Effect of late Rainfall Onset and Early Cessation on Farming Activities in Damaturu, Yobe state

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Abstract:

Late onset and early cessation are one of the most globally recognized farming hazards that damages farms products especially the drought prone of Sub-Saharan Africa. Considering that, the study envisaged the effect of late rainfall onset and cessation on farming activities in Damaturu. A systematic random sampling techniques was employed in selecting the study sample area. Krejcie morgan table was further used to determine the 384-sample size that were disseminated in the three selected. Onset and cessation pattern of Damaturu was analyzed using the Illesanmi method (1979ab). Both descriptive and inferential analysis were employed in the analyses of the data. Findings of the study indicated that rainfall onset is usually determine in the month of June to the early month of July with abnormal onset occurring the late month of July. Thus, rainfall ceased in the month ending of September to early October with abnormal cessation ending early September and cessation in Damaturu. The result of the study further explained that the pattern of rainfall in Damaturu over a decade have experienced late onset in 2012,2014 and 2018 whereas early cessation was noticed in the 2013, 2014 and 2019. Considering that, the length of growing season in Damaturu was observed as 125days. Thus, the longest length of growing season over a decade was noticed in 2020 (151 days) whereas the shortest length of growing season was experience in 2013 (105 days). The result of the study reveals that late onset and cessation affect crop production in Damaturu as it reduces crop yield, farm output, increase pest infestation such as grasshopper, beans and maize weevils and caterpillar. Despite the effect of onset and cessation in the study area, farmers are using local adaptation strategies such as early crop planation, used of improved seed varieties, fertilizers and manure. Based on that, the study recommended that establishment of more meteorological station to issue early warning, forecast and signal on late onset and cessation will aid to reduce the impact of climate variability on farming activities in Damaturu

***Keywords* —** Abnormal**, cessation, onset, season, climate, farming**

Introduction

One of the key driven factors of economic growth and development of any nation is Agriculture driven by primary productions that are dependent on rainfall pattern (Audu H.O et al, 2019). Rainfall occupies a central place in agricultural production. It's one of the forms of precipitation that made up an important part of the atmospheric moisture but however, the variability of rainfall onset and cessation has been a global paramount retarding agricultural development especially in the third world countries. (Mosunmola, Samaila, Emmanuel, and Adolphus, 2020).

Nigeria, being an agro-climatic based community, farming schedules including land preparation, crop selection, plantation, and harvest are mostly dependent the onset and cessation of rainfall pattern (Lacombe, 2008). Considering the climatic pattern of northern Nigeria characterized with intermittent duration of rainfall season and a significant variability of onset and cessation, crop production is predominantly rain-fed in the northern part. Over the years, the length of growing season had always been uncertain due to high variability of onset and cessation of the wet season in the region (Adekunle T.O, 2004). Considering rainfall fluctuations and variability, onset of rain is early while in other years it arrives late. This variability has affected the planning and selection and sowing of crop types and varieties difficult in the region (Sobowale, Sajo, and Ayodele, 2016).

Late onset and early cessation are one of the most globally recognized farming hazards that damages farm products (Guenang and Kamga, 2012). They occur when there is significant rainfall deficit that causes hydrological imbalances and affects the land productive systems. Practically they happen in all climatic regions with both high and low mean rainfalls (Um et al. 2017). It also, result in damage to agricultural production as well as to the natural environment and human society (Gidey et al. 2018). According to the Nigerian Meteorological Agency, (2022) define onset as the moment when the available water content of a root zone at the beginning of a cropping season reached 50% whereas cessation is a postulated period when soil moisture availability decreased below 50% requirement of a plant need which are usually observed when rainfall season is transiting to dry winter period (NiMet, 2022).

Furthermore, variability of the onset and cessation of the rainy season have significantly affected socio-economic and development of Nigeria as a nation. It threatens food security and induce hunger and poverty indirectly (Adekunle T.O *et al*, 2005). According to the USAID, (2021), Nigeria, being the populous country in West Africa with more than 182million people, the changes in climate over the decade has posed a significant threat to food security impeding access to basic service and market limiting agricultural activities and livelihood opportunity (USAID,2021). For instance, the erratic and significant delays in rainfall of the country's food production including cereals (maize, millet, soya bean and rice), which form the main staple food in the country. The Nigerian Meteorological Agency explained that onset and cessation of rainfall in Nigeria have indicated clear abnormalities especially between 1971 and the year 2000. The onset of the raining season between 1941 and 1970 was mostly normal except isolated places, but between 1971 and 2000 more than 80% of Nigeria witnessed onset and cessation variability (NiMet, 2015).

However, Damaturu town being a sudano-sahelian community characterized with low amount of rainfall of short period usually 120days -130 days. (NiMet, 2019). Early onset and late cessation have posed significant threat to farmers as its affect most of the agricultural activities from different aspect including plantation, cultivation, crop yield, output and market. Despite the menace of rainfall variability, most of the researches conducted in Damaturu relating to rainfall variability are generalized to environment, health, drought and desertification phenomena. This has been noticed in the studies of Judo N.E, (2018), Na'ibbi (2014), Jajere A. (2010), Mustapha, A, Yusuf M.B & Kazeem K.M (2021) and Aweda and Mustapha, A (2021). Considering the limited gap on literature relating to early onset and late cessation of rainfall on crop production. This research will bridge the knowledge gap relating to rainfall variability and its effect on farming activities in Damaturu.

Material and Method

Study Area

Damaturu town is situated in the eastern part of Yobe state, located between latitude 11^0 39' 30'' – 11^0 47' 00'' N and longitude 11^0 54' 00'' – 12^0 02' 00''E. It's the headquarter of Damaturu Local government and state capital of Yobe state which served as a nodal town connecting different regions of the state and Maiduguri, Borno state. The town cover a total land area of 2366 km^2 with an average elevation of about 456m above mean sea level (Jajere, Musa and Ismail. 2014).

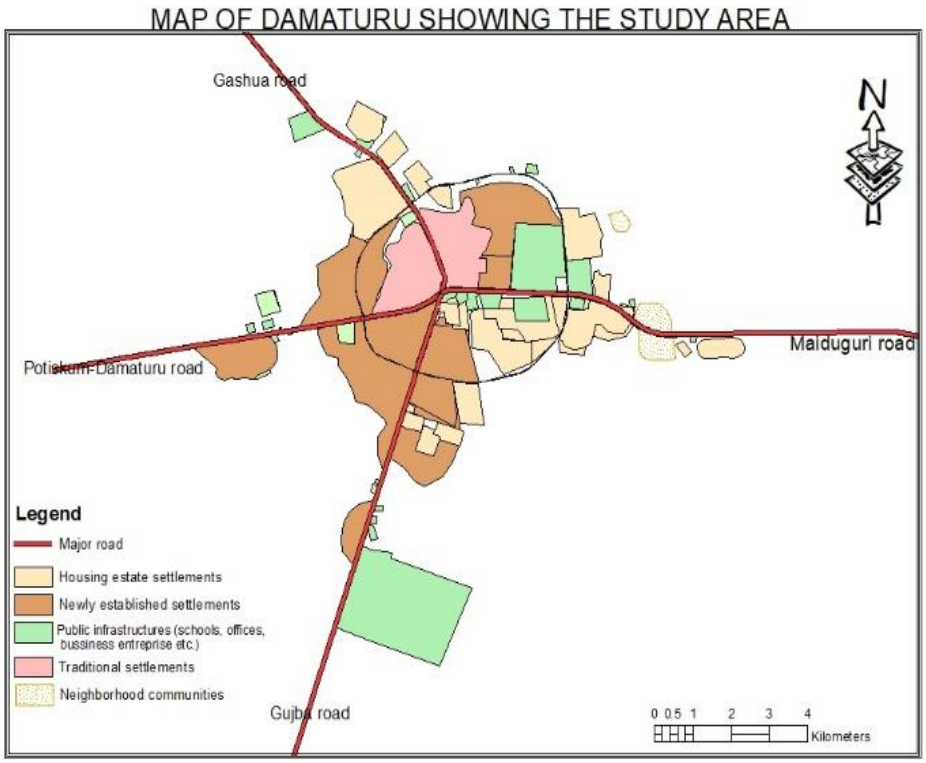

Fig. I. Study Area Map

Climate

Damaturu and its neighbouring towns are located in the Sudano sahelean transitional climatic belts of northern Nigeria. The climate is influenced by two major trade winds: the warm moist south-west maritime trade winds during the rainy season (June–October) and the north-east continental trade winds during the dry and dusty Harmattan season (November–April) period (United Nations Human Settlements Programme, 2012). This has led to the different seasonal pattern experienced which have an influence on the rate at which different diseases spread. Temperatures are generally high, ranging between 32^0C to 40^0C. Minimum temperature are mostly experienced between August and December and maximum temperatures between January to July. Annual rainfall averages about 700 millimeters per annum (NiMet 2016). Rainfall season starts from June and ceased in October. Relative humidity is generally high during the rainy season and low during the dry hot season of April, between 70 to 80 percent. The highest figures are experienced during the wet season and the lowest during the dry season (NiMet, 2019).

Soil and vegetation

The soil texture of Damaturu is manly sandy in nature typically of the semi-arid regions. It is porous and contains a lot of air space with high alkaline content. This gave rise to its whitish color; the soil also plays an important role in the development of Damaturu. The soil is drive from a drift material which vary in textural characteristics, mainly silt, sandy clay and clayey. The profile of the soil is poorly developed, and it has low water retention capacity. The productivity of the soil is greatly impaired due to lack of adequate vegetation cover to supply organic matters. Wind erosion poses a serious threat to the quality of the soil in the active area of the north. It has been observed that the windblown fine soil material particle has nutrients essential for plant growth. Alluvial soil is also found in Damaturu which are suitable for the cultivation of crops. The vegetation in the other hand is said to be closely related to the environmental factors such as soil, climate, and human interference. The area falls within the Sudan vegetation line; in this area found a belt of wood land dominated species of trees particularly of the *Conbretacial* family. *Acacia* species *Azadarichta Indica, Khaya Senegalensis,* there is also a large scale of distribution of *Adasonia digitata* and *Tamarindus Indica* (Nnadi, 2016).

Type and Source of Data

The study adopted two sources of data that include primary source and secondary source. The primary data sources obtained for the study includes the first-hand data obtain from the household through questionnaires administration. The secondary data source include data that were collected from secondary sources that comprises monthly record of rainfall from 2011 to 2020 from Desert Research, Monitoring and Control and Centre (DRMCC) in Yobe State University and Global Weather Data for SWAT were obtained for Damaturu town. To determine the sample size from the study population, Krejcie and Morgan formula of determining sample size of a population was adopted:

Krejcie and Morgan (1970) used the following formula to determine sample size:

$$n = \frac{x^2 \times N \times P(1-P)}{\left(ME^2 \times (N-1)\right) + (x^2 \times P \times (1-P)}$$

Where:

n = Sample size

x^2=Chi-square value for specified confidence level at 1 Degree of freedom

N= Population size

P= Population proportion at 0.5

ME=Desired margin error (degree of accuracy express as proportion (0.5))

Using this formula above, Damaturu with a population of 124,500 (2010 projection) and a density of about 51.62/Km^2. At confidence level of 95% and margin error of 0.5, the sample size of the study calculated as 384

Sampling Techniques

Systematic random sampling technique was adopted in the research. In selection of the residential sample unit, the study area was divided into systematically using the house numbering in each of the district. Out of the eleven wards of Damaturu, three wards were selected using random dummy codes assigned to each word. The selected ward includes Ajiyari, Nassarawa and Maisandari wards. (See table 3.2). Furthermore, household respondents in each of the selected wards were

chosen at the ration of 1:5 household (that is one household will be selected after skipping five household). 384 questionnaires were disseminated to the respondents in the study area proportionally based on the population distribution of each district.

Method of Determining onset and cessation dates

Data was analyzed to determine the mean rainfall onset and cessation dates. The method employed is that proposed by Ilesanmi (1972ab) which determined onset and cessation date using the cumulative percentage mean rainfall method. The method is one of the most widely adopted and is preferred to other methods of determining rainfall onset and retreat dates because it is mathematically elegant, efficient, and is free of assumptions of rainfall threshold values (Olaniran, 1983). Odekunle (2004) has also argued in favour of this method by pointing out that it is a more direct approach relying on rainfall data alone rather than the mere inferential methods based on some rainfall related factors. The basic procedures of the method include:

a. Derivation of the percentage of mean annual rainfall that occurs at each 5-day interval;
b. Cumulation of the computed percentage at 5-day intervals;
c. Plotting the cumulative percentage at 5-day
d. Intervals through the year; and
e. Identification of the time of rainfall onset and cessation.

The point of first maximum positive curvature and last maximum negative curvature on the graph of the cumulative percentage are respectively, the mean periods of rainfall onset and retreat. Alternatively, onset of the rains would be the timing of an accumulated 7 to 8 percent of the annual rainfall, and the cessation commences after the accumulation of 90 percent of the annual rainfall (Ilesanmi, 1972a).

In this study, the second method is adopted – onset and cessation periods were identified as when 7 to 8 percent and 90 percent of the accumulated annual rainfall are attained, respectively. The respective mean proportions were employed to estimate the rainfall onset and retreat dates for each year.

Result and Discussion

The research effect of onset and cessation on farming activities in Damaturu has clearly indicated that fluctuation in pattern of rainfall onset and cessation have a significant effect on farming activities as it determined the length growing season of a plant.

Damaturu town being a sudano sahelean zone, the spatiotemporal variability of temperature and rainfall indicate a significant fluctuation (fig. 4.1). These are characterised with short duration of wet season from June to September with an annual rainfall amount of less than 500mm and short length of growing season of averagely 150days annually. The rainfall pattern of Damaturu from 2011 to 2020 indicates a significant fluctuation that ranges from mean monthly rainfall amount of 322mm to 0.04mm. Thus, the highest amount of rainfall that is usually experience during the rainy season are mostly in the month of August whereas the lowest rainfall amount is mostly observed during the onset or cessation of the rainfall of the rainfall season (i.e. June and October). Over the decade, the highest mean monthly rainfall recorded in Damaturu was in August 2017, with more than 300mm of rainfall experience in the month of the year whereas the lowest mean monthly rainfall experienced over the decade was in May, 2012 with less than 4.2mm of rainfall observed

in the month (fig.4.2). The peak amount of rainfall observed in 2019 was is in line with Nigerian Meteorological Seasonal rainfall prediction of the year that stated a forecasted of high amount of rainfall in the year which are associated with flood vulnerability across farmlands in the country especially in the northern part of country (NiMet, 2019.

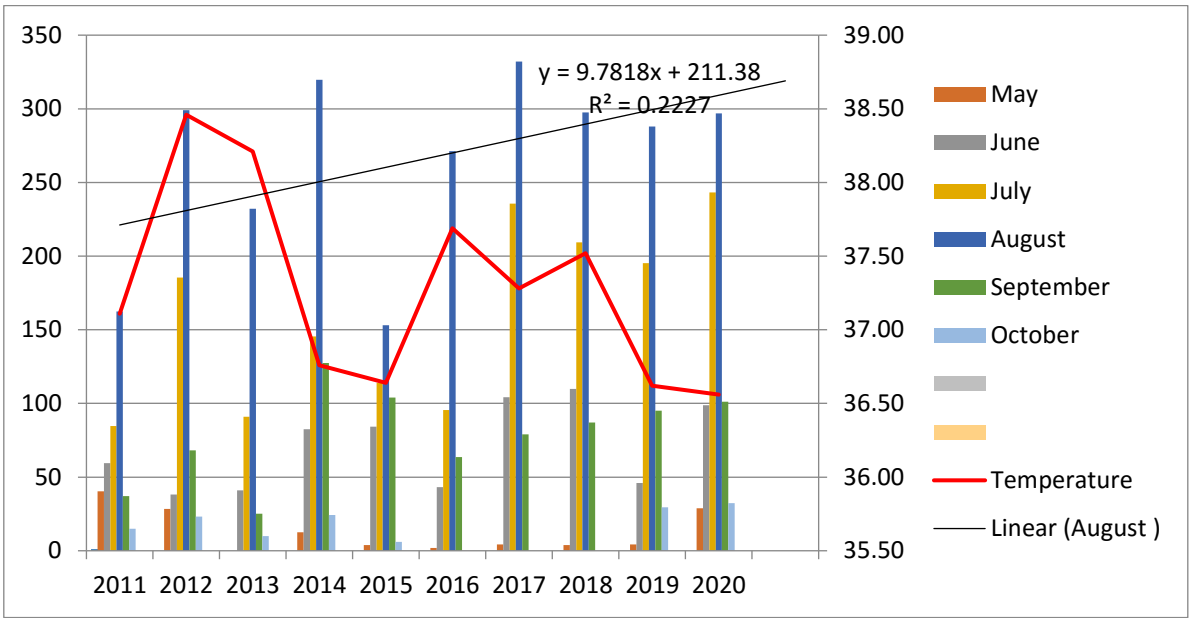

Fig. 4.1

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Table 4.1 Onset and cessation date of rainfall of Damaturu from 2011 to 2020

Years	Onset Date	(5days interval)	Cessation Date	Cumulative %	Length of Growing Season.
2011	28th May	10%	22nd September	90%	118
2012	5th June	6%	23rd October	90%	140
2013	7th June	10%	20th September	96%	105
2014	1st May	12%	20th September	91%	142
2015	23rd May	18%	27th September	92%	127
2016	14th June	9%	12th October	90%	130
2017	11th June	14%	26th September	90%	107
2018	22nd May	16%	14th September	94%	115
2019	11th June	7%	10th October	92%	119
2020	28th July	12%	22nd October	90%	151

Furthermore, the pattern of onset and cessation of rainfall trend in Damaturu reveal a significant fluctuation and variability. In Damaturu, onset is usually determined in the month of June to early month of July with abnormal onset phenomena occurring in the late month of July. Whereas cessation pattern of rainfall in Damaturu reveals that rainfall ceased in the month of ending September to early October, whereas as abnormal cessation usually extends to October ending.

Onset and cessation pattern, being one of the key determinants that plays a significant role in understand the length of growth of crops, farm yield output and infestation has indicated a significant changes, based on table.4.1 using Illesanmi model of predicting onset and cessation, Late onset was in the year 2012, 2014 and 2018 whereas early cessation was experienced in the year 2013, 2014 and 2018 in Damaturu. Considering the fluctuation of onset and cessation, the decadal average length of growing season in Damaturu was observed to be 125days (4 months) year. Thus, the longest period of growing season over the decade was observed in 2020 where rainfall season exist for the period of 151 days (4.8 months) whereas the shortest period of growing season was observed in 2013 with about 105 days (3.38 months) in the year.

Table 4.3 Climate requirement of the identified crop in Damaturu

Variable	Rainfall requirement	Temperature Requirement	Length of growing season
Millet	450-650mm	26-29^{0}C	70-90
Sorghum	450-650mm	27-30^{0}C	90-120
Groundnut	450-1250mm	30-35^{0}C	90-110
Maize	500-800mm	20-23^{0}C	80-110
Cowpea	188mm	20-35^{0}C	80
Beans	350-500mm	18-24^{0}C	65

Source: FAO, 2020

Considering the rainfall pattern of Damaturu over the decade, the study reveals that early onset and late cessation of crop have affected crop production from different aspect in the study area. For instance, Fig.2 indicated that beans, groundnut and sorghum are among the major type crop cultivated in Damaturu. Early cessation and late onset have affected crop production in Damaturu as it reduces crop yield, farm output increase infestation. But hence, spread of disease and pest infestation is one of the major factors that affect farmers in relation to onset and cessation.

Farmlands during the farming season, changes in pattern of rainfall leads to spread crop pest and diseases such as bean and maize weevils, caterpillar, grasshopper among others in the study area are mostly associated with the early cessation. The early cessation proliferates the infestation of farm crops due to the reasons that rainfall ceased before the maturity of crops and certain type of pest are usually incubated at the end of raining season, for that reason, crop plants are significantly affected by such infestation. This is in accordance with the research of Sobowale, (2016) which stated that Climate change has affected rainfall distribution across Sub Saharan Africa (SSA), as there is either less or more rainfall than the farmers have been accustomed to, the amount of rainfall for a given period can no longer be predicted accurately. Consequently, farmers are bound to suffer heavy losses due to either inadequate or excessive rainfall.

Despite the effect of cessation and onset pattern of rainfall, the study reveals that farmers in the community are using local adaptation strategies to reduce the menace of onset and cessation of rainfall pattern in Damaturu. Some of the adopting strategies includes early plantation of crops at the early onset periods, use of improved varieties of seeds such as hybrid seeds of beans, maize and groundnut with a smaller number of growing lengths as compared to the normal seeds, use of improved fertilizers and manure to hastened the growth of farm crops, also limiting farm tillage and other local method are mostly use to limit the effect of onset and cessation on crop production in Damaturu.

In conclusion, onset and cessation pattern of rainfall is one of the one of the key elements that plays a significant role in determined crop production. Rainfall has been the most critical fact responsible for crop production in the Nigeria. This is because water availability for crop production is dependent on the seasonal patterns of rainfall onset, cessation, amount and distribution. It's the most critical agro-meteorological factors of agricultural production, Also the importance of rainfall indices with the statement that rainfall onset and cessation dates can determine the agricultural practices of farmers, especially with a reliable prediction of rainfall onset and cessation times, and the thus the length of the growing season will greatly assist on time preparation of farmlands mobilization of seed/crop, manpower and equipment which will reduce the risk involve in it. If the desired food security must be achieved, then appropriate measures must be implemented to enhance irrigation of crops that will suite the small holder farming commonly practiced in the region and to increase the length of growing season.

Based on this, the study recommended the followings; -

i. More meteorological units should be established within each ecological zone to capture localized cases of climatic variation so as to facilitate generation of climatic data for long term planning and growth of crops.
ii. Frequent and timely information of climatic fluctuations should be communicated to farmers for necessary adjustment.
iii. Farmers should be made aware of the danger of their socio-economic activities that leads to climate change and variability.

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