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An Assessment of the Trends of Climatic Variables in Taraba State Nigeria

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Abstract- This paper is the second part of a TETFUND sponsored research carried out to examine trends of climatic variables in Taraba State Nigeria. Previous studies concentrated on the evidence of climate change in the state, awareness of climate change among students of tertiary institutions in the state and farmers perception and adaptation to climate change in northern Taraba. There is need to examine the trend and pattern of climatic variables in the whole state. This knowledge gap may greatly reduce the failures in measures to develop a state wide effective monitoring, adaptation and mitigation measures to climate change in the study area. Climatic data such as mean monthly and annual temperature and rainfall totals and rain days per annum for the four meteorological stations in the state (Lau, Gassol, Ibi and Gembu) for a period of 30 to 35 years was obtained. These were used in calculating the mean temperature, mean monthly rainfall, annual rainfall, the onset, cessation and length of rainy season. The result shows that all the stations exhibited a similar trend of increasing temperature with exception of Gembu where the temperature is decreasing. Annual rainfall show increasing trend in the southern and central part of the state with exception of Lau in the northern part of the state.

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ANASSESSMENTOFTHETRENDSOFCLIMATICVARIABLESINTARABASTATENIGERIA

Strictly as per the compliance and regulations of :

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Keywords: assessment, adaptation, climate change, trend, variables.

I. Introduction

Climate change is perhaps the greatest challenge facing our planet today (Adebayo and Oruonye, 2013). Some of these challenges manifest themselves in the form of drought, flooding and inundation of coastal lands, low agricultural productivity, alteration of surface and ground water and devastation of ecosystems among others. There is a growing consensus in the scientific literature that over the coming decades, higher temperature and changing precipitation levels caused by climate change will depress crop yields in many countries (Orindi *et al*, 2006; Stige *et al*, 2006). This is particularly crucial in low-income countries, where adaptive capacity is perceived to be low (IPCC 2007). Hulme *et al* (2000) estimated that by 2100, Nigeria and other West African countries are likely to have agricultural losses of up to 4% of GDP due to climate change. Other scholars have also observed that countries that depend on rainfed agriculture could experience decline agricultural yield of up to 50% between 2000 to 2020, due to increasing impact of climate change (Oxfam, 2007; IPCC, 2007 and Ifeanyi-Obi *et al*, 2012).

Several studies have shown that temperature is rising and rainfall frequency and intensity is fluctuating (Mendelsohn *et al*, 2000; Paavola, 2006, Ozor and Cynthia, 2010, Mohammed *et al*, 2013). The world average temperature rise has been given as 0.91ºC (Dube and Phiri, 2013). Available meteorological data in the country shows evidence of increasing air temperatures since about 1920s (NEST, 2003). For example, Anuforom (2010) and Odjugo (2010) observed that within 105 years, temperatures increased by 1.2ºC and 2ºC in the coastal cities of Niger Delta and northern extreme of Nigeria respectively. Mohammed *et al* (2013) observed that in Adamawa State of Nigeria, climatic data (temperature and rainfall) analysis over the past 25 years (1980-2005) shows that temperature has increased by 0.3ºC and rainfall fluctuated over the years (Adebayo, 2010; Sawa and Adebayo 2010; Audu 2013). In Taraba state, evidence of climate change includes delayed onset date of rains, increase in number of dry days during the raining season and increase in maximum temperature (Adebayo and Oruonye 2012a, b; Adebayo and Oruonye, 2013 and Adebayo 2012). This leads to warmer seasons, increased frequency and intensity of weather extreme events such as drought, decline in rainfall amount by about 15-20%, increased incidence of dry spell (Adebayo, 1998 and Anuforom 2010 cited in Mohammed *et al*, 2013). The problems of flood, high temperature and incidences of pests and diseases have also aggravated the farmers' loss which consequently increases the incidence of poverty and malnutrition in the state (Adebayo *et al*, 2012).

Taraba State is one of the states in the country that is well endowed with abundant natural resources. However, it is among the least developed parts of the country. Agriculture is the source of livelihood to an overwhelming majority of the population of the state. This sector employs more than 80% of the labour force (TSEED, 2004). The State's agricultural sector is

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dominated by small scale rural farmers. Farming is mainly subsistence with very few commercial base farms. Agriculture in the state is heavily dependent on natural rainfall, with irrigation agriculture accounting for less significant percentage of the total cultivated land. The types of cropping system practiced in the state are mixed farming, mixed cropping and mono cropping. Thus, the amount and temporal distribution of rainfall and other climatic factors during the growing season are critical to crop yields and food productivity in the state. Taraba State has suffered from periodical extreme climate events, manifested in the form of frequent flooding (Oruonye, 2012; Oruonye and Adebayo, 2013). Thus any change in climate, mostly manifested as an increase in frequency and severity of extreme weather events such as flood, has a potential to significantly reduce agricultural production and household food security.

For the fact that majority of the state population lives in rural areas and depends heavily on rain-fed agriculture for food and income, climate change presents a formidable challenge to the state's attempts to reduce rural poverty, which currently is on the increase. Not only does climate change affect crop production but also water access and availability, human and livestock health and may also cause damage to dwellings and infrastructure. Information on climate change and its interaction with agriculture is important for farmers and policy makers. With this information, farmers are better able to plan for possible changes in yields, water shortages, and possible increases in pests and livestock disease incidence. Planners and decision makers can also benefit from such information as it provides a basis for designing effective climate change adaptation interventions.

There is need to have a state wide research that examines the trend and pattern of climate change and local information and knowledge about this pattern. This knowledge gaps may greatly reduce the failures in measures to develop a state wide effective monitoring, adaptation and mitigation measures to climate change in the study area. it is against this background that this study examines the trend in climatic variables in the state.

II. Materials and Methods

a) *Description of study area*

Taraba State is located at the north eastern part of Nigeria. It lies between latitude 6° 30' and 8° 30' north of the equator and between longitude 9° 00' and 12° 00' east of the Greenwich meridian. The state shares boundaries with Bauchi and Gombe states in the north, Adamawa state in the east, and the Cameroon Republic in the south. The state is bounded along its western side by Plateau, Nassarawa and Benue states (Fig. 1). The state has a land area of 60,291km^2 with a population of about 2.5 million people (projected from the 2006 National Population Census). It is divided into sixteen Local Government Areas (LGAs) and three senatorial districts (Taraba north, central and south).

Taraba State is regarded as Nature's Gift to the Nation because of its abundant natural resource endowment. The state is well endowed with abundant solid mineral resources, surface water resources, arable and grazing land. The major occupation of the people of Taraba State is agriculture. The state is blessed with climate and vegetation types that cut across the country, ranging from a more humid climate and forest vegetation in the south to a more seasonal wet and dry climate and savanna vegetation in the north. These favour the growth of tree crops such as palm oil, banana/plantain, orange etc. Root crops in the state include cassava, potato and yam, while cereals include maize, rice, millet, sorghum and guinea corn. Cash crops produced in the state include coffee, tea and groundnuts. In addition, cattle, sheep and goats are reared in large numbers, especially on the Mambilla Plateau, and along the Benue and Taraba river valleys (Oruonye and Abbas, 2011). Communities living on the banks of River Benue, River Taraba, River Donga and Ibi (on the bank of River Benue) engage in fishing activities all year round. The state is also a tourist haven in the country. The famous Mambilla plateau with its beautiful landscape characterized by valleys and waterfalls and its lush green vegetation makes the state a potential pace-setter in the field of tourism in the country. The Gashaka-Gumti National Park located at the foot of the Mambilla plateau is another major outstanding tourist landmark in the

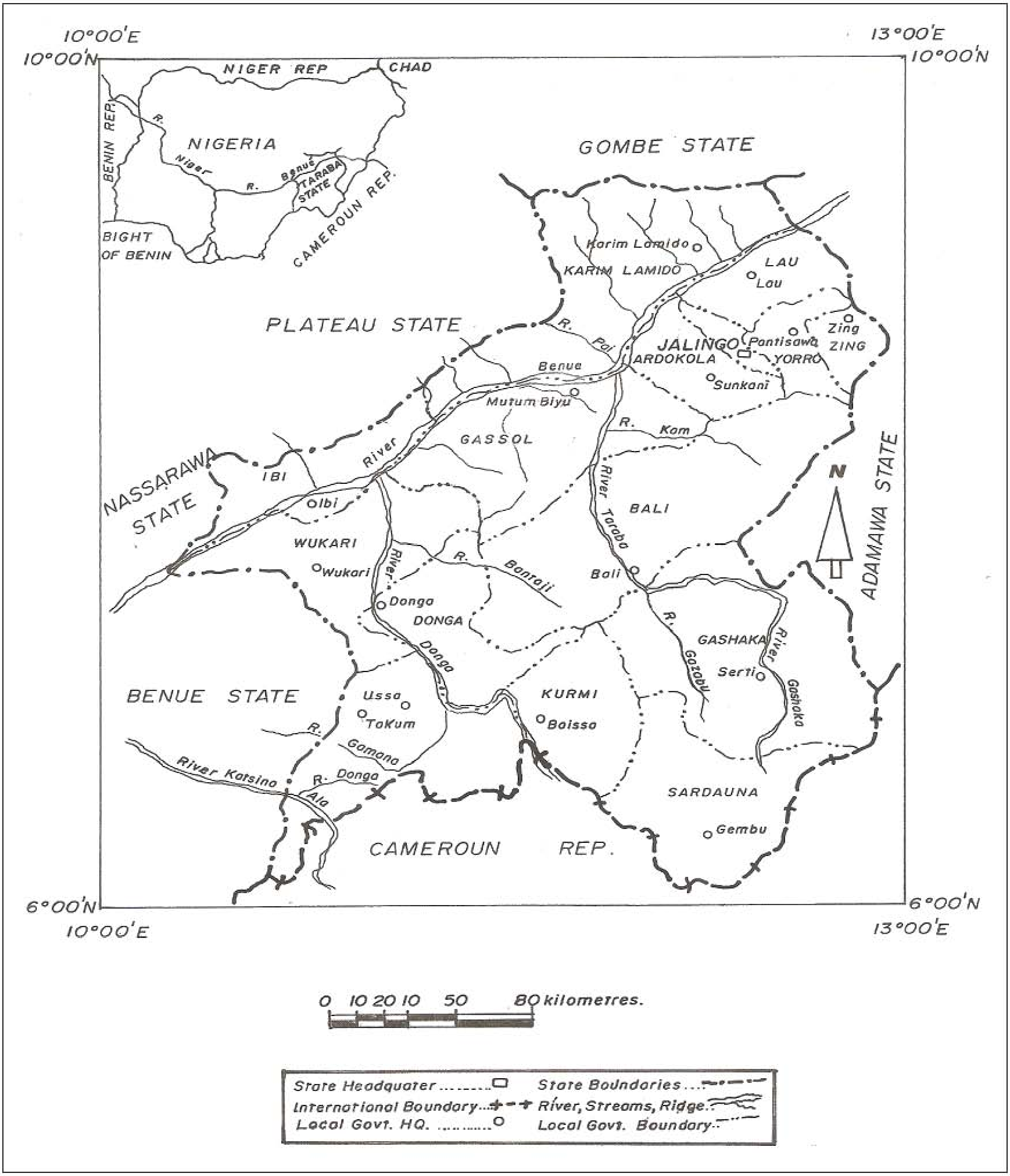

Figure 1 : Map of the study area (Taraba state)

state. It is not only the largest of the eight National Parks in the country, but it is the most diverse in terms of species in the whole of West Africa, harbouring such rare animals like the colobus monkey and warthogs, including buffalo, roam ante¬lope, chimpanzee, hippopotamus, hyena, giant forest hog, lion and leopard (Oruonye and Abbas, 2011). Taraba State is one of the Nigerian states with the most diverse ethnic groups comprising over 80 ethnic groups.

b) Data Collection

The data required for this study includes monthly and annual temperature and rainfall totals and rain days per annum for the different senatorial zones of the state for a period of 30/35 years depending on the availability of data. The monthly rainfall data for the various stations were used in calculating the mean monthly rainfall, annual rainfall, the onset, cessation and length of rainy season.

Although, there are many methods of calculating the onset and cessation of rains, the Walter's method (Walter, 1967), which utilizes monthly rainfall data, was adopted in this study. The choice of Walters's method is because it is relatively easier to accomplish, more economical and original as it requires no derivation of other indices for the computation but utilizes only the rainfall records which are measured directly (Umar, 2010). The method used to determine the actual date of the onset of rains is as follows;

$$\frac{\text{Days in the month } (51 - \text{accumulated rainfall of previous months})}{\text{Total rainfall for the month}}$$

Where the month under reference is that in which the accumulated total rainfall is in excess of 51mm^3 for the cessation dates of rains, the formula is applied in the reverse order from December.

Monthly rainfall and temperature data were collected from all the meteorological stations in the state for 30/35 years. These were the Upper Benue River Basin Development Authority (UBRBDA) Meteorological stations at Lau (latitude 9°15'N) (Northern Taraba), Gassol (latitude 8°31'N) and Gembu (latitude 6°41'N) towns (Taraba Central) and Nigerian Meteorological Agency (NIMET) Meteorological station at Ibi (latitude 8°11'N) town (Southern Taraba). These were the only stations with long term and consistent climatic data (Adebayo, 2012). Thus, all the three senatorial districts have one or more weather stations. The data were obtained from the archives of the Nigerian Meteorological Agency Headquarters in Oshodi, Lagos and the Upper Benue River Basin Development Authority Headquarter in Yola.

The decadal and inter annual variability in the time series of annual temperature and rainfall were analyzed using the trend analysis. Minitab statistical package was used for the analysis. The decadal and inter annual variability in the time series of annual rainfall, length of rainy season, onset and cessation was determined using coefficient of variation (CV), while the trends in the time series of these parameters (annual rainfall, length of rainy season, onset and cessation) were determined using simple regression and correlation analysis. The coefficient of variation is given as;

$$CV = \frac{\sigma}{\bar{x}} \times 100\%$$

where $\bar{x}$ the mean of the entire series and σ is the standard deviation from the mean of the series. In order to determine the trend in the time series of the annual rainfall, length of rainy season, onset cessation and temperature in all the stations considered for the period 1978/80 – 2010/12, the simple regression analysis was used where by the values in the time series were regressed on time. The equation of the line of best fit was then computed using the Minitab statistical software. The equation is as follows; $Y = a - b\bar{x} + c$

Where a = intercept of the regression, b = regression of the coefficient and c = error term or residuals of the regression.

To determine whether the trend line in the time series analysed is upward or downward, the simple correlation coefficient (r) was used and defined as follows;

$$r = \frac{\frac{\sum xy}{N} - \overline{xy}}{\sigma x - \sigma y}$$

where r is correlation coefficient, N is total number of observations in the series, Y is the observation in the series, x is the time in years, σx is the standard deviation of x and σy is the standard deviation of y. Where the value of (r) is positive, it indicates upward trend in the time series analysed and where the value of (r) is negative, it indicates down ward trend in the time series analysed. The data were presented using tables, frequencies, figures and percentages.

III. Result of the Findings

a) Description of the trend of the climatic elements

The climatic data collected were processed and subjected to trend analysis. The summary of the trends of the climatic elements studied is presented in Table 1 and 2, while the Graph of the trend analysis are shown in Figures 2 – 35.

b) Temperature

Looking at Table 1 and Figures 2, 3, 29, 30, all the stations exhibited a similar trend of increasing temperature with exception of Gembu where the temperature is decreasing. The trend of temperature in Gassol and Ibi indicates that there is an upward movement in this element over the years in these locations and in most parts of the state. Temperature data for Lau station was not available. This upward trend in temperature is a reflection of the global warming resulting into general increase in the earth's temperature (Adebayo 2012). However, the reverse is the case at Gembu station where the temperature is reducing. This situation was earlier reported by Adebayo (2012) and on the Jos plateau by BNCR (2011). The equation of the temperature trend shows that the temperature increases by 0.025°C at Ibi station.

Table 1 : Summary of the Trends of Climatic Elements Studied

Climatic elements	Lau	Ibi	Gassol	Gembu
Temperature	N.A.	Increasing	Increasing	Decreasing
Annual rainfall	Decreasing	Increasing	Increasing	Increasing
Onset date of rains	Late	Late	Late	Late
Cessation date of rains	Early	Early	Early	Late
Length of rainy season (LRS)	Decreasing	Stable	Decreasing	Decreasing
July monthly rainfall	Decreasing	Increasing	Increasing	Increasing
August monthly rainfall	Decreasing	Increasing	Increasing	Increasing
September monthly rainfall	Decreasing	Increasing	Increasing	Increasing

Source: Computer analysis (NA = data not available)

c) Annual Rainfall

Annual rainfall show increasing trend in the southern and central part of the state with exception of Lau in the northern part of the state where the rainfall is decreasing. The trends of annual rainfall in Gembu, Ibi and Gassol showed an upward trend in the southern and central parts of the state while the trend in Lau showed a general downward trend of annual rainfall in the northern part of the state (Fig. 4-6 and 28). A look at the distribution pattern of rainfall in the state shows that the rainfall decreases from south to north. Annual rainfall decreases as latitude increases. Rainfall averages in the state for the period 1978 to 2012 vary from 1807mm^3, 1047mm^3, 958mm^3 to 866mm^3 at Gembu (Lat. 6°41'N), Ibi (Lat. 8°11'N), Gassol (Lat. 8°31'N) and Lau (Lat. 9°51'N) stations respectively (Table 2).

d) Length of Rainy Season (LRS)

Length of Rainy Season (LRS) is the difference between the cessation date and onset date. Length of rainy season show decreasing trend in all the stations with exception of Ibi, where it is relatively stable (Table 1 and Fig. 13 – 15 and 27). The implication of such a trend, mean a reduction in annual rainfall, and hence reduced crop yield, especially if the trend persisted for a long period of time, which can lead to a tendency towards a drier condition. The implication of this is that the length of rainy season is decreasing in all the locations. The mean length of rainy season (LRS) shows Ibi 166 days, Lau 155 days, Gassol 145days while Gembu has a higher LRS of 210 days.

Table 2 : Summary Analysis of Climatic Data

Variable	IBI (8°11')	Lau (9^{0}15')	Gassol (8^{0}31')	Gembu (6^{0}41')
Temperature				
Mean (^{0}C)	28.1	NA	34.22	21.39
Coefficient of Variation (%)	1.4	NA	3	6
Annual Rainfall				
Mean (mm)	1046.5	866	957.7	1807.4
Coefficient of Variation (%)	21.6	19	15	12
Onset date of rain				
Mean (date)	26th April	10th May	10th May	25th March
Coefficient of Variation (%)	15	8	6	19
Cessation date of rain				
Mean (date)	11th Oct.	11th Oct.	6th Oct.	21st Oct.
Coefficient of Variation (%)	4.4	3	4	3
Length of rainy season (LRS)				
Mean (days)	166	155 days	145 days	210 days
Coefficient of Variation (%)	14.8	10	9	9

Source: Computer analysis (NA = data not available)

e) Onset and Cessation

The onset refers to the time a place receives an accumulated amount of rainfall sufficient for the growing of crops. It is not the first day the rain falls (Adebayo and Oruonye, 2013). Walter (1967) define onset of rains in Nigeria in terms of time of receiving an accumulated amount of rainfall in excess of 51mm. Rainfall cessation means the termination of the effective rainy season. It does not imply the last day rain fell, but when rainfall can no more be assured (Adebayo and Oruonye, 2013). The end of the rains is the date after which no more than 51mm of rain is expected (Umar, 2010). All the four stations where synoptic data were obtained (Gembu, Gassol, Ibi and Lau) shows late onset of rain, while only Gembu show late cessation of rains (Table 1 and Fig. 7-12). It is important to stress that from Tables 1, the onset and cessation of the rains at all the stations tended to be concentrated around the months of April/May and October/September respectively. Onset date of rain exhibits an upward trend in all the four locations. This indicates that the rain is starting late and hence the beginning of growing season is being delayed all over the state. The mean onset of rainfall is much earlier in Gembu than Ibi, Gassol and Lau. This was reported in previous studies in the state by Adebayo 2012. Cessation date of rain exhibits a downward trend in all the locations except Gembu. This clearly shows that the rains now end earlier in the state. The specific date of occurrence of either the onset or cessation of the rains is an important consideration in determining the beginning and end of the growing season in an area (Umar, 2010). Efficient crop production in the tropics is equated with the onset of rain and cessation of rainy season and its variability. This is because, onset, cessation and length of the rainy season form important components of moisture resources status for determining the potential of various crops (Olanrewaju 2006).

In regions characterized by seasonal rainfall which is associated with dry spells of varying magnitudes as is the case with the study area, a reliable determination of the onset of the rains is not only pertinent to the determination of the time to plant or transplant with minimum risks of crop failure but also critical to good crop yield (Umar, 2010). On the other hand, a fairly accurate determination of the cessation of the rains might not only facilitate the determination of a dependable duration of the rains at a given location but is also beneficial to the selection of crop varieties that will mature by the end of the growing season.

IV. Discussion of Results

The rainy season is of variable length in the state but usually occurs between April to October. It occurs as a result of the northward movement of the Inter Tropical Convergence Zone (ITCZ). The rainfall distribution pattern in the state is also significantly influenced by altitude because of orographic factor (Adebayo, 2001, 2012). The annual rainfalls, length of rainy season, onset and cessation dates are important crop growing season parameters. This makes growing season variability an important indicator of climate change. Hence, better knowledge of the characteristics of the rainfall regimes is required to make assessment of agricultural potential more realistic. Although temperature varies considerably from year to year, it is the variability in the rainfall in time and space, from one year to another that is the real problem. Annual rainfall in the state poses serious constraint on agricultural activities in the state.

From the findings of the study, July and August monthly rainfall show increasing trend in Gassol, Gembu, Ibi and decreasing trend at Lau. The monthly rainfall of September show increasing trend in Gembu and Ibi, while that of Gassol and Lau show decreasing trend (Fig. 18, 19, 21-24). In Gassol, monthly rainfall in July and August is increasing while that of September is decreasing. This finding is corroborated by the result of an earlier study by Adebayo (2012). Increase in rainfall in August and September is usually accompanied with floods. Adebayo (2012) observed that the floods are being aggravated in many parts of Taraba and Adamawa states by the release of excess water from Lagdo dam in the Republic of Cameroon.

The onset of the rainy season determines the commencement of the growing season and date of planting for the farmer. A delay in the onset of the rainy season, particularly in the wet and dry environment like the study area will delay the date of planting and will result in crops extending their growing into the winter season, where the prevailing lower temperatures will negatively affect crop yield. On the other hand, an early cessation of the rainy season will result in the cutting short of the growing season of crops and consequently result in crops failing to reach their physiological maturity stage. The length of rainy season which also determine the length of the growing season is defined as the period in days from the date of the onset to the date of cessation of the rainy season.

Adebayo (2001) conducted a study in Taraba State using monthly rainfall data collected from 19 stations for the period 1979 – 1997 to derived vital agro-climatic parameters such as onset, cessation and length of rainy season, seasonality index and hydrological ratio. The result of his study showed that mean onset dates vary from 16th March in the extreme south on the Mambilla Plateau to 26th April around Zing and Jalingo (Adebayo, 2010). Mean cessation dates range from 10th October in the north to 31st October in the south. Based on the outcome of his study, Adebayo (2001) divided the State into three zones for the beginning of growing season.

a. The southern zone where growing season commences as early as 16th March including Sardauna, Kurmi and Takun LGAs.
b. The central zone where onset date starts from 6th April comprising of Bali, Ibi, Gashaka, Wukari and Donga LGAs.
c. The northern zone where onset date starts from 26th April covering Gassol, Zing, Yorro, Lau and Jalingo LGAs.

The finding of this study using climatic data of 30 years (1978/82–2010/12) for four stations shows slight deviation from the above results. The onset of rainfall ranges from 25th March at Gembu, 26th April at Ibi to 10th May at Gassol and Lau stations respectively (Table 2). The mean dates of cessation also range from 6th, 11th and 21st October at Gassol, Lau, Ibi and Gembu stations respectively (Table 2).

Dry spells cause Poor germination, increase the need for replanting and leading to wilting and drying out of crops. Most of the respondents interviewed complained that temperatures are becoming hotter and the rains are arriving late and becoming more intense and concentrated which reduces the length of the growing season and triggered more floods. Onsets of rainfalls are becoming more uncertain and unpredictable with dry spells after planting. It use to rain for few days (i.e.5days), then dry for a couple of days. The dry spell could not be calculated for all the stations studied because of difficulty of getting the daily records for the past 30/35 years. Dry spell is usually the number of days (often 5days) in each month without rainfall. You can have a single dry spell (5 days) or double or 15 days dry spells as the case may be. Since farming in the state usually follows the start of the rains, if a long dry spell occurs, the seedlings die (false start) and the farmers are compelled to replant. In many parts of the state some of the causes of crop failure have been attributed to dry spells of about 10 days or more length, as well as a shorter growing season due to replanting or late onset and/or early cessation of the rains. Therefore, a reliable estimation of the onset and cessation dates of the rain could help maximize rainwater use by farmers in the state.

V. Conclusion

This study has examined the trends of climatic variables in Taraba State. The result shows that all the stations exhibited a similar trend of increasing temperature with exception of Gembu where the temperature is decreasing. Annual rainfall show increasing trend in the southern and central part of the state with exception of Lau in the northern part of the state. All the four stations where synoptic data were obtained (Gembu, Gassol, Ibi and Lau) shows late onset of rain, while only Ibi show late cessation of rains. Length of rainy season in the study area show decreasing trend in all the stations with exception of Ibi, where it is relatively stable. The implication of such a trend, mean a reduction in annual rainfall, and hence reduced crop yield, especially if the trend persisted for a long period of time, which can lead to a tendency towards a drier condition. With persistent changes in the environment, the farmers are having difficulty to properly time their planting because of the changing climatic patterns, a situation that makes it imperative for experts to trace the new trends and come up with conclusive recommendations on when to plant. The heavy dependence of agriculture on the seasonal characteristics of rainfall in the state and the increasing evidence of decreasing rainfall and length of rainy season in the state particularly in the northern part means that it is essential that these characteristics are predicted accurately.

VI. Recommendations

1. Part of the problem with climate change is the incidence of pest and diseases, particularly during dry spells. This is further exacerbated by the fact that farmers are often poorer and rarely have access to safe and effective pesticides, robust varieties of plants/seeds and adequate irrigation facilities. The government can do well by assisting the farmers with these necessary inputs at subsidized rate.
2. It is important that government make issues of climate change adaptation top of its political agenda. Policies of reducing poverty and ensuring food security need to include climate change strategies. A detailed analysis of the risks and possible solutions could assist in finding appropriate adaptation strategies and play an important role in achieving food security and fighting poverty.

VII. Aknowledgement

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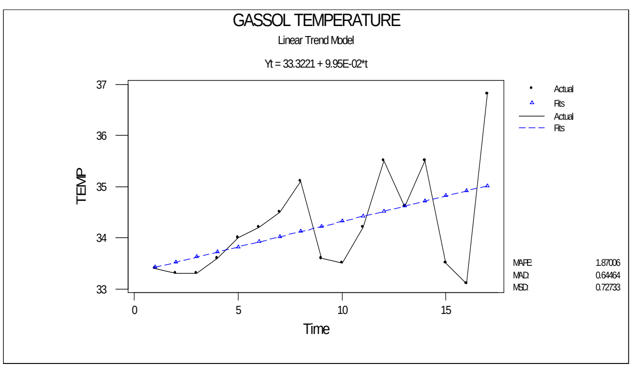

Figure 2 : Trend of Mean Temperature in Gassol

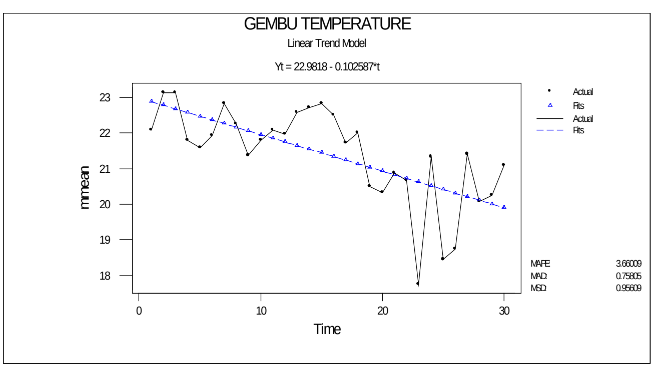

Figure 3 : Trend of Mean Temperature in Gembu

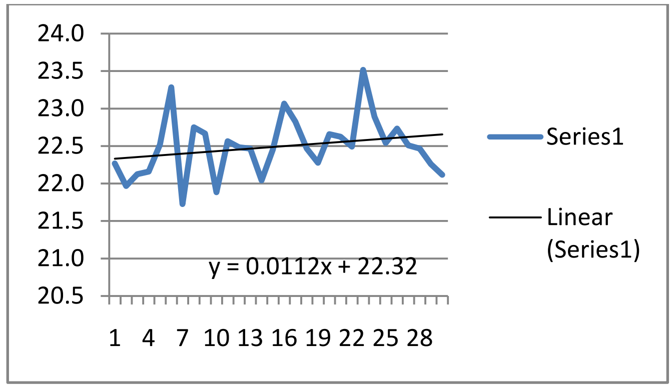

Figure 4 : Trend of Mean Temperature in Ibi

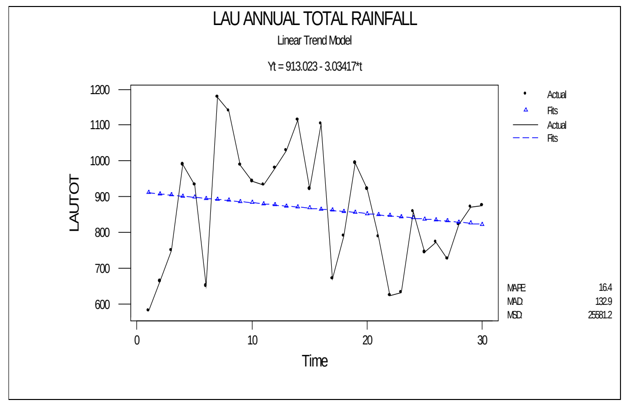

Figure 5 : Trnd of Annual Total Rainfall in Lau

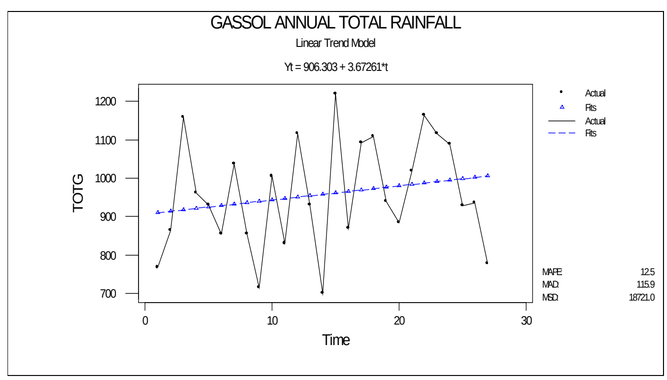

Figure 6 : Trend of Annual Total Rainfall in Gassol

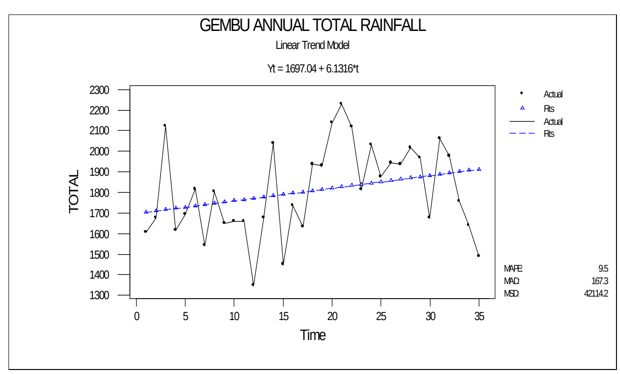

Figure 7 : Trend of Annual Total Rainfall in Gembu

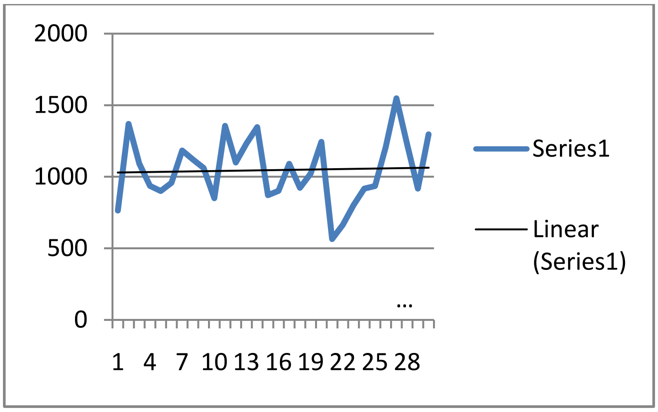

Figure 8 : Trend of Annual Total Rainfall in Ibi

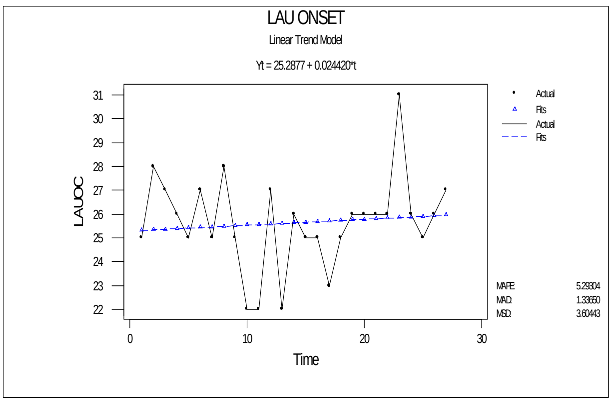

Figure 9 : Trend of Onset Dates of Rain in Lau

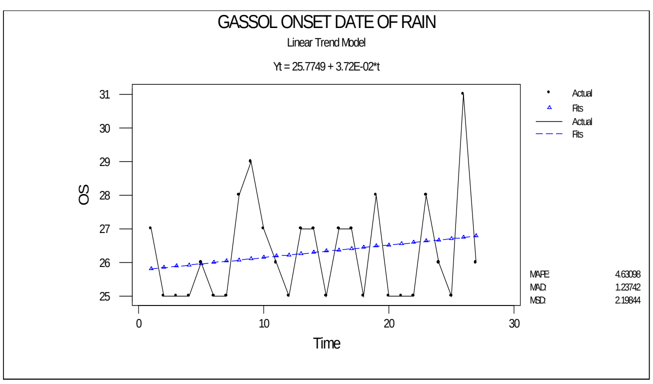

Figure 10 : Trend of Onset Dates of Rain In Gassol

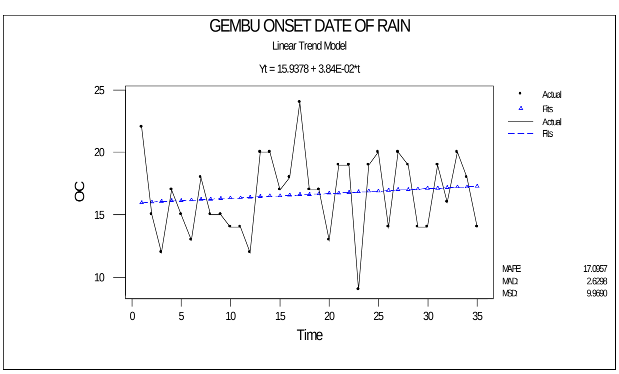

Figure 11 : Trend of Onset Dates of Rain in Gembu

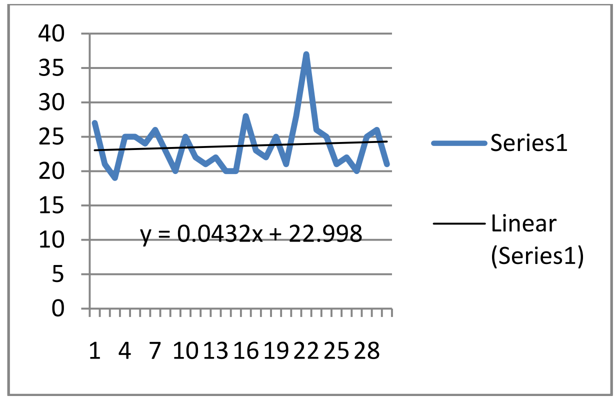

Figure 12 : Trend of Onset Dates of Rain in Ibi

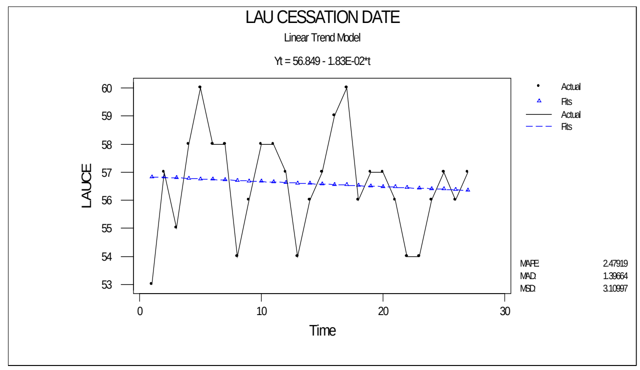

Figure 13 : Trend of Cessation Dates of Rain in Lau

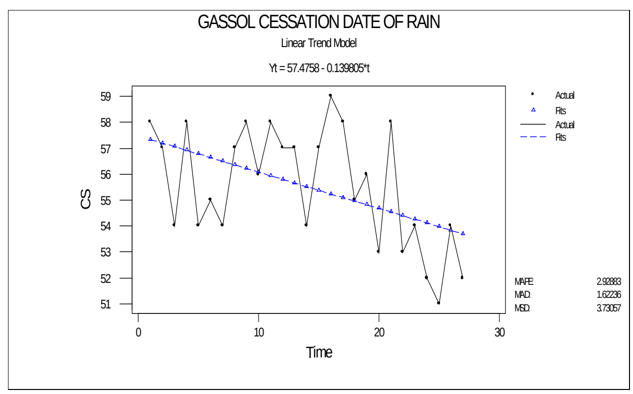

Figure 14 : Trend of Cessation Dates of Rain in Gassol

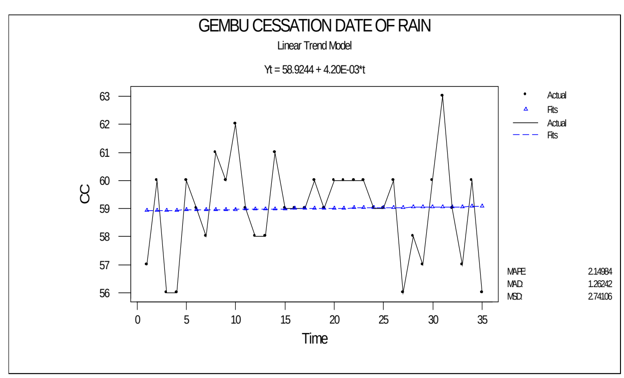

Figure 15 : Trend of Cessation Dates of Rain in Gembu

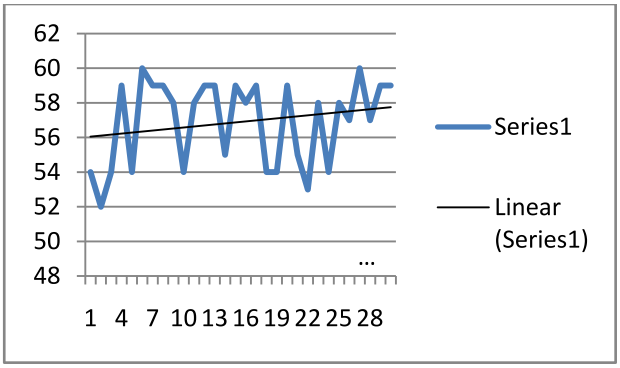

Figure 16 : Trend of Cessation Dates of Rain in Ibi

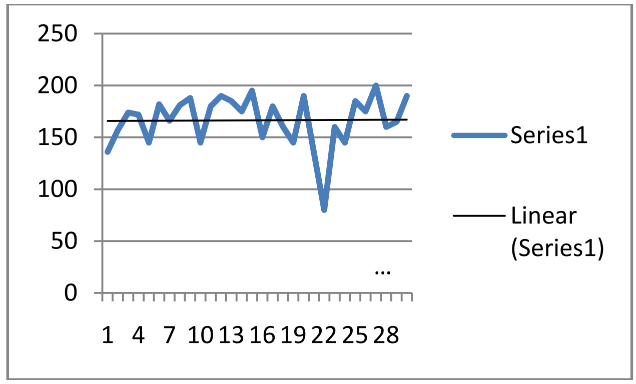

Figure 20 : Trend of LRS in Ibi

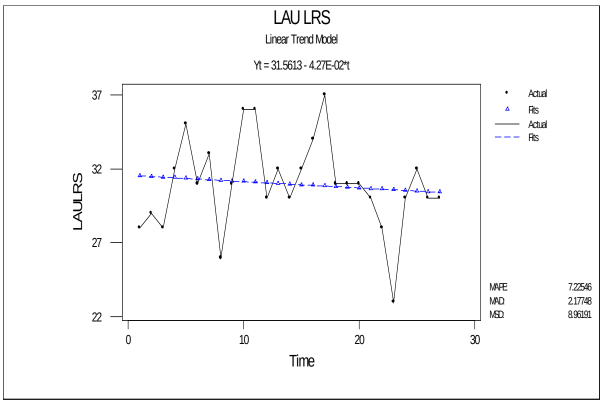

Figure 17 : Trend of LRS in Lau

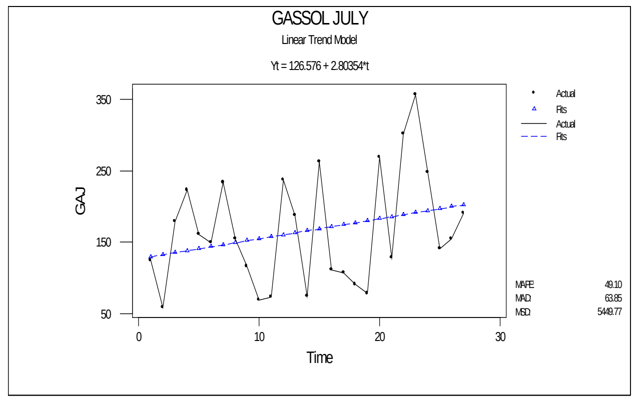

Figure 21 : July Rainfall in Gassol

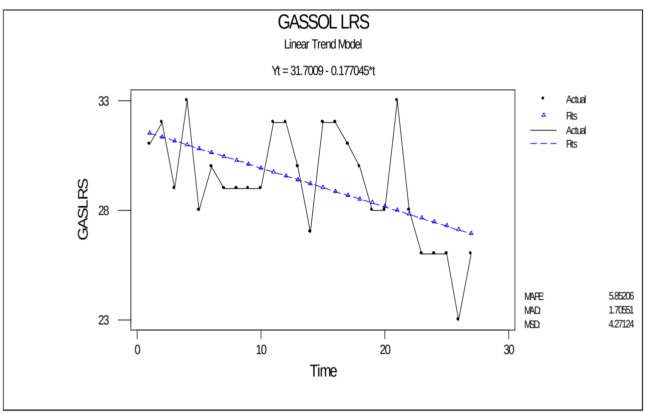

Figure 18 : Trend of LRS in Gassol

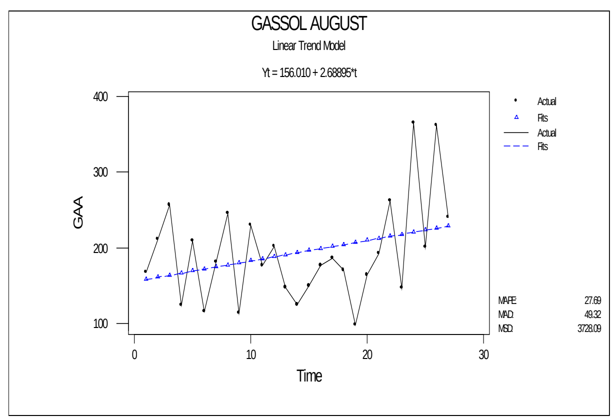

Figure 22 : August Rainfall in Gassol

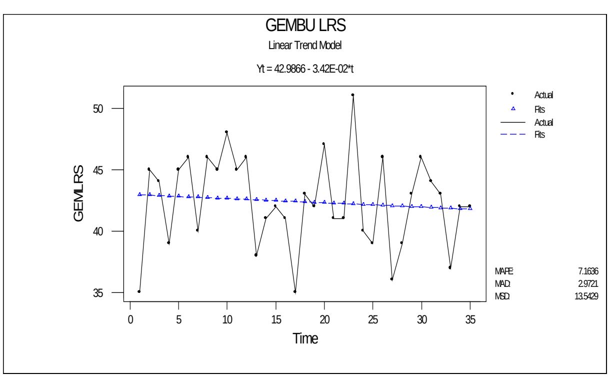

Figure 19 : Trend of LRS in Gembu

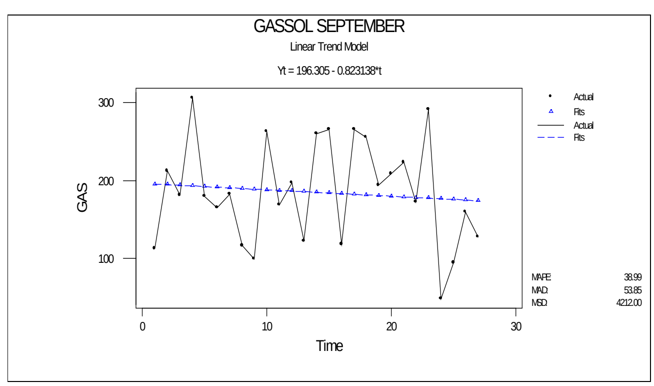

Figure 23 : September Rainfall in Gassol

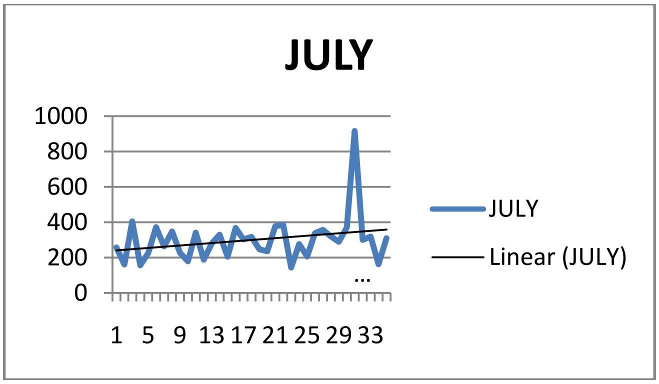

Figure 24 : July Rainfall in Gembu

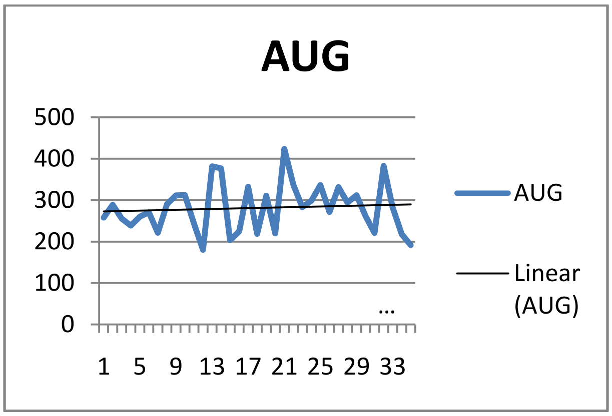

Figure 25 : August Rainfall in Gembu

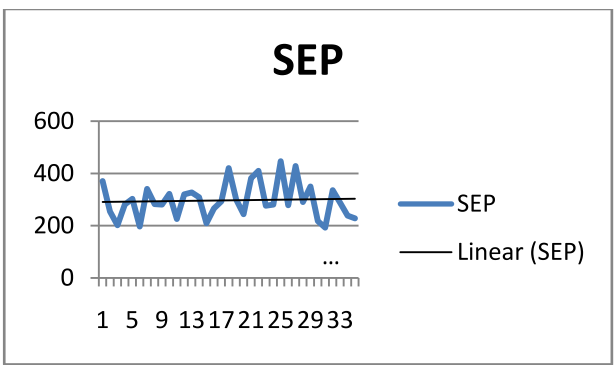

Figure 26 : September Rainfall in Gembu

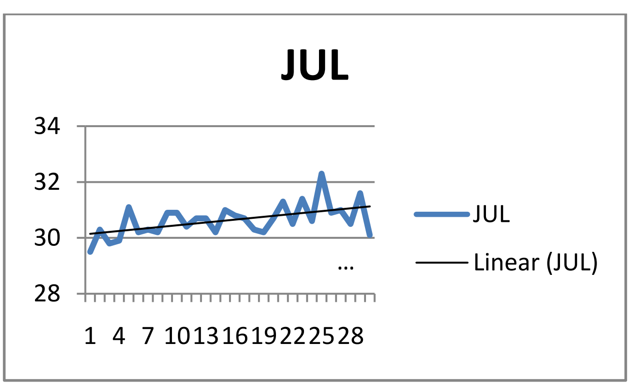

Figure 27 : July Rainfall in Ibi

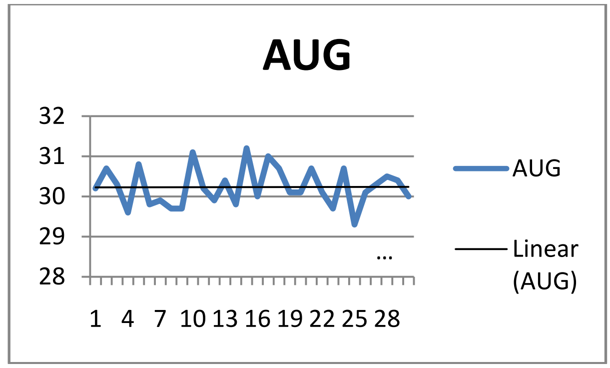

Fig.28: August Rainfall in Ibi

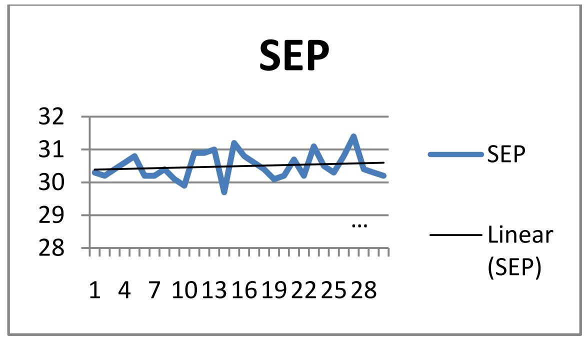

Figure 29 : September Rainfall in Ibi

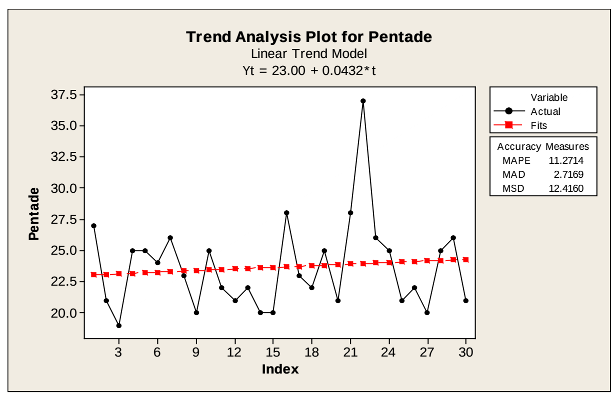

Figure 30 : Trend Analysis graph for Pentade

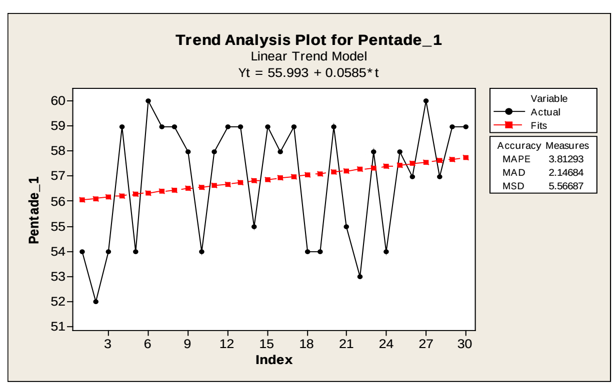

Figure 31 : Trend Analysis graph for Pentade _1

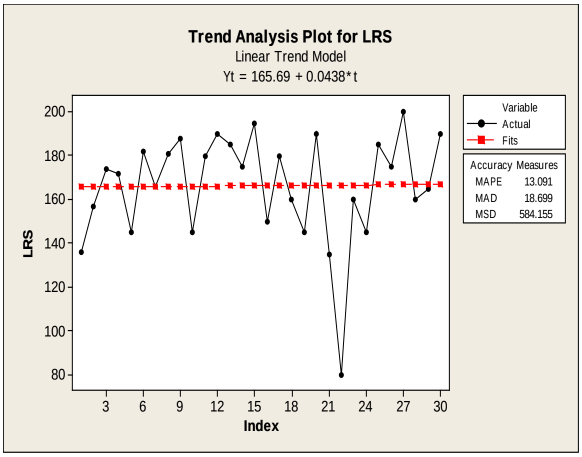

Figure 32 : Trend Analysis graph for LRS

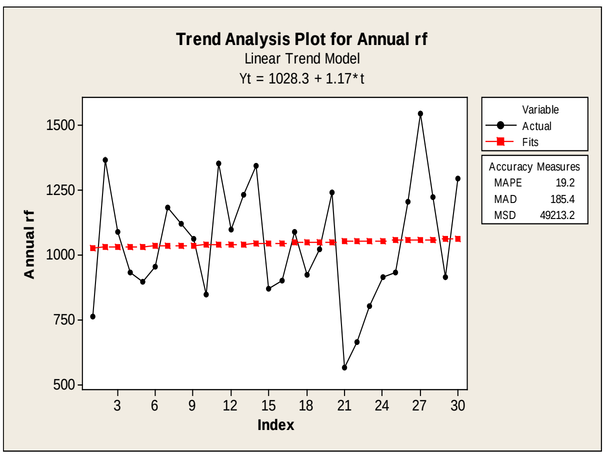

Figure 33 : Trend Analysis graph for Annual Rainfall

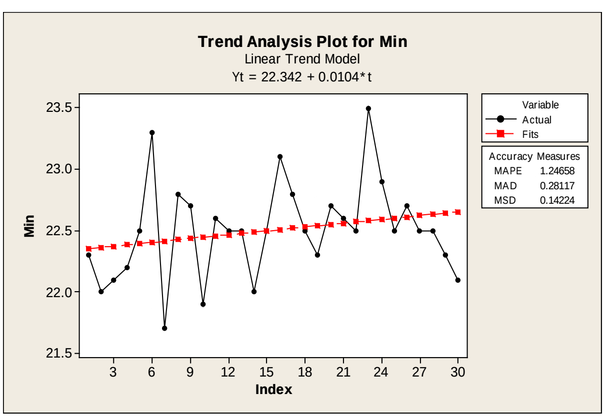

Figure 34 : Trend Analysis graph for Minimum Temperature

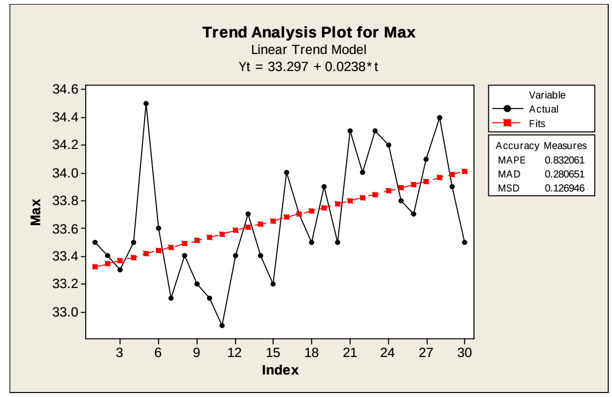

Figure 35 : Trend Analysis graph for Maximum Temper

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