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Analysing over all chance of rainfall and rainfall anomaly in west Oromia, Ethiopia

1*Gemechu Raga Osena , 2*Melkamu Diriba Ujulu
1 Ethiopia Meteorology Institute (EMI), Western Oromia Meteorological service center , Jimma, Ethiopia
2 Ethiopia Meteorology Institute (EMI), Benishangul Meteorological service center , Asosa, Ethiopia
Email -[1] gemechuraga@gmail.com , [2] melkamu.diriba2007@yahoo.com

Abstract: Climatologically Ethiopia receives its highest rainfall (50-80%) when the low-pressure is established in northern equatorial region .Steady decline of precipitation was observed in many parts of the country. The spatial and temporal variation of rainfall over Ethiopia in general and in western Oromia in particular is complex and not well known yet. Understanding the probability of rainfall occurrence is essential in handling climate risks. Rainfall data (1987-2017) were collected from West Oromia meteorological service centre. INSTAT+ V3.37 software and Microsoft Excel Statistical Tool (2010) were used in analysing the data. At Jimma less probability of wet spell was existing and it was more at limugenet while it was almost the similar at the rest of the stations in the study area. The analysis of standardized anomaly indicated that 71% of the stations were normal while the rest 13% & 15% were below normal and above normal respectively.

Key words: Rain fall, wet spell, Variation, probability, anomaly, and Ethiopia

1 .INTRODUCTION

In Ethiopia a steady decline in precipitation was observed in many parts of the country (Osman and Sauerbon, 2002) although increases have been reported in some areas (NMA,

2001) and no changes detected in others (Seleshi and Zanke, 2004).The country normally receives its highest rainfall (50-80%) when the low-pressure is established in northern equatorial region following the sun's apparent movement towards the northern hemisphere(Camberlin and Philippon, 2002).The rainfall is highly variable both in amount and distribution across regions and seasons

(Tilahun, 1999). The seasonal and annual rainfall variations are results of the macro-scale pressure systems and monsoon flows which are related to the changes in the pressure systems (Beltrando and Camberlin, 1993). The spatial variation of the rainfall is, thus, influenced by the changes in the intensity, position, and direction of movement of these rain-producing systems over the country (Taddesse, 2000). Moreover, the spatial distribution of rainfall in Ethiopia is significantly influenced by topography (NMSA, 1996), which also has many abrupt changes in west Oromia.However, the spatial and temporal variability of both rainfall and temperature over Ethiopia in general and in western Oromia in particular is complex and not well known yet. This variability of the rainfall and recurrent droughts in the country affects the lives of millions of people whose livelihood is mainly dependent on agriculture

1.1. Description Study Area: Location of the study area is at latitude and longitude of 7.2°′N 34°.2′E / 10.5°N 38.2°E(GIS reading) .West Oromia consists four Zones namely: Jimma, Illubabor, Misrak wollega and Mirab wollega which are found in Oromia Regional State(figure1) . East and West Wollega zones are classified into three agro ecological zones based on agro- climatic conditions : East Wollega Zone ; low land 56.4% (1200-1799 m), mid land 28.2 % (1800 -2450 m) ,and high land 15.4% (2460- 3178 m) .West WollegaZone; low land 19.1% (1100 -1700 m), mid land 78.4%(1800-2200 m) , and high land 2.5 % (2300 - 2850 m)(Temesgen , 2014) . Jimma zone has a tropical rainforest climate under the Köppen climate classification. It features a long annual wet season from March to October. Over the past three decades Rainfall has decreased by 84.4 mm per decade at Gore, but increased by 61.5 mm at Jimma (Getinet and Woldeamlak, 2009) . Illubabor Zone ranges between 1400 and 2000m a.s.l and is characterized by steep- sided river valleys and flat, waterlogged valley bottoms. The mean annual temperature is 20.7ºC and the rainfall is often in excess of 1800 mm per annum (Dixon, 2005).

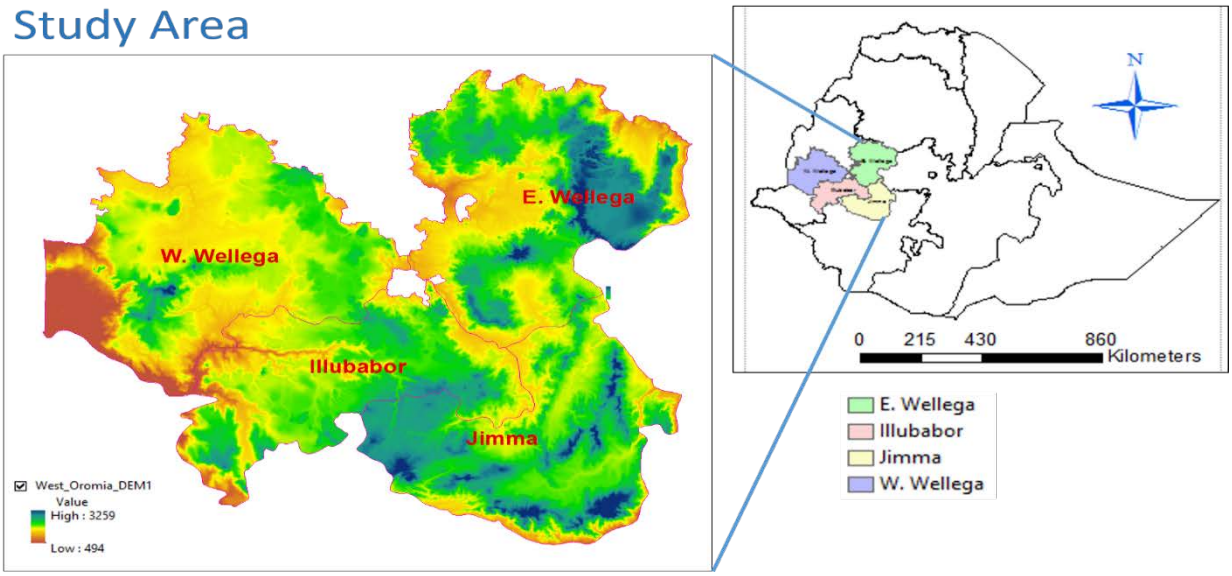

Figure 1: Map of the study area

2. METHOD OF DATA ANALYSIS

Statistically, wet spell probability were identified and plotted by using instat+ v3.37 software. While linear trend lines and standardized anomaly index (SAI) were analysed and also plotted using Microsoft Excel Statistical Tool (2010) .According to Stern *et al*. (2006), missing data was filled with mean values.

2.1. Analyzing wet Spells

The start of the rain season: Defined as the first occasion proposed at first March when the rain accumulated in the three consecutive days is at least 20 mm and no dry spell of more than 10 days in the next 30-days periods (Hadgu *et al*., 2013) was computed by using INSTAT+ V3.37 software.

According to NMSA (2001), a day is said to be wet if it accumulates rainfall>1 mm with in the duration of 24 hours. It was computed using first order Markov of chain in INSTAT+ V3.37 software

2.2 Analyzing standardized Rainfall Anomaly (Z)

Standardized rain fall anomaly was used to determine: Inter- annual fluctuation, Wet and dry years and also seasonal and annual trend of the rainfall.

It was computed as: $Z = \frac{(X - \mu)}{\delta}$

Where, Z is standardized anomaly; x is annual value, μ is long year mean and **δ** is standard deviation **.**According to MCkee *et al.* (2008); Z >2 indicates extremely wet, Z value from 1.5 to

1.99 very wet ,Z value from 1.0 to 1.49 moderately wet, Z value from -0.99 to 0.99 near normal ,Z value from -1.0 to -1.49 moderately dry ,Z value from -1.5 to -1.99 severely dry and Z value <-2 is extremely dry

3. RESULT AND DISSCUSION

3.1. Determining the overall chance of wet spells

3.1.1 Determining the overall chance of wet spell at Jimma

From (61 DOY)(March1) to (105 DOY)(April 14)the probability of wet spell at Jimma was between 20% to 50% while from 106 DOY(April 15) to 270DOY (September 26) the probability was between 50% and 70% from 270 DOY to 300DOY (October 26) the probability was between 20% to 50% and after 300 DOY and before 61 DOY it was less 20% (Figure2)

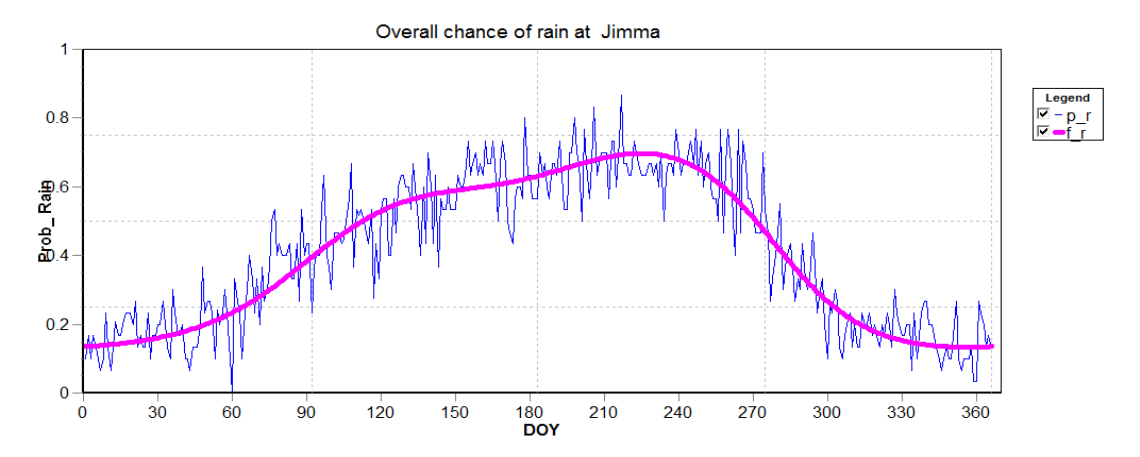

Figure2: Overall chance of rain at Jimma (1987- 2017)

3.1.2 Determining the overall chance of wet spell at Bedele

From (65 DOY)(March5) to (120 DOY)(April 29)the probability of wet spell at Beddele was between 20% to 50% while from 120 DOY(April 29) to 270DOY (September 26) the probability was between 50% and 80% from 270 DOY to 300DOY (October 26) the probability was between 20% to 50% and after 300 DOY and before 65 DOY it was less 20% (Figure3)

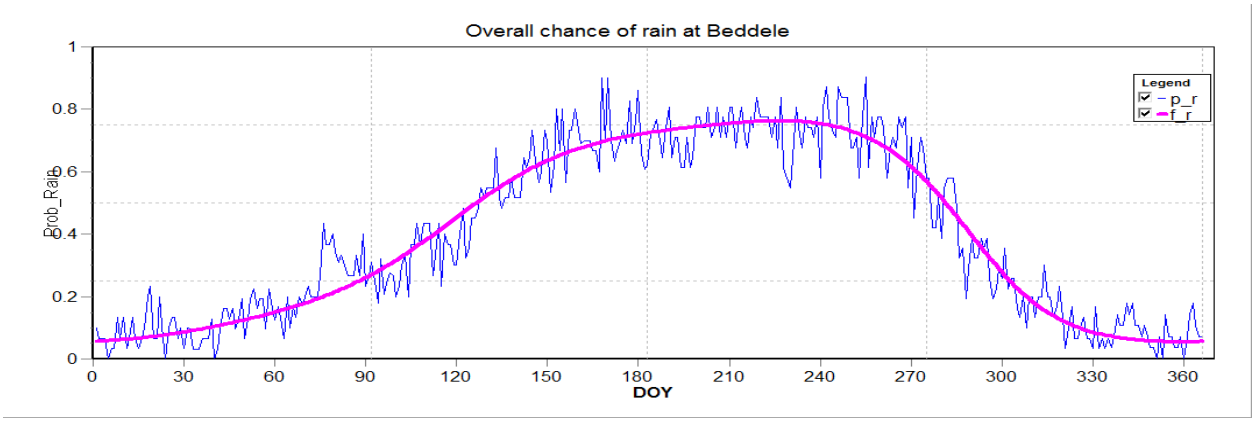

Figure3: Overall chance of rain at Beddele (1987- 2017)

3.1.3 Determining the overall chance of wet spell at Gore

From (56 DOY)(February 25) to (115DOY)(April 24)the probability of wet spell at Gore was between 20% to 50% while from 115DOY(April 24) to 285DOY (October 11) the probability was between 50% and 80% from 285 DOY to 315DOY (November 10) the probability was between 20% to 50% and after 315DOY and before 56 DOY it was less 20% (Figure4)

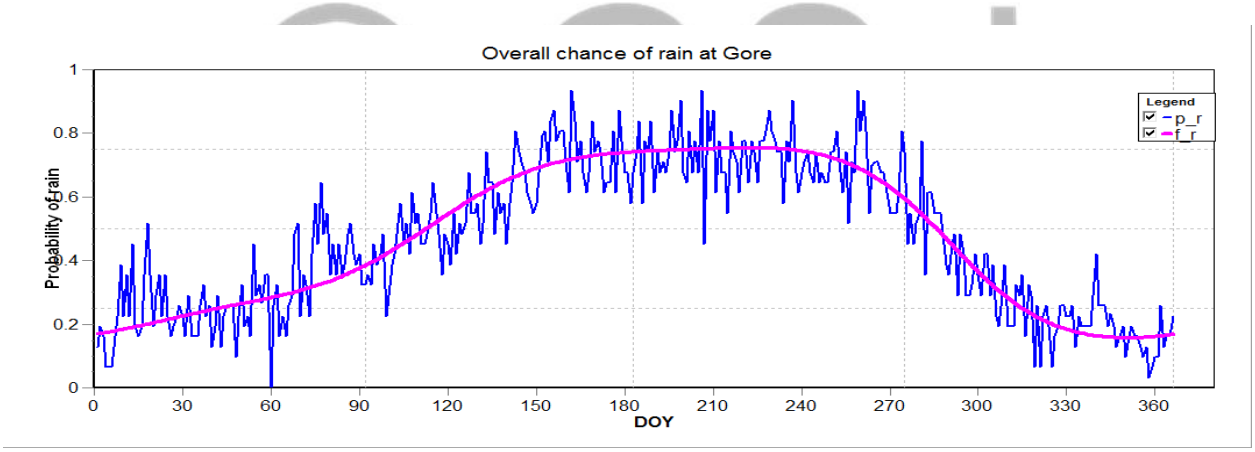

Figure4: Overall chance of rain at Gore (1987- 2017)

3.1.4 Determining the overall chance of wet spell at Limugenet

From (80 DOY)(March 20) to (120DOY)(April 29)the probability of wet spell at Gore was between 20% to 50% while from 120DOY(April 29) to 275DOY (October 1) the probability was between 50% and 83% from 275 DOY to 315DOY (November 10) the probability was between 20% to 50% and after 315DOY and before 80 DOY it was less 20% (Figure5)

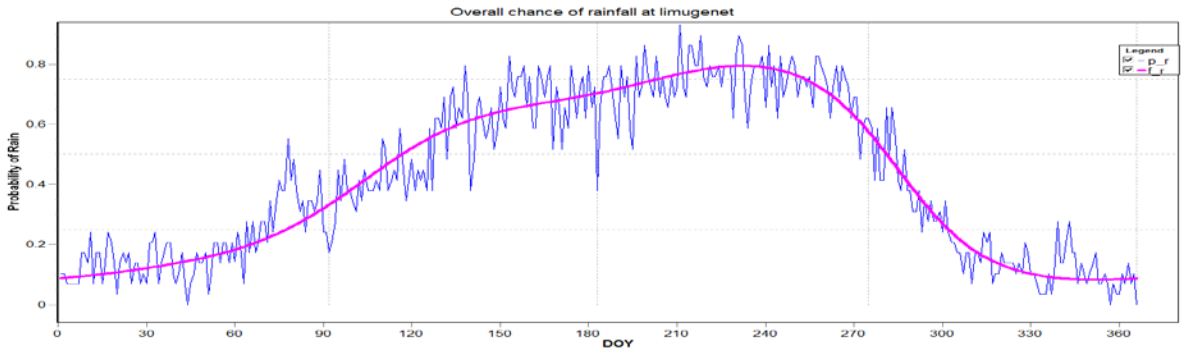

Figure5: Overall chance of rain at Limugenet (1987- 2017)

3.1.5 Determining the overall chance of wet spell at Sokoru

From (60 DOY) (February 29) to (120DOY) (April 29)the probability of wet spell at Sokoru was between 20% to 50% while from 120DOY(April 29) to 270DOY (September 26) the probability was between 50% and 80% from 270DOY to 300DOY (October 26) the probability was between 20% to 50% and after 300DOY and before 60 DOY it was less 20% (Figure6)

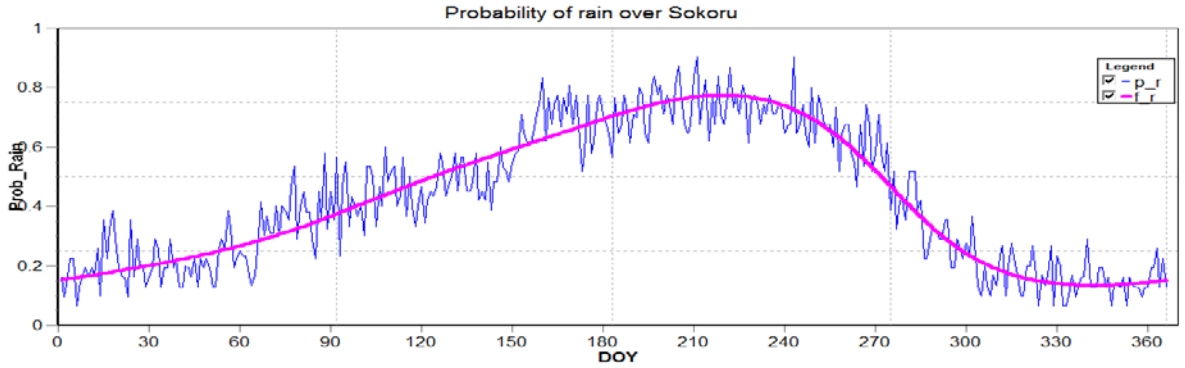

Figure 6: Overall chance of rain at Sokoru (1987- 2017)

3.1.6 Determining the overall chance of wet spell at Chira

From (60 DOY)(February 29) to (120DOY)(April 29)the probability of wet spell at Chira was between 20% to 50% while from 120DOY(April 29) to 285DOY (October 11) the probability was between 50% and 80% from 285DOY to 315DOY (November 10) the probability was between 20% to 50% and after 315DOY and before 60 DOY it was less 20% (Figure7)

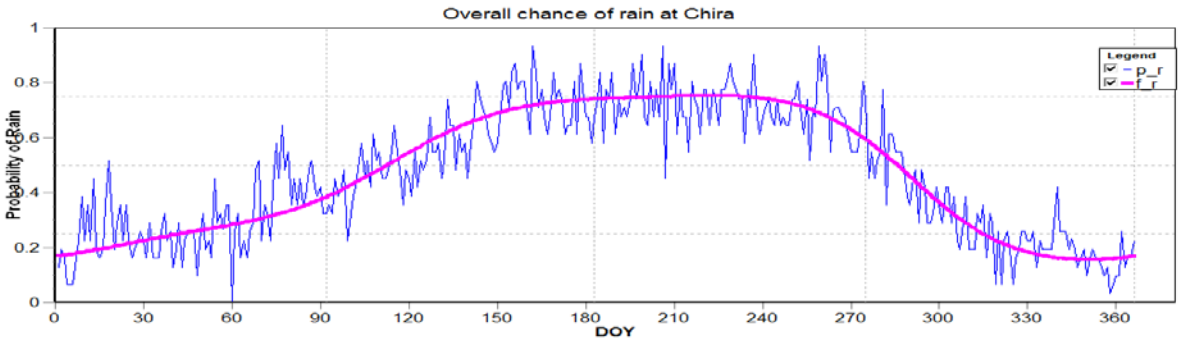

Figure7: Overall chance of rain at Chira (1987- 2017)

3.1.7 The overall chance of wet spell at Gatera

From (70 DOY)(February 29) to (120DOY)(April 29)the probability of wet spell at Gatera was between 20% to 50% while from 120DOY(April 29) to 275DOY (October 1) the probability was between 50% and 80% from 275DOY to 300DOY (October 26) the probability was between 20% to 50% and after 300DOY and before 70 DOY it was less 20% (Figure 8)

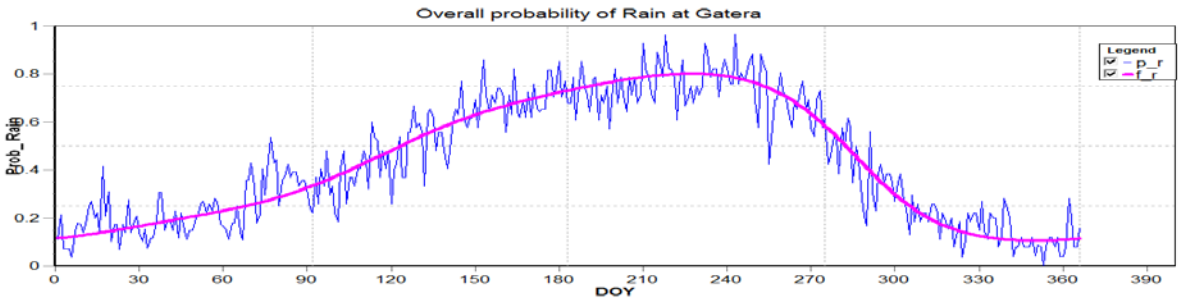

Figure 8: Overall chance of rain at Gatera (1987- 2017)

3.2 Determining standardized Rainfall anomaly index (SAI)

3.2.1 Determining standardized Rainfall anomaly index at Jimma

Rainfall was increasing annually by0.02mm at Jimma (figure 9)

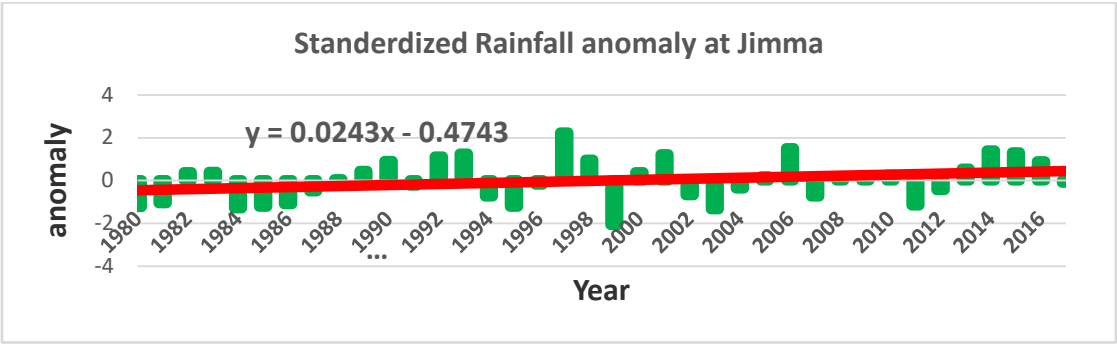

Figure 9: Rainfall anomaly at Jimma (1987- 2017)

3.2.2 Determining standardized Rainfall anomaly index at Bedele

Rainfall was increasing annually by 0.008mm at Bedele (figure 10)

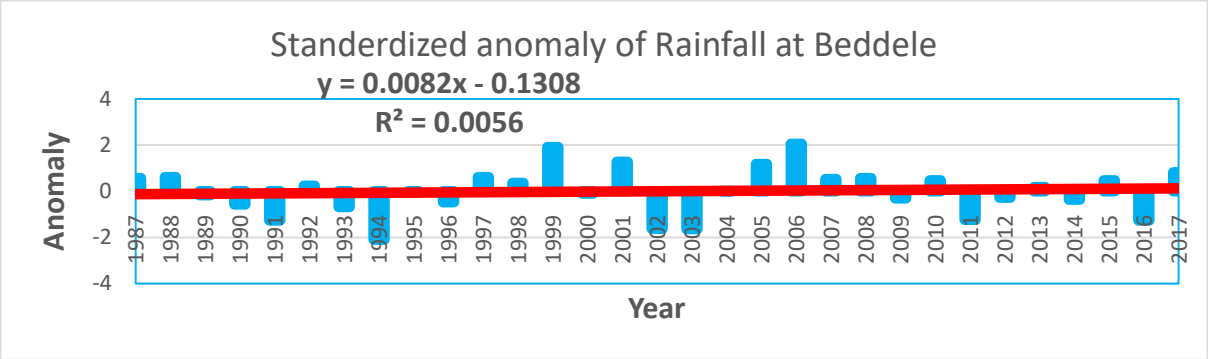

Figure10: Rainfall anomaly at Beddele (1987- 2017)

3.2.3 Determining standardized Rainfall anomaly index at Gore

Rainfall was declining annually by0.04mm at Gore (figure 11)

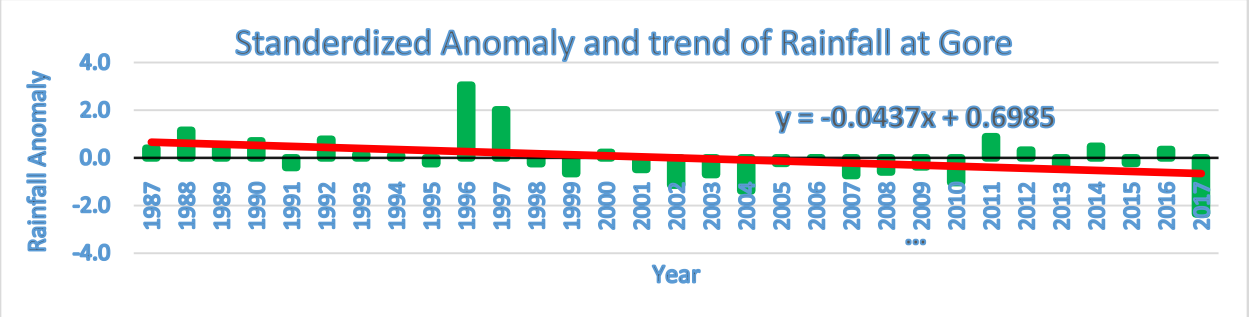

Figure11: Rainfall anomaly at Gore (1987- 2017)

3.2.4 Determining standardized Rainfall anomaly index at Limugenet

Rainfall was increasing annually by 0.05mm at Limugenet (figure 12)

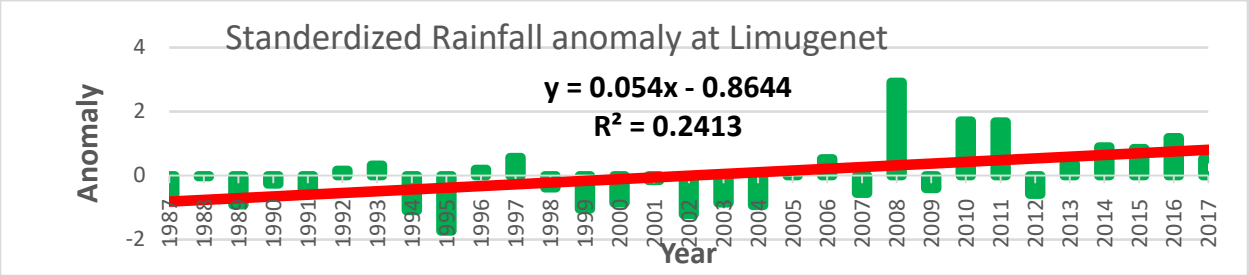

Figure12: Rainfall anomaly at Limugenet (1987- 2017)

3.2.5 Determining standardized Rainfall anomaly index at Sokoru

Rainfall was declining annually by 0.01mm at Sokoru (figure 13)

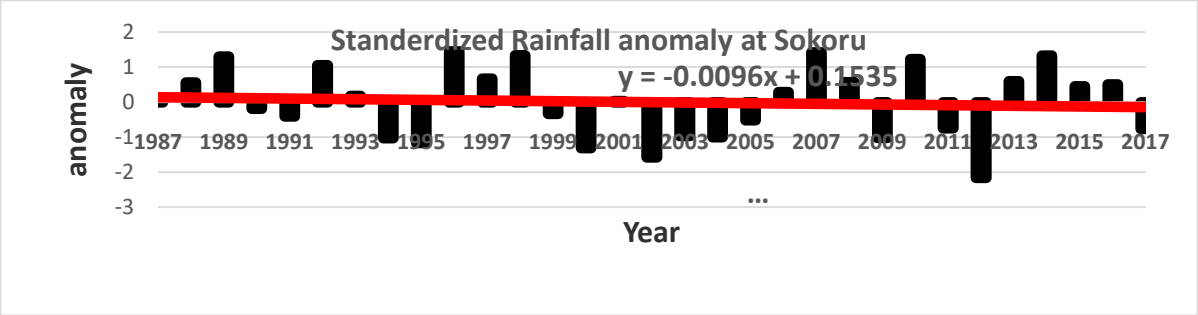

Figure13: Rainfall anomaly at Sokoru (1987- 2017)

3.2.6 Determining standardized Rainfall anomaly index at Chira

Rainfall was declining annually by 0.01mm at Chira (figure 14)

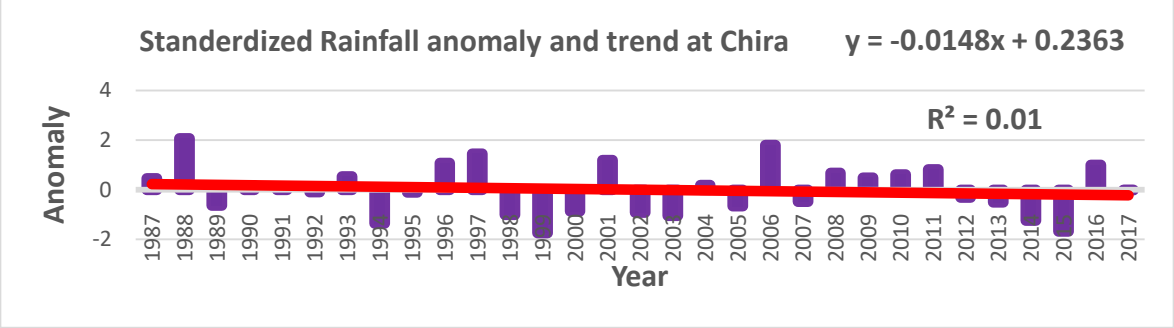

Figure14: Rainfall anomaly at Chira (1987- 2017)

3.2.7 Determining standardized Rainfall anomaly index at Gatera

Rainfall was increasing annually by 0.03mm at Gatera (figure 15)

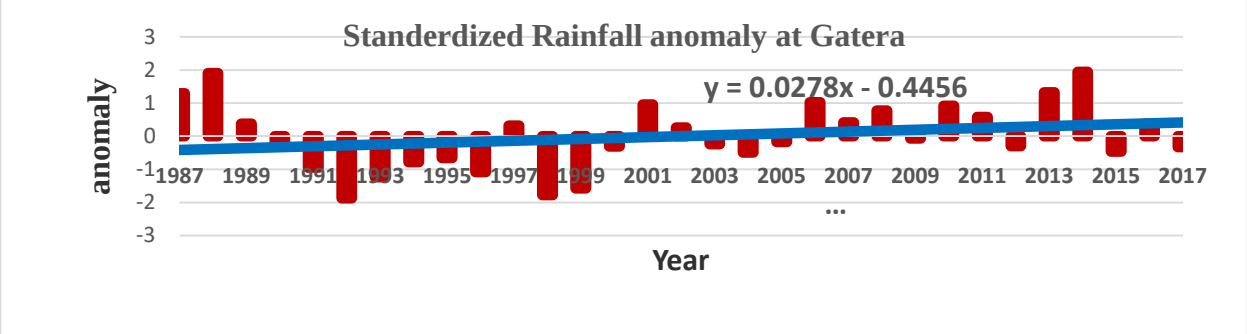

Figure15: Rainfall anomaly at Gatera (1987- 2017)

4. CONCLUSIONS

Analysis of rainfall data in west Oromia stations indicated that at jimma from 106 DOY (April 15) to 270DOY (September 26) the probability of wet spell was between 50% and 70% ,at Beddele 120 DOY(April 29) to 270DOY (September 26) the probability of wet spell was between 50% and 80% , at Gore from 115DOY(April 24) to 285DOY (October 11)the probability of wet spell was between 50% and 80% , at Limu genet from 120DOY(April 29) to 275DOY (October 1) the probability was between 50% and 83% ,at Sokoru from 120DOY(April 29) to 270DOY (September 26) the probability was between 50% and 80% ,at Chira from 120DOY(April 29) to 285DOY (October 11) the probability was between 50% and 80% ,at Gatira from 120DOY(April 29) to 275DOY (October 1) the probability was between 50% and 80%.The Standardized anomaly of Rain fall at Jimma was mostly below normal ,while normal years were greater at Bedele, Gore, Limugenet, Chira, and Gatira except at Sokoru where above normal was greater . Generally the trend of standardized anomaly was increasing at Jimma, Bedele, Limugenet and Gatira while it was decreasing at Gore, Sokoru and Chira; it was increasing and declining at 57 % and 43% of the stations respectively.

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Competing Interests: The authors declare that there are no conflicts of interests regarding the publication of this paper

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