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RESEARCH ARTICLE

RAINFALL TREND AND IT IMPACT IN KEFFI NASARAWA STATE

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ABSTRACT

Rainfall is the vital ingredient and factor of soil nourishment on which crops are grown. The basic agricultural practices all over the world depend on rainfed cultivation for their sustainable development. This study focus on the rainfall trend between 2010 -2018 as it affects crop production in Keffi Nasarawa State, Nigeria. The time series analysis was conducted by using appropriate techniques of data collection and analysis. The linear integration model, quadratic trend model, growth curve model and regression analysis was applied to show the correlation between the rainfall and crop production in the study area. It was discovered that the period of rainy months have high correction and significantly fitted the model which indication high crop yields per harvest.

KEYWORDS

Rainfall Trend, Crop Production, Linear, Quadratic, Regression Analysis.

1. INTRODUCTION

1.1 Effects of Temperature and Rainfall Variability on Crop Production in Nigeria

Nigeria agriculture is almost entirely rain-fed which makes it intuitively susceptible to the vagaries of weather scientific evidence is now overwhelming that there is climate change in Nigeria and its presents serious environmental risks and challenges demand urgent national response; that is, climatic fluctuation is putting Nigeria's agricultural system under serious threat and stress (Ayanlade et al., 2010). In Nigeria it has been shown that rainfall patterns are highly variable from year to year. An examines the spatial-temporal dynamics of rainfall and temperature fluctuations in Nigeria over the last century and shows that the mean annual temperature has increased by about 0.04ºc (Ayanlade et al., 2009). It was observed that Lagos due to her industrial and commercial activities had recorded the highest correlation coefficient of 0.78 which was attributed to urban heat generation. Keffi recorded the highest correlation coefficient of 0.6, followed by Ondo (0.49) Port Harcourt (0.48) Enugu (0.46) and Calaber (0.43).

The highest correlation recorded by Keffi was ascribed to the influenc7 of the Niger, Benue trough, while those of Port Harcourt and Enugu were ascribed to anthropogenic heat production, alteration of natural surfaces and canyon geometry. The inter-decadal variability of rainfall over Nigeria between (1911-2000) showed that rainfall is decreasing at the rate of about 78.4mm per decade. It also shows that 1981 -1990 was the worst decade in terms of the inter-annual variability in rainfall with highest value of the coefficient of variation of 54.7% 1981-1990 decade has the highest rainfall failures over the period of the study followed by 1971-1980 decade which were ascribed to the periods of the great Sudano-Sahelion droughts of the 1970s and 1980s as documented in the literature (Cooper et al., 2008).

Nigeria's climate has shown significant variability leading to extreme climate events such as drought and flood; there exists a number inter-annual fluctuations observed in the annual rainfall over the country which is responsible for dry and wet years or extreme climate events such as drought and flood. Temperatures in Nigeria have also been on the increase in the last five decades, and have been very significant since 1980s after the last major drought in 1983 New 2006 Even though the finding showed that the temperature of Abuja, Nigeria has no significant variation in its trends over the years, it has a mean annual temperature of 27.4°c with a standard deviation of 0.24 and a coefficient f variation of 0.9 percent; which they concluded to suggest that Abuja has maintained a uniformly high mean annual temperature over the years (Ifatimehin and Ufuah, 2006).

A studied on comparative analysis of the distribution of rainy days in different ecological zones observed that the rainy days in southern zone shows relatively less variability than those in the central (middle belt) and the northern zone, in the same view the distribution in the middle belt shows less variable more than those of northern zone (Sofoluwe et al., 2011). Rainfall characteristics in Nigeria have also been examined for dominant trend notably (Olaniran and Sumner, 1989; Oluwasegun and Olaniran, 2010). They showed that there has been a progressive early retreat of rainfall over the whole country and consistent with this pattern, they reported a significant decline of rainfall frequency in September and October which respectively coincide with the end of the rainy- season in the northern and central parts of the country.

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The pattern of rainfall in Southern Rainforest zone of Nigeria is highly variable in spatial and temporal dimensions with interannual variability. As a result of the large interannual variability of rainfall, it often results in climate hazards, especially floods with devastating effects on food production and associated calamities and sufferings (Oladipo, 1993). Temperature and precipitation (rainfall) are the climatic variables most critical to measure with regard to crop production systems. This change in climate, according to tile report of Intergovernmental Panel on Climate Change can be caused by the natural process of volcanic eruptions, variations in the sun's intensity or very slow changes in ocean circulation or land surfaces which occur on time scales of decades, centuries or longer (Swart et al., 2003). However, human activities are by far the major causes of climate change through the continuous release of greenhouse gases and aerosols into the atmosphere by changing land surfaces, and by depleting the stratosphere ozone layer.

This change in climate has the potentials of affecting all-natural systems thereby becoming a threat to human development and survival socially, politically and economically (Apata et al., 2009). It affects agriculture for instance in several ways, one of which is its direct impact on food production. This is because climatic factors play an important role in the realization of higher or lower crop yields. Rainfall and temperature are most vital climate variables affecting crop production globally; hence there is a growing consensus in the scientific literature that over the coming decades, higher temperatures and changing precipitation levels caused by climate change will be unfavorable for crop growth and yield in many regions and countries (Yesuf et al., 2008).

Rainfall is described as the most critical agro-metrological factors of agricultural production in the tropics (Ifatimehin and Ufuah, 2006). This is because rainfall can vary considerably even with few distances and different time scale. This implies that crop yield can vary over space and time depending on the rainfall amount and spread, that is rainfall can determine the kind of crop to be grown, the farming system to be adopted and the sequence of farm operations (Adejuwon, 2004).

Rainfall can also be seen as the supplier of soil moisture to crops, although moisture does not depend on rainfall alone but also on various concerns such as the evapotranspiration and surface run-off the perceived impacts of climate change that bear direct repercussions on agricultural practices in Nigeria is on rainfall indices. Important rainfall indices crucial for agricultural activities in the tropics are the rainfall onsets, cessation and the length of the rainy season which is synonymous with the length of the growing season (LGS) (Oguntunde et al., 2012).

Climate change has a direct adverse influence on the quantity and quality of agricultural production and by extension the type of crop that can be cultivated (Parry et al., 2004). Temperature, rainfall, humidity, sunshine (day length) are the important climatic elements that influence cropping production (Chima et al., 2011). As a result of the large inter-annual variability of rainfall, it often results in climatic hazards, especially floods with their devastating effects on food production and associated calamities and sufferings reported that rainfall variability is very high in most part of Northern Guinea Savannah except Jos which has a unique pattern and a significant relationship with tuber yield (cassava and yam) (Oladipo, 1993; Adejuwon, 2004; Ayanlade et al., 2010).

In a study on comparative analysis of the distribution of rainy days in southern zone shows relatively less variability than those in the central (middle belt) and the northern zone, likewise, the distribution in the middle belt shows less variable more than those of the northern zone (Akintola, 2001). Rainfall characteristic in Nigeria has also been examined for dominant trend notably (Olaniran and Sumner, 1989). They showed that there has been a progressive early retreat of rainfall over the whole country and consistent with this pattern, they reported a significant decline of rainfall frequency in September and October which respectively coincide with the end of the rainy season in the northern and central parts of the country.

1.2 Monsoon Rain in West Africa

Rainfall is considerably seasonal in Nigeria as well as in Keffi. it was characterized by the movement of Intertropical continental Zone (ITCZ). This operates at multidecadal time scale controlled by the role of atmospheric circulation that resulted to planetary winds and energy budgets. The Hadley cell transports moisture into the ITCZ in its lower branch and transports energy away from the ITCZ in its upper branch. In the mean, the ITCZ is just north of the equator, with the net result that energy is moved from the Northern Hemisphere (NH) into the Southern Hemisphere (Marshall et al., 2014). If the NH experiences anomalous heating, the atmosphere partially compensates by rearranging the circulation so that there is enhanced transport of heat away from the NH. For this to happen more moisture needs to be transported into the NH and the ITCZ must shift to the north (Schneider et al., 2014; Kang et al., 2009).

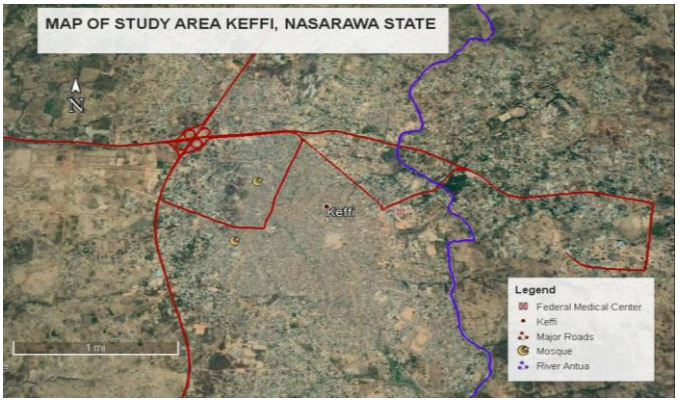
The impact of rainfall variability was also connected to the dynamic's nature of the West African Monsoon wind blowing from the Atlantic Ocean. Associated with ascent in the rain band is a divergent circulation, with low-level southerly flow converging moisture into the Sahel and compensating divergence extending over the depth of the free troposphere. Intertwined with the divergent circulation are the geostrophic circulations: into the Sahara Heat Low (SHL) at low levels and around the anticyclones at mid and upper levels. The anticyclones are associated with two distinct jets, the African Easterly Jet (Xu et al., 2018).

The zonal component of the flow is not the only important regional feature distinguishing the monsoon circulation from the Hadley cell. Another difference is emphasized in Figure 4 which provides a schematic of the meridional structure of the circulation over West Africa. Superimposed on the deep moist cell that produces the rain band is a shallow circulation. According to a study, at the surface the southerly flow penetrates well north of the rain band and into the pressure minimum associated with the SHL, shallow and dry ascent maximizes at the ITD, and the northerly return flow of Saharan dry air at about 600mb penetrates into the rain band (Donohoe et al., 2013).

2. Material and Methods

2.1 Study Area

Keffi is one of the fastest growth city with high rate of Urban development due to its location closer to the Federal Capital Territory Abuja Nigeria.



2.2 Locations

GCP 1 Lat 8°51'36.50"N, Long 7°50'2.01"E
GCP 2 Lat 8°48'43.57"N, Long 7°51'42.03"E
GSP 3 Lat 8°49'19.17"N, Long 7°55'36.48"E
GSP 4 Lat 7°55'36.48"E, Long 7°54'59.90"E

2.3 Dataset and Sources of data

The methodology adopted involved Trend analysis. The use of software Minitab 19 was employed to analysis the required statistical analysis to obtain the result. The source data is from Air Force Meteorological unit in Markudi, Benue State Nigeria 2019.

The four fundamental analyses were conducted in order to get the model fit and the correction solution the data collected in the field. These include the:

1. Linear Trend Model
2. Quadratic Trend Model
3. Growth Curve Model and
4. Polynomial Regression Analysis

3. Result and Discussion

3.1 Effects of Linear Trend Model of Rainfall Variability in Keffi

Table 1 presents the data on the rainfall variability and the effects of crop yields. The rainfall is measured at different stations and locations in the study area (Keffi).

Table 1: Effect of Rainfall and the Crop Yields

S/no	Rainfall Variability (mm)	Trend	Detrend
May	1900	2987.53	-1087.53
June	2000	2341.74	-341.75
July	2400	1835.56	564.44
August	2500	1438.79	1061.21
September	1200	1127.79	72.21
October	1000	884.01	115.99
November	600	692.92	-92.92
Dec	500	543.14	-43.14
Jan	400	425.74	-25.74
Feb	300	333.71	-33.71

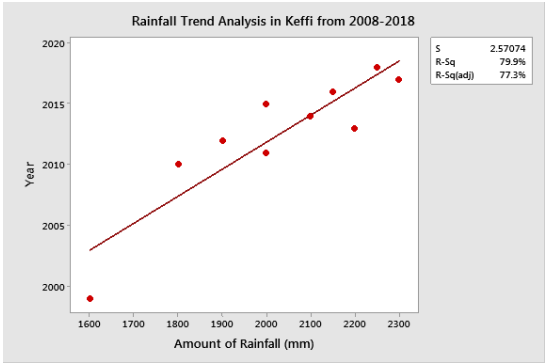


Figure 1: Linear form of rainfall trend in Keffi

The above figure explains the straight line rainfall behaviour in the study area. The relationship is very cordial and mutually exclusive with the dots clustered in the regression line. The relationship in the model is fitted with 79.9%. This indicates that the rainfall trend having relevance with the amount and time of the year.

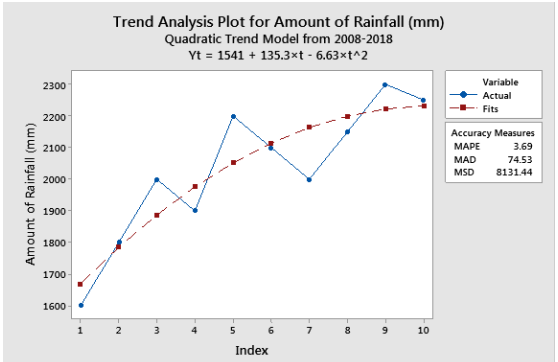


Figure 2: Quadratic trend model showing the amount of rainfall at different index

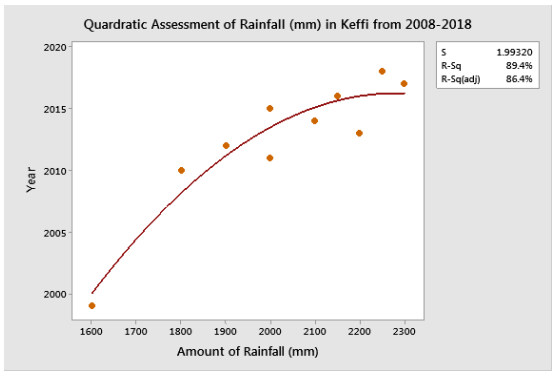


Figure 3: The Quadratic Trend Model of rainfall in Keffi

The model trend touches the rainfall line squall with an upward trend indicating that the about 74.53 accuracy measure was established in the model. The differences between the two quadratic trend models is that the figure 2 is showing the rainfall trend index and amount while figure 3 illustrates the amount of rainfall trend and the period of it occurrence. The model in figure 3 is more accurate with 89.4% root mean.

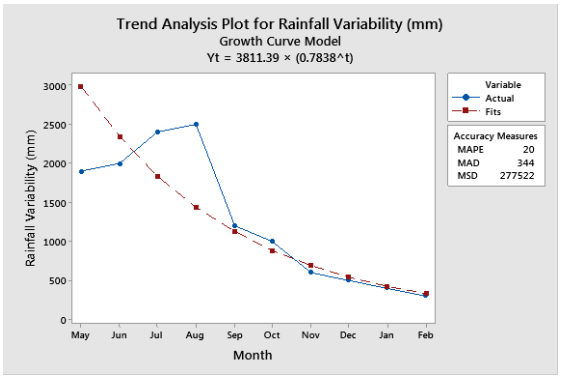


Figure 4: The growth Curve Model of Keffi

The curve model above indicates the period of high rainfall not only in Keffi, Nasarawa State but the entire Nigeria. This peak period recorded in the model figure 4 are from May to September almost every year. Except with little shift due to climate change from one state to another.

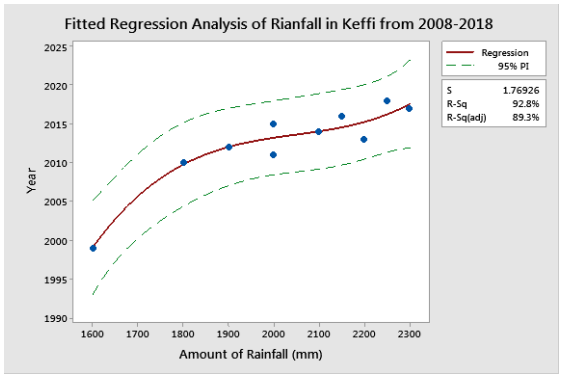


Figure 5: Regression Analysis of Rainfall Trend in Keffi from 2008-2018

The above model is shown the significant value of correlation. The R^2 is 92.8% which indicates the perfect fitted of the amount of rainfall at particular time of the year (as shown in figure 4.

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