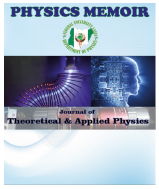

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Original Research

An Assessment of Rainfall Attributes and Onsets-Cessations Dates Effective for Cropping in Lafia, Nasarawa State, Nigeria

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Abstract

Rainfall affects almost all human lives, significantly in diverse fields like agriculture, business, health, transportation and tourism. Amongst the main endeavours engaged by man, agriculture is the main stake for man's source of livelihood. Most people are not aware of the attributes of rainfall peculiar to their surroundings, as such embarked on agricultural activities through "try by error" and are faced with challenges due to the unstable nature of weather. Weather does disappoint most people that are into farming because rainfall varies in the study area. This study aimed at assessing Lafia rainfall attributes and the determination of its onset-cessation dates effective for cropping. Eleven years rainfall data of Lafia was collected for the study. The analysis was carried out using Excel tool and Mann Kendall analytical approach with the aid of Xl statistical software in the description of Lafia rainfall attributes. The study reveals a less stability nature of rainfalls at a value greater than 40, and a fluctuating onset dates between April and May with drought and dry spell occurrences in each of the growing seasons were recorded. The study therefore concluded that, there exist a less stable rainfall amount and a highly stable rainfall frequency of occurrences; all these affects food crops production and its output as the average rainfall amount recorded is (1371.2 mm) while the average number of rainy days in the study was (95 days) . It is therefore recommended that other researchers should carry out an empirical study on the severity of drought and dry spell in the study area.

Keywords: Assessment, Rainfall, Attributes, Crops Production

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1. Introduction

1.1. Background to the Study

Rainfall is seen to be the most weather element that all human activities depend on [1-4]; with impacts on food security [1-15]. The impact of rainfall onsets and cessations are significant to rain fed agriculture [1-19] which the economies of most emergent countries depend [8] with less adaptive capacity [10]. Predominantly, many low income nations, located in the tropical and sub-tropical region are vulnerable to changeable climate [7], and this can also be seen posing great threat to crop production and food security in most countries of the world.

Agriculture on the other hand, is basically dependent on rainfall for food production in most part of the globe [19]. The main socio-economic activity engaged by larger percentage of the population in West Africa is agriculture, in spite of how variability in rainfall affects the whole world [6]. Farmers no longer have confidence on when to start cropping because drought and dry spell occurrences are posing more threat to many Nations in the tropics. False rain is also a matter of concern as it confuses farmers on real rainfall onset and whether to start cropping or not; for fear of crop seeds and seedlings spoilage during planting period. Farmers have the need to know when actual rainfall is starting for them to begin cropping. This will assist in curbing the issue of food insecurity in any nation. The issue of food security globally and particularly in Nigeria, is topical. Determination of rainfall onset and cessation dates with the assessment of rainfall attributes is a key player in determining crop yield of a state, for instance, in the last decade, the tropical Africa has been experiencing fluctuations in the onsets and cessations of rains with a longer period of dryness along the Northern coast of the West African region which is leading to a harsh-drop of crop output in most parts of the tropics [18]. Nasarawa State has been experiencing great loss in terms of seeds and seedlings during planting due to the unstable nature of rainfall onset in the study area. The farmers have been living on assumptions and mere guess work they call 'farming by experience' which at some points they succeed while others, they fail woefully. A careful observations have been made by the researcher and discovered that there has never been any recorded academic research conducted in Lafia to help educate farmers on when to start cropping.

This fact above is supported by [1], where he stated that, crop production is significantly linked with rainfall distribution in its onset, cessation and amount during rainy season. Hence, changes in timing of planting date in relation to rainfall onset affects farming activities. Such system disrupt farmers' practices of land clearance, tilling of soil and planting while its (rainfall) distribution and cessation greatly affects crop growth, yield formation, harvesting and storage systems. To this end, the study aimed at assessing Lafia rainfall attributes and the determination of its onset-cessations dates effective for cropping in Lafia. To help achieve the aforementioned aim, the following objectives ensued;

(i) assess rainfall onset-cessation dates and number of rainy days in Lafia Local Government of Nasarawa State between 2006 and 2016.

(ii) examine and discuss the trend and stability state of Lafia rainfall between 2006 and 2016.

Finally, the rapid drop in food production in Nasarawa State is alarming and has drawn the attention of the Nasarawa State Government to venture into knowing and addressing the cause of the quandary [11]. Many researchers have swung, conducting researches and results are underway and this has also informed the decision to contribute our quota by conducting this empirical study. This study will help in providing the farmers with adequate knowledge on what and when to start cropping in the Study area.

2. The Study Area and Research Methodology

2.1. Geography of the Study Area

Lafia Local Government area is situated in Nasarawa State and it is the headquarters of the State. It lies between latitude $7^o45'$ & $9^o25'$ N of the Equator and between longitude 7^o & $9^o37'$ E of the Greenwich meridian [2]. Lafia is the largest town in Nasarawa state with area coverage of about 2,756 km^2 and has a population of 330,712 [12]. Lafia is bounded to the North by Nasarawa Eggon and Wamba Local Government Area and to the East, is Plateau State. To the Southern part, Lafia is bounded with Obi and Awe Local Government Area and South-West is Doma Local Government Area. To the West, it is bounded by Kokona Local Government Area of Nasarawa State.

The general topography of Lafia Local Government is that of undulating plains and lowlands. The southern Nasarawa valley and troughs where Lafia is situated extends inland for some 30 kilometers and it is made up of flood plains lying generally below 250 meters.

Lafia is surrounded by hills, some of which are rocky and of undulating highlands of average height of about 1,400 m above mean sea level [13]. Areas such as Nasarawa-Eggon and Shandam of Plateau state that bounds with Lafia are generally highlands, hilly and rocky, while areas such as Doma, Awe and Keana are fairly plain terrains as same as the Lafia itself. The river Benue has tributaries from Nasarawa State and part of which is the River Kelema in Lafia town.

The Lafia Local Government Area has some few numbers of drainage as compared to other local areas. The major rivers in Lafia Local Government are River Kelema in Lafia town along Doma road, and River Asakiyo in the eastern part of Lafia where it shares boundary with Shendam of Plateau State. These small rivers dissect the terrain of the study area. All these Rivers drain into River Benue at the south-western part of Nasarawa State with many tributaries along their route.

The soils type in Lafia is that of sandstones derived from old sedimentary rocks with extensive occurrences of lateritic crusts. Soils at the foot of Nasarawa Eggon hills extends to Lafia Local Government area where mostly is volcanic in nature and therefore loamy and rich, while the higher grounds are characterized by thin soil.

Alluvial soils are found along the flood plains which are always swampy in nature due to availability of water all the year round. The forest soils are rich in humus and lateritic; they are found in most parts of the Local Government area where slash and burn approach is adopted in land clearance and acquisition for crop production. Furthermore, the major soil units of Lafia Local Government belong to the category of oxisols or tropical ferruginous soils [13]. The soils are derived from the basement complex and old sedimentary rocks. Lateritic crust occurs in extensive areas on the plains, while hydromorphic soils (inceptisols) occur along the flood plains of the major river areas of Lafia.

Many parts of the Lafia Local Government area are ravaged by sheet, rill and gully erosions, particularly Lafia town which is heavily gullied. Since most of the inhabitants of the town are farmers; extensive areas in the countryside are used for farming and overgrazing, thus exposing wide areas of land to erosion. The case of unplanned buildings has equally exposed the residential areas to erosion due to poor drainage system.

Lafia Local Government falls within the southern guinea savannah zone; however, lumbering vegetation for farming, fuel wood extraction for domestic and cottage industrial uses and saw milling have led to the development of re-growth vegetation at various levels of its development. Dense forests are few and far apart now in the Local Government area, particularly inside the town where urbanization is taking over.

Such forests are found in the outskirt of the Lafia city, particularly where population pressure is less. Gallery forests are common along major rivers like in Asakiyo axis. Trees of economic value amongst others include Locust Bean (Parkia Biglobossa), Baobab (Adasonia digitata), Shea butter, Mango, Citrus, Pawpaw trees e.t.c., are scattered across the area.

The Lafia climate appears to be one of the sunniest and the driest town in Nigeria due to the prevailing presence of the subtropical ridge with subsiding hot, dry air masses. Lafia holds much heat-related record amongst others; the area has the hottest extended period year-round. Rainfall in Lafia Local Government is general like that of the West Africa pattern, for instance, rainfall in the tropics is mostly convective and therefore rather unevenly distributed over time and space, i.e. the tropics is recorded with the highest variability in rainfall. Convective events can occur at any time in the year, but are more likely in the rainy season, particularly in a region that experience single rainfall maxima.

The rainfall period of Lafia in Nasarawa State last for 5-6 months with an annual rainfall figures range from 1100 mm to about 2000 mm and it has a varied diurnal rainfall from 131.7 millimeters in some places to 145 millimeters or more in others [19]. Annual average temperatures in Lafia ranges between 20^oC and 35^oC, but distinction exists in the overnight temperatures and near-surface humidity: night-time temperatures regularly fall below 26^oC in most period of the year in Lafia metropolis and some diurnal temperature occurrences of about 40^oC-47^oC in the months between February and May of every year are recorded [19].

The temperature of Lafia is generally high during the day; particularly between the months of March and April and it starts dropping down in the month of May all through to the months of December and January when the temperature is relatively cold due to the harmattan winds blowing across the study area.

Table 1. Annual Rainfall Onset and Cessations Dates with Number of Rainy Days in Lafia

Year	Annual Rainfall Total (mm)	Rainfall Onset Date	Rainfall Cessations	Total Annual Rainy Days
2006	1319.9	1st May	19th October	96
2007	1529.6	10th April	6th October	100
2008	1123.8	17th April	20th October	101
2009	1595.7	12th April	4th October	112
2010	1438.3	20th April	6th October	97
2011	1261.4	2nd May	7th October	85
2012	1267.4	16th April	3rd October	82
2013	1297.8	4th April	3rd October	91
2014	1322.0	16th April	23rd October	111
2015	1367.2	1st May	12th October	84
2016	1560.8	25th April	9th October	86

2.2. Materials and Methods

2.2.1. Data

Data for this research work is observed rainfall daily data sourced from the Nigerian Meteorological Agency (NiMet) Abuja covering 11 years between 2006 and 2016.

2.2.2. Method for Data Analysis

The analytical method used in describing and summarizing the data was a descriptive statistical technique. Further methods were adopted in addressing each objective of the study as stated below.

2.2.3. Accessing Rainfall Onset, Cessation Dates and Number of Rainy Days in the Study

To examine the onset and cessation dates with number of rainy days per annum in Lafia between 2006 and 2016;

(i) [16] approach was used in determining rainfall onset and cessation dates in the study, even though other researchers had arguments like in the works of Oarnault cited in [5] which stated that when rainfall drops below a threshold of 30 mm amount in a month, cessations of rains has set in. But however, this study adopted [16] to help achieve the first objective of the study. Rainfall onset date derivation by [16] stated that the start of the raining season is obtained by the number of days in the first month in which cumulative monthly rainfall is greater than 50.8 mm multiply by (50.8 – Rainfall total of the previous month divided by the total rainfall of that first month with cumulative rainfall greater than 50.8). The Days in Month of Effective Rain "MER" multiplied by (50.8mm – accumulated total of previous months) divided by total for MER.

(ii) Rainfall Cessation To determine rainfall cessation, it is done in the same manner with that of onset except that here, the computation is done backward from December. According to [16], it is the number of days in the first month from December with cumulative monthly rainfall greater than 50.8m (50.8 – Rainfall total of the previous months/Total rainfall of that first month with cumulative rainfall greater than 50.8mm).

(iii) Number of Rainy Days In achieving that, a descriptive statistical technique was used in counting the number of days rain fell within the raining season with the aid of excel toolpak to derive at the number of raining days.

2.2.4. Examination of Trend and Stability State of Rainfall in Lafia

For the study to be able to examine the trend and stability condition of rainfall in Lafia, Mann-Kendal trend analysis was adopted with the aid of Xl statistical package in computing the trend of rainfall in Lafia while excel tool was used in determining the stability state of rainfall in Lafia.

3. Results and Discussion

The results of the findings were derived using the variable for the study such as rainfall data. The daily rainfall data with number of rainy days per annum for the period under study was used; and thus have the following results and discussions.

Table 2. Trend and Stability Test of Annual Rainfall Total in Lafia

Statistic	**Annual Rainfall Total**
Minimum	1123.8
Maximum	1595.7
Mean	1371.2
Standard deviation	138.3
Coefficient Variation	0.10
Z	0.16
S	9.0
p-value	0.542
Alpha	0.05

3.1. Annual Rainfall Onset and Cessations Dates with Number of Rainy Days in Lafia

The results in Table 1 revealed that rainfall onset for the period of 11 years between 2006 and 2016 at Lafia is in the month of April except in 2006, 2011 and 2015 where rainfall started in the month of May. Rainfall cessation dates showed that rainfall terminates in Lafia in the month of October except in 2010 when rainfall terminated on 06th September. Annual number of rainy days shown in Table 1 indicates that 2012 has the least number of rainy days of 82 days while 2009 had the highest number of rainy days of 112 days within the study period. A fluctuating and varying dates, days and amount of rainfall were recorded in the study as indicated in table 1.

The implication of this result is that rainfall duration in Lafia often last for 5-6 months which is a good duration recommended for both cereal and tuber crops farming as opined by the International Institute for Tropical Agriculture (IITA). On the other hand, the number of days' rain falls and the annual amount of rainfall in the study area are less than the required number of days and amount of rainfall required for tuber to grow in each of the year under study. For instance, International Institute of Tropical Agriculture stated that it requires an average number of 150 days of adequate rainfall for yam to grow and produce good yield, so also, annual rainfall amount of 1500 mm is required for a good and adequate yield of tuber to be recorded. From the foregone, average annual number of raining days in Lafia and average annual rainfall amount have not met the required standard for tubers production as opined by the International Institute of Tropical Agriculture, even though the duration of raining season in Lafia has met the required standard of rainfall for cereal and tuber production in the study area.

3.2. Examination and Discussion of the Trend and Stability State of Rainfall in Lafia

This section examines the trend and stability state of rainfall in Lafia and further discusses the research results and its implications.

3.2.1. Examining the Trend and Stability State of Rainfall in Lafia

The result presented in Table 2 displays the rainfall attributes of Lafia, like the minimum, maximum, average, stability state and trends of Lafia rainfall amount.

Table 2 revealed that Lafia experienced minimum annual rainfall of 1123.8 mm and maximum annual rainfall of 1595.7 mm within the period under review. It also revealed that the annual rainfall had a mean of about 1371.2 mm amount and a standard deviation of 138.3 during the period of the study. The standard deviation that measures the stability nature of the climatic elements under study (Rainfall) is 138.3 which indicate that the Lafia rainfall amount is less stable at confidence level of 0.05.

From table 3, the average number of raining days in Lafia is 95 days with a standard deviation of 10.47854952 at a confidence level of 0.05 and a sample variance of 109.8.

Table 3. Stability Test of Annual Number of Rainy Days in Lafia

Statistic	**Annual Rainy Days Total**
Mean	95
Standard Error	3.159401554
Median	96
Standard Deviation	10.47854952
Sample Variance	109.8
Kurtosis	-0.957826948
Skewness	0.42895623
Range	30
Minimum	82
Maximum	112
Sum	1045
Count	11
Largest (1)	112
Smallest (1)	82
Confidence Level (95.0%)	7.039585322

3.2.2. Results Discussion

The results in table 2 shows that the annual rainfall amount had a standard deviation figure of (138.3) while table 3 shows that the annual number of rainy days standard deviation is (10.5). This simply means that the annual rainfall amount of Lafia is less stable while the annual number of rainy days is highly stable respectively. The results are back-up with the classification of [14], were it stated that stability of rainfall is determine as; when standard deviation is <10 it is consider to be very highly stable, between 10-20 it is consider to be highly stable, and if standard deviation is between 20 and 40, it is consider as moderately stable, while >40 consider to be less stable. Tables 1 and 3 shows that Lafia rainfall onsets and cessations dates are relatively stable and that Lafia number of rainy days is fewer, and this record has always been highly stable with a standard deviation of 10.48. The implication here is that, there are only fewer rainy days of about 95 days on an average spread across the period of 5-6 months of rainfall period per annum; In a comparison to the required rainfall days for cereals and tubers crops productions which are the major crops types farming in Lafia, this means that crops production in the study area suffers the effect of dry spells and drought in-between the growing season. The above fact is supported by the work of food and agriculture organization (FAO) on crop water needs, published by [3]. Households also are face with the challenges of long dry periods as it affects water table level in most sources of water which are used for irrigation, domestics and industrial purposes in the study area. Animal husbandry and man's health also are not left behind as man is facing the pandemic effects cause by the very highly unstable nature of Lafia rainfall amount.

Furthermore, in table 2, it revealed the trend analysis of annual rainfall distribution of Lafia. The result shows that Lafia has a positive trend with a Z-value of 0.16. This indicated that the annual rainfall had increased over the study period with the tendency of increasing in the near future; even though, the annual rainfall trend showed insignificant level α 0.05. From the daily rainfall data collected on Lafia, rainfall usually start either April or May and ends in October except in the year 2010 were it terminated in September, this simply means that rainfall in Lafia suppose to have an average of 180 days to rain but this research reveals that only an average of 95 days instead of 180 days that is recorded to be the rainy days in Lafia, this implies that about 91 days during the raining season in Lafia is experiencing drought or dry spell. This turns to be potential threat to man's endeavours in the study area. Another implication is that Nigeria food security is been threaten by this climatic effect of the prevalence challenges.

4. Conclusion

The aim of this research was to assess the rainfall characteristics of Lafia. In an attempt to achieve that, the following objectives were used in carrying out the research and were achieved, thus:

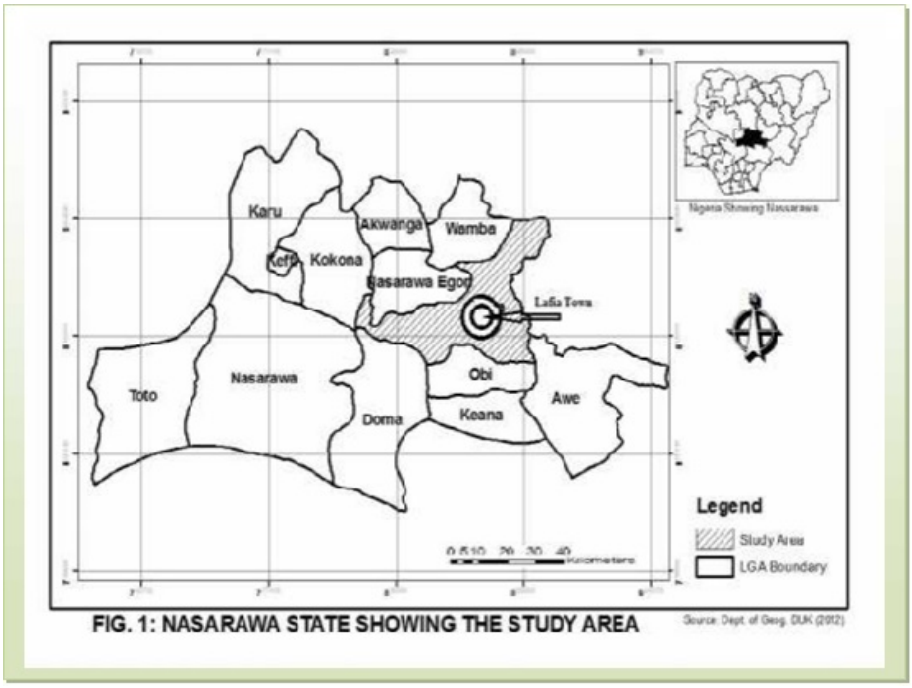

Figure 1. Nasarawa State Showing the Study Area

(a) examination and assessment of rainfall onset, cessation and number of rainy days in Lafia Local Government of Nasarawa State between 2006 and 2016.

(b) examination and discussion on the trend and stability state of Lafia rainfall between 2006 and 2016.

The following under listed issues came out as the major findings of this study:

1. Annual rainfall onsets, cessations and number of rainy days in Lafia Local Government reveal considerable fluctuations of varying extent over time and space.

2. There is a less stable rainfall amount and highly stable number of rainy days in Lafia.

For the purpose of this study meeting up to her objectives through policy formulation and proper implementation the following recommendations were made:

1. Government, community base organizations and all other stake holders in the agricultural sector should give priority to improving output per unit area through the provision of crop variety that can resist or withstand the impacts of unstable nature of rainfall amount. This will assist in boosting food crop output and availability in Nigeria since there is an increasing growth of population generally.

2. An educating and sensitization team should be re-enforced by agricultural stakeholders to help educate farmers in understanding how rainfall instability can affects crop output. This will enable farmers to adequately plan in their farming endeavours, as in line with the works of [17].

Finally, other researchers should as a matter of urgency carry out an empirical investigation on the severity of drought and dry spell in Lafia with its impacts to man's endeavours.

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