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Research Article

Long Term Historical Precipitation and Temperature Trend Analysis for Selected Stations in Bale and East Bale Zones of Southeastern Ethiopia

Zerihun Dibaba Tufa[1, *], Wondmagegn Bekele[1], Hirpa Abebe[1], Bacha Bultuma[1], Bikila Mengistu[2]

[1]Oromia Agricultural Research Institute, Sinana Agricultural Research Center, Bale-Robe, Ethiopia
[2]Oromia Agricultural Research Institute, Fitche Agricultural Research Center, North-Shewa, Ethiopia

Abstract

Trend analysis for the long-term average temperature and precipitation of Bale and East Bale Zones during 1901 to 2016 has been performed for selected 5 stations to understand the pattern of these important meteorological features under climate change. The precipitation characterizations viz. standardized Precipitation Index has been considered for Sinana, Goro, Ginnir, Dallo menna and Agarfa stations. This study was aimed to analysis ‘’long term historical climate analysis selected stations in Bale and East Bale zones’’. The study considered station nearby kebeles was selected purposively from highland, midland and lowland districts. Standardized Precipitation Index drought index method was used to classify drought condition of the area. The findings showed that, the average temperature of the district showed an increased in the past three decades whereas the annual precipitation of the districts showed a decreasing trend with some variation from the mean in the period 1901- 2016 which was validated with 1984 – 2016 observed data. In line with this, representative respondents were considered from lowland, highland and midland agro-ecologies. Long term annual mean temperature showed increase trends by 0.17 ℃ per decade at Sinana, Goro, Ginnir and Agarfa stations. Additionally, it was revealed more increment by 0.19 ℃ per decade at Dallo menna station. From long term climate data analysis, it was indicated that extremely wet recorded in 1903, 1914, 1917, 1926, 1977 and 2013, while extremely dry conditions were recorded in 1919, 1938 and 1943 annual precipitation recorded for the whole period has been calculated and interpreted.

Keyword

Long-Term, Standardized Precipitation Index, Precipitation, Trend and Variability

1. Introduction

The impact of climate change on precipitation and air temperature has received much attention by the research-community all around the world. Several studies have been carried out to show these changes in temperature and precipitation are becoming evident on a global scale [4]. Time series trend analysis involves analyzing the magnitude of the trend and its statistical significance. In various studies analyzing climate trends the following researchers [5, 6] explained the

*Corresponding author: zerihun.dibaba@gmail.com (Zerihun Dibaba Tufa)

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reasons for using non parametric tests instead of parametric methods. Analyzing long term trends in climatic parameters is an essential challenge in climate change monitoring research. Precipitation and temperature are the most significant physical variables in the climate [3]. These variables determine a region's climatic condition, influencing the agricultural output [2]. Long term precipitation dynamics may be affected by planetary climate change, diminishing water supply and increasing the danger of flooding and water shortage [1].

The climate, particularly precipitation, in East Africa is known for its inter-annual variability, which has contributed to the devastating droughts and foods [7, 8]. Several studies highlighted that the variability in precipitation in this region is linked to large-scale climate variability, including the ElNino Southern Oscillation (ENSO), Indian Ocean Dipole (IOD) [9, 10] and movement of the inter-tropical convergence zone (ITCZ) [12, 11]. ENSO has shown multiple effects in precipitation; warming of the ocean temperature leads to an increase in precipitation and change in direction of the ITCZ. In general, variability in precipitation in East Africa, particularly the inter-annual variability, is modulated by large scale climate forcing's and changes in sea surface temperature, which affects the precipitation amount (e.g., decrease during the long-rain season; March-May) by changing wind patterns and moisture fuxes [13]. Ethiopian economy is driven by agriculture despite the issue of high precipitation variability that leads to frequent drought and severe land degradation [19]. These effects vary from region to region in particular the risk in Ethiopia becomes more severe since more than 85% of the country's economy dependent on rainfed agriculture [14].

Based on station long-term precipitation data analysis, however, neither annual nor seasonal precipitation trend were showed reduction in amount for long term climate data analysis. Climate is unique in each region and climate change in different locations can be significantly different [15, 16]. Among a range of statistical approaches to assess the time series of past climate records and differentiate the anthropogenic changes from the climate variability, often referred as "exploratory data analysis" [17].

2. Materials and Methods

Climate Data Analysis

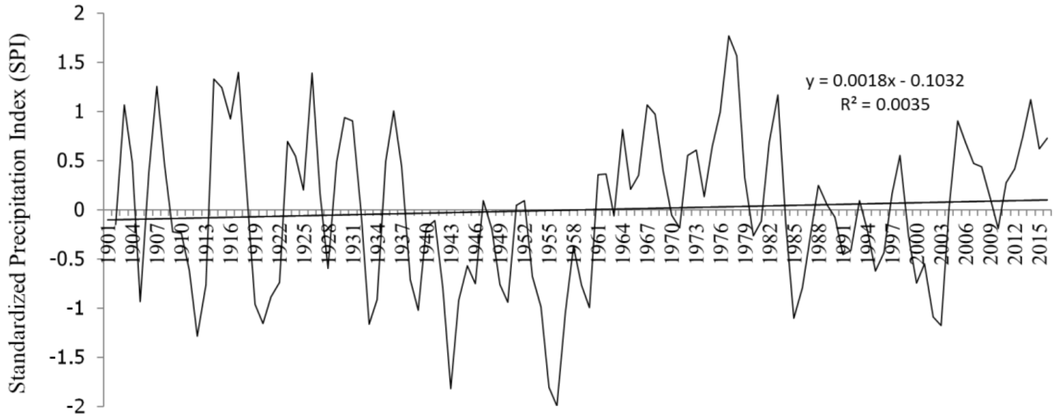
Meteorological data were collected from meteorological nearby stations in the study area. Two types of data were used in this study, primary and secondary data. The data was described and summarized quantitatively and qualitatively, which was collected from the nearby station. Essential climatic data were downscaled and downloaded for all stations using climate knowledge portal tool developed by World Bank Organization. Available historical climate data on precipitation and temperature of East Bale and Bale Zones covers a period of 115 years from 1901 to 2016 was downloaded from climate knowledge portal tool. In this study the selected meteorological stations were no missing data were used for data validation using 32 years (1984-2016) data. The primary data were collected from the household's survey through Farmer interviews using semi-structured household questionnaires approaches. Download and observed meteorological stations were purposively selected, based on the availability of daily precipitation, minimum temperature and maximum temperature data in the study area. Download historical climate data, observed historical climate data and household data were used in descriptive statistics, to show farmers' perceptions on climate variability and climate change impact on agricultural practices. Those data were analyzed to indicate drought frequency of the areas using drought indices calculator (DrinC) tool. So, Standardized Precipitation Index (SPI) was computed for all stations. Standardized Precipitation Index (SPI) was classified to indicate drought frequencies for all selected stations using [18].

3. Results and Discussion

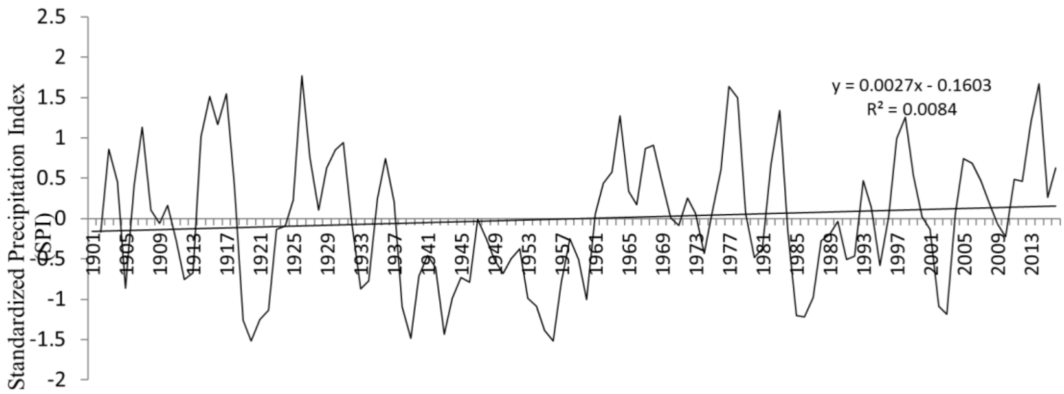
3.1. Historical Precipitation Trend Analysis

The statistical trend analysis of the climate variables had shown an annual decrease in precipitation. Based on historical climate data analysis, Standardized Precipitation Index was computed to classify drought conditions of study areas. These classifications were based on anomaly values like extremely wet (>2.0), very wet (1.5 to 1.99), moderate wet (1.0 to 1.49), near normal (-0.99 to 0.99), moderately dry (-1.0 to -1.49), sever dry (-1.5 to -1.99) and extremely dry (< -2.0) [18]. From long term climate data analysis, it was indicated that Sinana station, extremely wet recorded in 1903, 1917, 1926, 1977 and 2013, while extremely dry conditions were recorded in 1919, 1938 and 1943. For Agarfa station, extremely wet recorded in 1903, 1914, 1926, 1977 and 2013, while extremely dry conditions were recorded in 1938. At Ginnir station, extremely wet recorded in 1903, 1917, 1926, 1977 and 2013, while extremely dry conditions were recorded in 1919, 1938 and 1943. At Goro station, extremely wet recorded in 1903, 1914, 1977 and 2013, while extremely dry conditions were recorded in 1938 and 1943. Similarly, Dallo mena station extremely wet recorded in 1903, 1914, 1977 and 2013, while extremely dry conditions were recorded in 1938 and 1943.

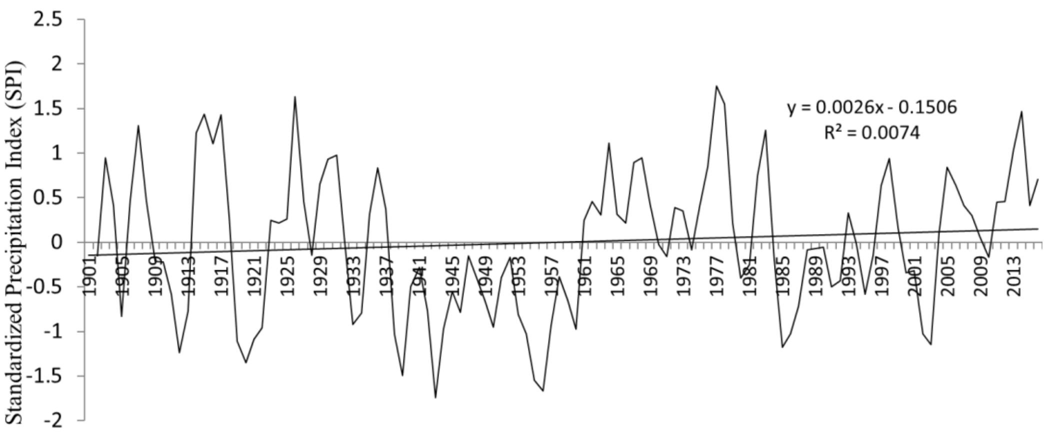
SPI at Dallo menna station



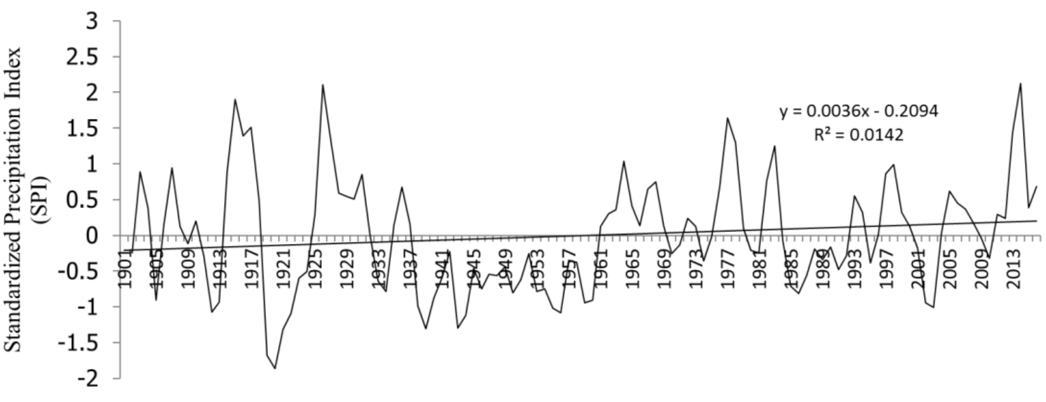
SPI at Agarfa station



SPI at Goro station



SPI at Ginnir station



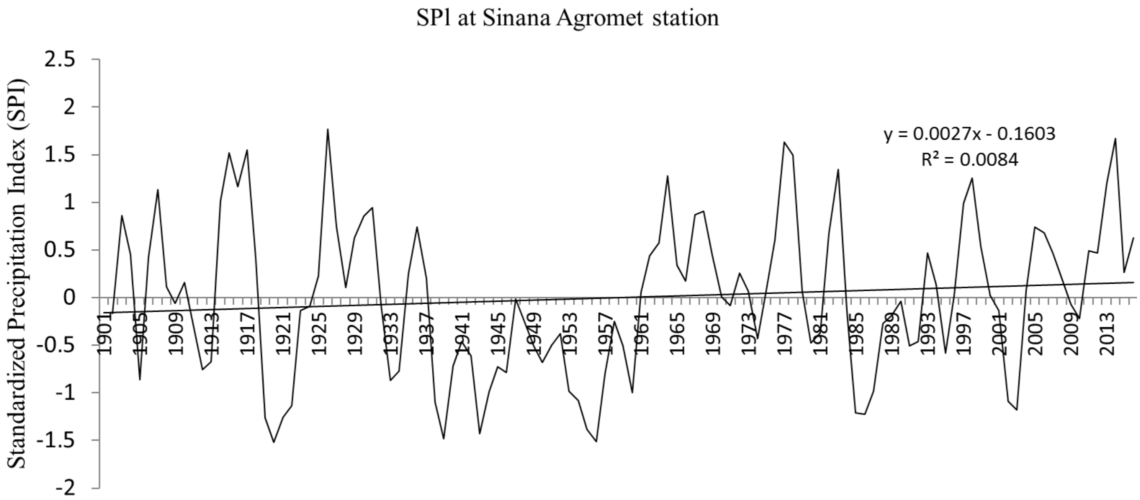


Figure 1. *Trend of precipitation anomaly for selected station.*

3.2. Temperature Trend Analysis

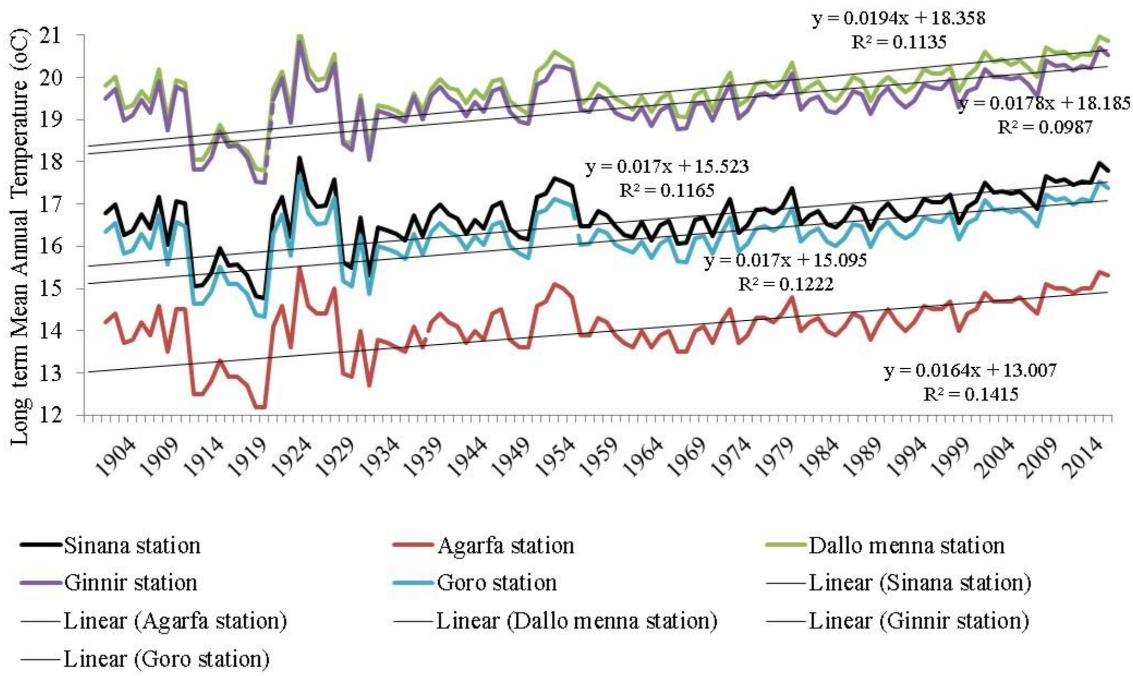


Figure 2. *Trend of annual temperature for selected station.*

The statistical trend analysis of the climate variables had shown an increase in temperature with an annual. The Figure 2 shows a linear trend in temperature with an average increased as the following figure. Long term annual mean temperature showed increase trends by 0.17 ℃ per decade at Sinana, Goro, Ginnir and Agarfa stations. Additionally, it was revealed more increment by 0.19 ℃ per decade at Dallo menna station. For all stations, from 1966-2016 annual mean temperature was extremely increased and also contributed for global warming.

4. Conclusions

This study was performed to find out the trends and the variability of the temperature and precipitation in Bale and East Bale Zones by considering 5 stations in the areas. The analysis was done using observed data of minimum and maximum temperature and precipitation parameters. Results from the trend analysis in annual and monthly scales showcase significantly increasing temperature trends for all stations areas and in all climatic zones with observations of slightly increasing trends in precipitation. The minimum and maximum temperatures were found with increasing trends in most of the stations. In addition, the precipitation shows similar trends in most of the stations. Time series trend analysis involves analyzing the magnitude of the trend and its statistical significance. These results were discussed in the context of agriculture, it required for climate smart agricultural practices.

Abbreviations

EPCC	Ethiopian Panel on Climate Change
ENSO	ElNino Southern Oscillation
IOD	Indian Ocean Dipole
SPI	Standardized Precipitation Index
DrinC	Drought Indices Calculator

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Author Contributions

Zerihun Dibaba Tufa: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Wondmagegn Bekele: Conceptualization, Data curation, Formal Analysis, Methodology, Writing – original draft, Writing – review & editing

Hirpa Abebe: Conceptualization, Data curation, Formal Analysis, Methodology, Writing – original draft, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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Research Fields

Zerihun Dibaba Tufa: Climate data preparation, Precipitation trend analysis, Temperature trend analysis, Climate variability analysis, standardized Precipitation Index

Wondmagegn Bekele: Climate data preparation, Precipitation trend analysis, Temperature trend analysis, Climate variability analysis, standardized Precipitation Index

Hirpa Abebe: Climate data preparation, Precipitation trend analysis, Temperature trend analysis, Climate variability analysis, standardized Precipitation Index