 2022)

From 1992 to 2021 (30 years), the maximum temperature recorded for every month of the year showed reduced variation (CV <10%) (Table 7). The entire month's slope suggests a positive value, implying an increase in the average monthly temperature. Additionally, there is a positive association between the time period and the monthly mean maximum temperature record. Table 4 provides the findings of the Mann-Kendall test for the yearly maximum and minimum temperatures for the years 1992–2021. Table 4 displays the yearly mean maximum and lowest temperature. At a 5% significance level, it indicates a significant increasing trend for MaxT and a significant increasing trend for MinT for the research period. The Mann-Kendall test revealed a significant declining trend with Mk value of -5 and Z-value of -0.08 for the annual minimum temperature in the study region and a significant increasing trend with Mk value of 25 and a Z-value of 0.045 for the annual maximum temperature. The Sen's slope shows an annual increase, with a lowest annual temperature of 0.006 and a maximum temperature of 0.009 degrees Celsius, respectively.

**Table 4:** Mann-Kendall and Sen's slope results of MaxT and MinT (1992 to 2021)

| Variable | Temperature | | | | |
|---|---|---|---|---|---|
| | MK | SS | Z-value | CV % | Trend Evaluation (α=0.05) |
| Mean maximum temperature | 25 | 0.009 | 0.045 | 1.83 | Increasing |
| Mean minimum temperature | -5 | 0.006 | -0.08 | 5.19 | decreasing |

***Source**: Data from NMA, (2022)*

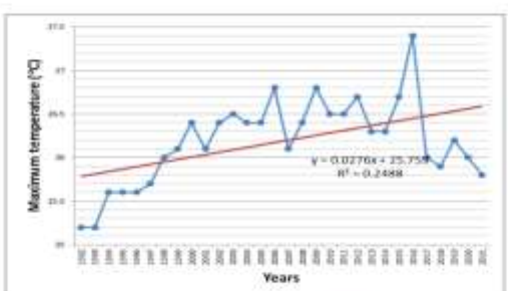


**Figure 5**: Mean annual maximum temperature trend of Nedjo District

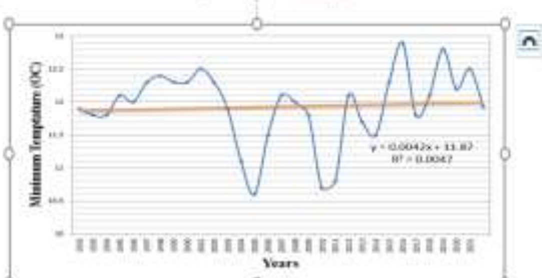


**Figure 6**: Mean annual minimum temperature trend of Nedjo District

The mean maximum and lowest temperatures were determined to exhibit an uneven distribution tendency, as seen in Figure 11. The observed yearly maximum and lowest temperature data for the years 1992 to 2021 are shown in the graphic as a green line. Over the period from 1991 to 2021, the second yellow line shows the continuous time series trend of the measured maximum and minimum temperature (Figure 6).

One of the KIIs in the Nedjo district study area reported that during the previous ten years, the area has seen a rise in temperature and an increase in irregular rainfall. There were instances of both high and low temperatures, together with frosty conditions that harmed crops in the early morning hours. The respondents' opinions were consistent with certain literature and could be applied generally because the area's temperature is rising, which suggests that one of the climate's components is permanently changing. The temperature increase patterns align with Ethiopia's temperature trends as reported by NAPA (2007), and the project's rationale regarding climate change's contribution to risk-management systems to safeguard Ethiopian farmers' livelihoods from repeated drought risk is supported by this finding.

## CONCLUSION

The study reveals key demographic insights into watershed management participation, showing a significant gender imbalance with 82% male respondents, largely involved in agricultural tasks, and only 18% female participation. The majority (74.2%) of respondents were young to middle-aged (21-40 years), reflecting the physical demands of such activities. Additionally, most respondents (87.7%) were married, indicating a stable social structure. Larger households (4-5 persons) were more likely to adopt labor-intensive watershed management practices, benefiting more from these activities than smaller families.

Regarding education, 53.39% of respondents were illiterate or had only basic literacy skills, highlighting the need for increased education on watershed management. On climate change, 95% of respondents noticed changes, particularly in temperature (65.25%), while 55.93% observed rainfall shifts, though perceptions were more divided. Extension services were the primary source of climate information for 44.92% of respondents. Meteorological data from Nedjo District (30 years) showed irregular rainfall with a significant increase in some years, such as 2013, which had the highest recorded rainfall (1792.4 mm). The Mann-Kendall test confirmed a statistically significant annual increase in rainfall (7.47 mm per year), with peak rains in the summer months (June-August). However, erratic rainfall patterns posed challenges, including floods and unpredictable agricultural outcomes. Temperature data indicated an increasing trend in maximum temperatures over the past 30 years, with the minimum temperature showing a slight decrease. These findings, supported by local farmers' perceptions of increasing temperatures, underscore the need for adaptive strategies to cope with climate variability and its impact on agricultural and watershed management practices.

## Recommendation

The researchers recommended that there should be an increase in female participation in watershed management. Local authorities and community leaders should create tailored programs to support and encourage women's involvement. Youth, particularly those aged 21-40, and larger households should be prioritized in watershed management initiatives. Local governments and community organizations should actively engage these groups in capacity-building activities. There should be enhanced extension services that provide accurate, real-time climate data to farmers. The Ministry of Agriculture and meteorological organizations should ensure that this information reaches farmers effectively. Local governments and agricultural agencies should promote the adoption of climate-smart agricultural practices, focusing on water conservation and drought-resistant crops, while providing technical support to farmers. There should be continuous monitoring of climate patterns to ensure accurate climate data for adaptation strategies. The Ethiopian Meteorological Institute and local authorities should integrate local observations into decision-making to refine watershed management practices.

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