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DETERMINATION OF ONSET OF THE FARMING SEASON OF MAIZE IN UYO LOCAL GOVERNMENT AREA, AKWA IBOM STATE

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ABSTRACT: *The study was conducted to determine the Onset of Farming Season in Uyo Local Government Area. The study analyzed the annual rainfall trend in Uyo from 2004 - 2023, investigated the trend in temperature within the study period, determined the onset of rain in the study area as well as the cessation date of rain in the study area. Daily rainfall and monthly temperature data were collected from the University of Uyo weather station from 2004 – 2023 for the study. The data were analyzed using descriptive and inferential statistics. Results showed that mean annual minimum rainfall was 3095.3 mm obtained in 2023 while annual maximum rainfall amount was 4594.82 mm obtained in 2022. The mean annual rainfall in the area within the study period was 3868.91 ± 428.96 mm. The variability of annual and mean rainfall within this study period was 11.09 %. The annual trend of rainfall showed an increasing trend at an annual rate of 41.53 with R^2 of 32.81 % while the annual trend of temperature showed a decreasing trend at an annual rate of 0.045 and R^2 of 19.19 %. The results also showed that rainfall commences in Uyo between 62 and 112 Julian days with a mean of 77.6 ± 12.9 Julian days. The coefficient of variability was 16.6 % which showed that yearly onset period differs moderately in Uyo. Similarly, rainfall ceases in the area between 264 and 355 Julian days with mean of 309.6 ± 34.2 Julian days for the individual years between 2004 and 2023. The coefficient of variability was 11.0 % which shows that yearly retreat periods in Uyo differ slightly. The minimum length of growing season in Uyo was between 173 and 293 Julian days with a mean of 234.5 ± 35.1 Julian days. This implies that the majority of the period had long rain which suggests that farmers can successfully grow a second short maize crop. It was recommended among others that the farming calendar for maize should be reviewed to identify new planting dates for farmers in every new season.*

KEYWORDS: Farming season calendar, Annual rainfall, Trend, Julian days, Cessation date.

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INTRODUCTION

Climate change is one of the greatest contemporary environmental challenges and is global in dimension. The rising incidence of extreme climatic events associated with climate change are developing concern that has raised researchers' interest in finding mitigation measures. The Intergovernmental Panel on Climate Change (IPPC, 2012) defined climate change as statistically significant variations in climate that persist for an extended period, typically decades or longer. It includes shifts in the frequency and magnitude of sporadic weather events as well as the slow continuous rise in global mean surface temperature. Change in climate, either negative or positive, has a direct influence on the environment and human activities globally and locally. Poor agricultural yields, food insecurity (famine), flooding, and even death are some of the catastrophic impacts of drastic climate change (IPCC, 2012). According to Usoh *et al.* (2017), crop production depends mainly on the relationship between soil, water and climate; a high level of water availability and soil with nutrients together with conducive climate usually ensures an optimal crop yield. Nta *et al.* (2017) noted that various forms of solid waste generated have destroyed most water bodies as well as affecting agricultural productivity. According to Usoh (2023), the composition of solid waste generated varies greatly and contains dissolved and suspended materials and depends on the type and age of the waste. Ahuchaogu *et al.* (2022) posited that lack of appropriate water conservation measures has also led to degradation of natural resources like water which is a very important element in crop yield while Udom *et al.* (2023) observed that pig waste contains excessive nutrient that can negatively affect aquatic environments and in a long run also hindered crop yield. Experts agree that climate change threat is a serious set-back to development efforts, placing least developed countries and sub-Sahara African countries that are already vulnerable, in a more precarious position (Wolfe *et al.*, 2005; IPCC, 2012). It has thus become the most important topical development policy and global governance issue in the 21st century. Climate change has become the biggest global challenge, raising issues in terms of crop development and yield through rising temperatures and uneven rainfall events, leading to threats regarding food security for the growing population.

The onset of rainfall can be described as the possible start of rainfall in a year, whereas the cessation is a period that is characterized by the end of rainfall in a year. A number of researchers have defined the onset of the rainy season. For example, according to Zhang *et al.* (2002), the start of rain is the first occurrence of any specified rainfall amount (20 mm) in 1 or 2 consecutive days with no dry spell of 10 days or more within the next 30 days; Kipkorir *et al.* (2004), in modeling daily rainfall sequence for farm operations planning in Ibadan (Nigeria), defined the start of rain as the first 10 day period with a minimum cumulative rainfall of 20 mm followed by a dry spell of less than 10 days; Omotosho *et al.* (2000) modified the definition for the onset of rainy season as the beginning of the first 10-day period with cumulative rainfall of 20 mm, above one of which is 10 mm, or above, followed by another two 10-day period each with 50% or more of the minimum decadal crop water requirement. The minimum decadal crop water requirements for the Nigerian southern region (coast to 8°N), the middle belt (8°N to 11°N), and the northernmost (11°N to the northern border) are 3, 4 to 5, and 6 mm, respectively. Nnoli (1996) defined the cessation of the rainy season as any day (after 1 September) that was the last day of rain or any day after which there existed a dry spell of 20 days or more. Omotosho *et al.* (2000) defined cessation of rainfall as any day from 1 September after which there are 21 or more consecutive days of rainfall less than 50% of the decadal crop requirement.

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The presence of a relationship between the onset and cessation dates and between the length of the season and the onset and/or cessation dates is also very relevant for planning activities in the season. Sivakumar (1993) carried out an analysis of long-term daily rainfall data for 58 locations in the southern Sahelian and Sudanian climatic zones of West Africa. The study showed that a significant relationship exists between the onset of rains and the length of the growing season. Oladipo and Kyari (1993) investigated the fluctuation in the onset, cessation and length of the growing season in Northern Nigeria and reported also that the length of the growing season is more sensitive to the onset of the rain than to the cessation. Reliable prediction of rainfall characteristics, especially the onset, is needed to determine a less risky planting date or planting method, or sowing of less risky types/varieties of crops in responsive farming (Stewart, 1991). The ability to estimate effectively the actual start of the season therefore becomes vital. This is why the study is conducted to determine the onset and cessation of the rainy season in Uyo, Akwa Ibom State. The specific objectives of the study were as follows:

i. to examine the annual rainfall trend in the study area;

ii. to examine the temperature pattern in the study area;

iii.to determine the onset and cessation dates of rain in the study area; and

iv to determine the length of growing season in the study area

METHODOLOGY

Study Area

The study was conducted in Uyo Local Government Area, Akwa Ibom State. Uyo Local Government was created as a district between 1900 and 1906. Uyo was given the status of an urban center and a third class town in 1919. In 1950, it became Uyo District Headquarters comprising six other Local Government Areas. Uyo Local Government as it is known and called today came into existence in 1976 during nationwide Local Government Areas in Southeastern States. Uyo became one of the twelve, afterward, seventeen and then nineteen (12, 17 and 19) Local Government Areas in Cross River State. On 23rd September 1987 precisely, when Akwa Ibom State was created, Uyo was chosen as the State Capital. Today, this town is one of the thirty-one (31) Local Government Areas of Akwa Ibom State, and also the State capital.

The area lies between latitude 4º30' and 5º30' north and longitude 7º30' and 8º30' east. This is within the tropical rainforest belt with evergreen foliage of trees, shrubs, and oil palm trees. Uyo shares boundaries with Etinan, Nsit Ibom, Nsit Atai, Ibesikpo Asutan, Itu, and Uruan Local Government Areas (Uyo Local Government Handbook, 2008). Uyo has two climatic conditions: the dry season caused by dry continental north-east trade winds, prevalent between November and late march; and the rainy season from March to October, with July and September as months with the heaviest rains. Uyo, the seat of government/capital of Akwa Ibom State has a large population and comprises four (4) clans, namely: Offot, Oku, Ikono Ibom and Etoi clans.

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Data Collection

The data collected for this study were daily rainfall and monthly temperature. The data were sourced from the Nigerian Meteorological Services, University of Uyo. The data were collected at one synoptic meteorological station in Uyo between 2004 and 2023.

Percentage Mean Cumulative Rainfall

The proponents of the method of percentage cumulative mean rainfall for determining rainfall onset and retreat dates include Ilesanmi (1992), Rao *et al.* (2007), Adejuwon (2008) and Adejuwon *et al.* (2009). The first essential step of this method is to derive the mean annual rainfall that occurs at each 5-day interval of the year. This was followed by computing the percentage of the mean annual rainfall that occurs at each of the 5-day intervals throughout the year. The next step involves cumulating the percentages of the 5-day periods. Finally, the cumulative percentage was plotted against time through the year. The first point of maximum positive curvature of the graph corresponds to the time of rainfall onset, while the last point of maximum negative curvature corresponds to the rainfall retreat. These points of maximum curvature which correspond to the onset and retreat of rainfall were respectively 7–8 percent and over 90 percent of the annual rainfall. In this study, the graphical method was used to determine the mean proportion, which was then used to estimate the rainfall onset and retreat dates for each year.

Rainy Days

A first step in the use of this method was to define the threshold value of rainfall amount required for a day to be counted as rainy. The Nigerian Meteorological Services, Oshodi, Lagos usually employs two thresholds 0.3 mm or 1 mm. However, several thresholds have been investigated by Adefolalu (2010) and 0.85 mm was found appropriate for agricultural purposes in West Africa. Therefore, a threshold value of 0.85 mm was employed in this study. This implies that all days with rainfall below this threshold value were not included as rainy days.

Techniques of Data Analysis

Data collected were analyzed using descriptive and inferential statistics. The descriptive statistics includes percentages, maps, tables, charts and other graphical illustrations and representation such as trend lines.

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RESULTS AND DISCUSSION

Seasonal and Annual Rainfall Pattern in Uyo

Figure 1 shows the mean monthly rainfall in Uyo from 2004 - 2023. The average minimum rainfall within this study period ranged from 0 mm in January to 390.4 mm in June, average maximum rainfall varied from 55.5 mm in January to 1062.4 mm in June while average mean rainfall was between 6.70 ± 13.16 mm in January and 694.22 ± 200.14 mm in June. The standard deviation (Sd) values for all the months are > 1 indicating high degree of variability of monthly rainfall from one

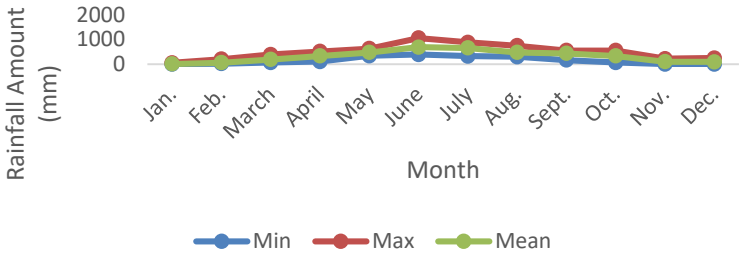

Figure 1: Monthly rainfall pattern in Uyo

year to another. The result showed that the highest rainfall month in terms of rainfall in Uyo was June. Mean annual minimum rainfall was 3095.3 mm obtained in 2023 while annual maximum rainfall amount was 4594.82 mm obtained in 2022. The mean annual rainfall in the area within the study period was 3868.91 ± 428.96 mm. The variability of annual and average annual rainfall within this study period was 11.09 %. Implication of this variability is that the yearly rainfall amount in Uyo over the years was not the same. Such variability may influence onset periods and agricultural activities. Pattern of mean seasonal rainfall amount in the area reveals two peaks otherwise referred to as double maxima. The first peak occurred in June while the other peak was obtained in September. This pattern reflected the general rainfall pattern of Akwa Ibom State as reported by Stephen *et al.* (2005) that Akwa Ibom State has bimodal rainfall pattern.

Inter-annual rainfall variability in Figure 2 clearly showed that the period between 2004 and 2016 was characterized by a decreasing rainfall amount in Uyo while the period between 2017 and 2022 recorded an increasing rainfall pattern. The greatest decrease was obtained in 2015 with 773.6 mm below normal, followed by 2008 with 496.7 mm below normal while 2011 had the least (84.8 mm below normal). Similarly, the greatest increase was obtained in 2022 with 725.9 mm rainfall above normal followed by 2018 with 717.6 mm while 2017 had the least increase in rainfall amount (27.9 mm). Below normal rainfall patterns indicated rainfall deficit (drought) which could lead to crop failure and economic loss among farmers due to heat stress. Similarly, above normal rainfall implies rainfall surplus where flooding could occur leading to environmental hazard. Hence, increasing rainfall in recent times was an indication of climate change even on the local scale.

Annual rainfall trend in the study area is as presented in Figure 3. The annual trend of rainfall showed an increasing trend at an annual rate of 41.53 with R^2 of 32.81 %. This indicates that

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time variability in rainfall was significant in the study area. The trend obtained is in line with the opinion of IPCC (2012).

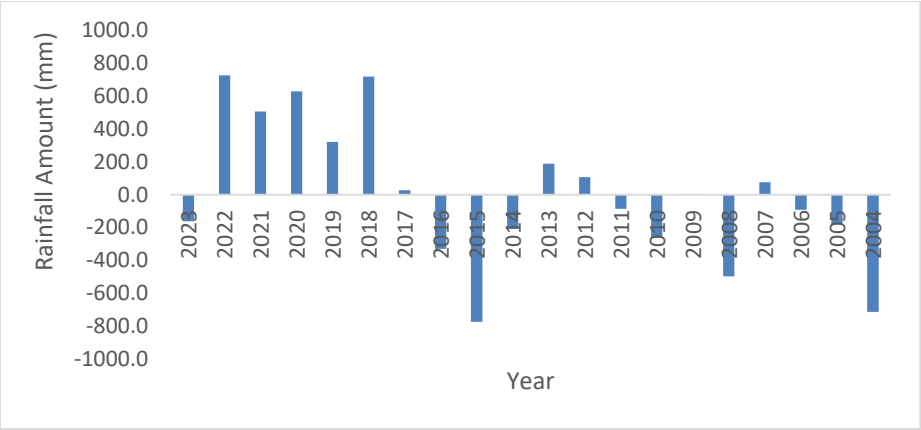

Figure 2: Inter-annual rainfall variability in Uyo

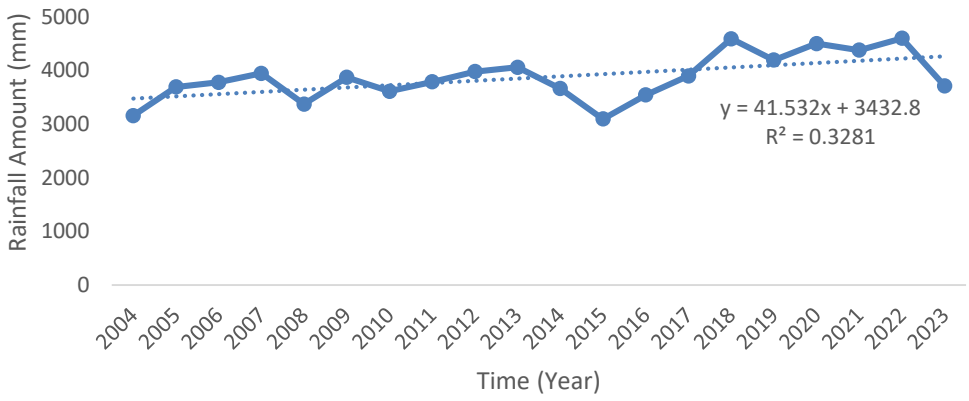

Figure 3: Trend of Total Annual rainfall in Uyo from 2004 – 2023

Seasonal and annual temperature pattern in Uyo

Results for temperature variability in the study area are as shown in Figures 4. Results showed that the maximum temperature in Uyo ranged from 25.08 ºC in August to 28.31 ºC in February with a mean of 26.75 ± 0.98 ºC. Generally, time variability of temperature in the study was very low. Specifically, the seasonal maximum temperature in Uyo showed a Cv of 3.68 %. The mean monthly temperature clearly showed that dry season temperature was significantly higher than the wet season temperature in the study area. Annual trend of maximum temperature (Figure 4.5) showed decreasing trend at annual rate of 0.045 and R^2 of 19.19 %.

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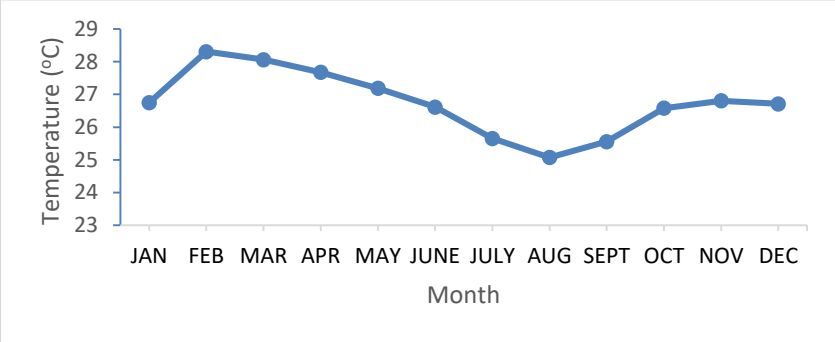

Figure 4: Seasonal temperature profile in the study area

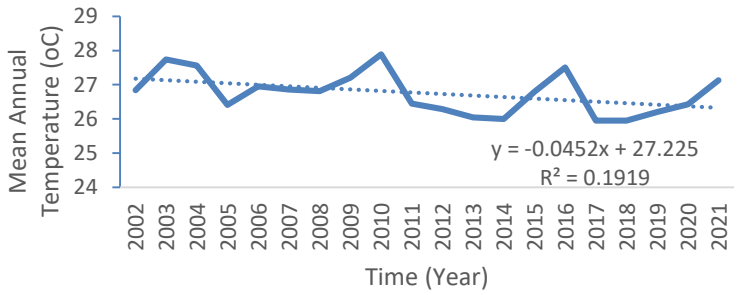

Figure 5: Trend of Maximum temperature in Uyo from 2002 – 2021

Determination of Onset and Retreat Dates in Uyo

Given the establishment of thresholds of 0.3 mm or 1 mm as rainy days by IPCC (2010) and several thresholds established by others like 0.85 mm by Adefolalu (2010) for agricultural purposes in West Africa. Days with rainfall less than 1 mm were not considered as rainy days in this study. From the cumulative percentage plotted against time of the year (Figure 6), the first point of maximum positive curvature of the graph corresponds to the time of rainfall onset, while the last point of maximum negative curvature corresponds to the rainfall retreat. These points of maximum curvature which correspond to the onset of rainfall accounted for 2.1 – 8.1 % of the annual rainfall while the maximum curvature which correspond to the retreat of rainfall accounted for 87.9 – 97.7 % of the annual rainfall in the study area.

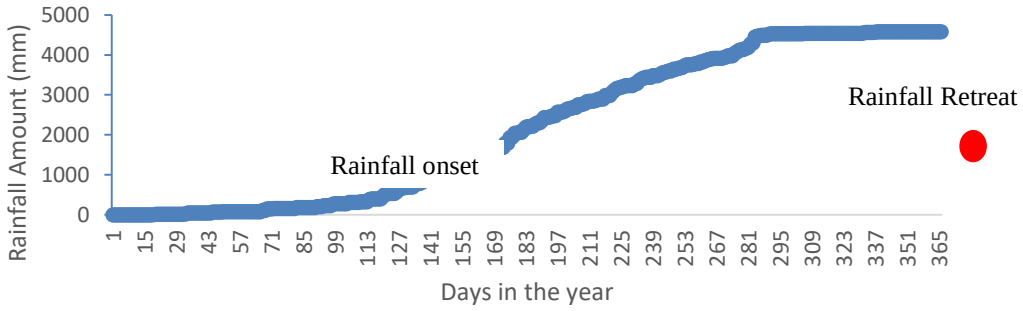

Figure 6: Determination of onset and retreat dates in Uyo

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Onset Dates in Uyo between 2004 and 2023

Figure 7 shows the rainfall onset dates obtained using rainfall for individual years between 2004 and 2023 in Uyo. The results showed that rainfall commences in Uyo between 62 and 112 Julian days with mean of 77.6 ± 12.9 Julian days for the individual years between 2004 and 2023. The coefficient of variability was 16.6 %. which shows that the yearly onset period differs moderately in Uyo. The least onset date was 62 Julian days occurring in 2012 while the highest onset date was 112 Julian days occurring in 2012. The 62nd day of the year coincides with 3rd March (first week of March) while 112th day coincides with 22nd April (Fourth week of April). The mean of 77.6 (78 Julian days) which is the normal onset period coincides with 19th March (Third week of March). This suggests that rainfall begins between the first week of March and the fourth week of April in Uyo. The results showed that rainfall can either start early, occur normal or it comes late in respective years in the study area. From the study, rainfall occurring below 78 Julian days is early onset period, those occurring on the 78 Julian days or

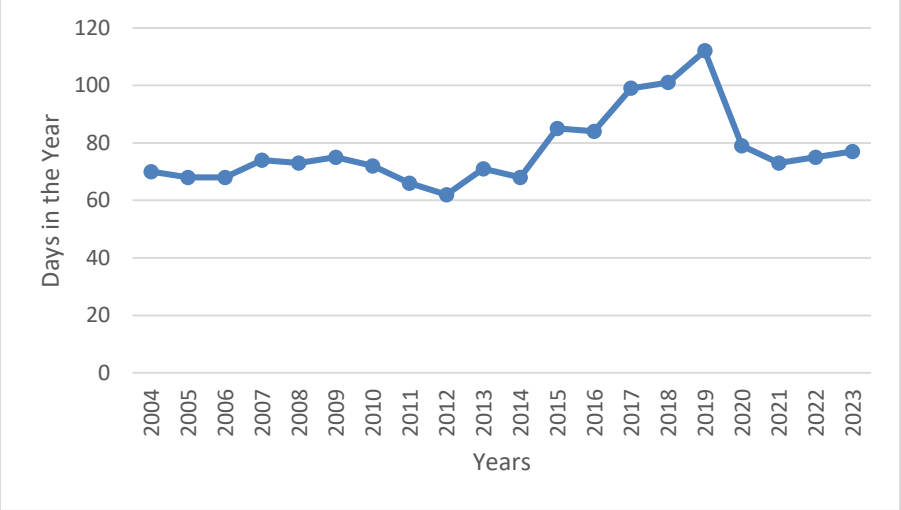

Figure 7: Yearly onset rainfall dates in Uyo

the third week of March is considered a normal start while those that start above 78 Julian days are considered late in the study area. Figure 8 shows the distribution of early, normal and late onset period in Uyo within 2004 and 2023. Most of the years (55 %) had early onset, 25 % had late onset while 20 % had normal onset.

Considering the onset rainfall amount, Figure 9 shows the least onset rainfall 78.5 mm occurring in 2011 while the highest onset rainfall was 279.6 mm occurring in 2018. The mean onset rainfall was 175.95 ± 58 mm. The results showed that there was a positive correlation between rainfall amount and onset dates. The positive relationship implies that rainfall amount increases as onset dates increase and vice versa.

Retreat Dates in Uyo between 2004 and 2023

The cessation of rainfall is a period that is characterized by the end of rainfall in a year. This also means the scanty few days of rainfall which may occasionally occur. Figure 10 shows the rainfall retreat dates in Uyo between 2004 and 2023. The results showed that rainfall ends in Uyo between 264 and 355 Julian days with a mean of 309.6 ± 34.2 Julian days for the individual years between 2004 and 2023. The coefficient of variability is 11.0 % which shows that the

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yearly retreat period in Uyo differs slightly. The least retreat date was 284 Julian days occurring in 2006 while the highest retreat date was 355 Julian days occurring in 2012. The mean retreat date was 309.6 ± 34.2 mm with coefficient of variability of 11 %. The 284th day of the year is the 9th day of October (second week of October) while 355 days coincide with the 18th day of December (third week of December). The mean of 309.6 (310 Julian days) which is the normal retreat period coincides with

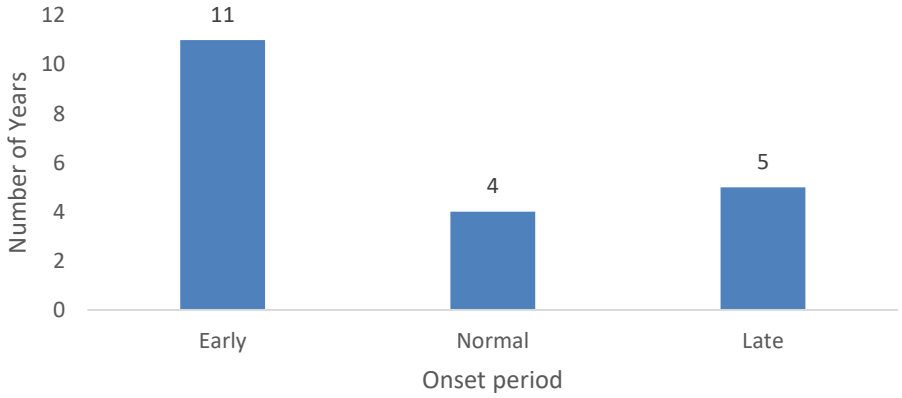

Figure 8: Distribution of Early, Normal and Late onset of rain in Uyo

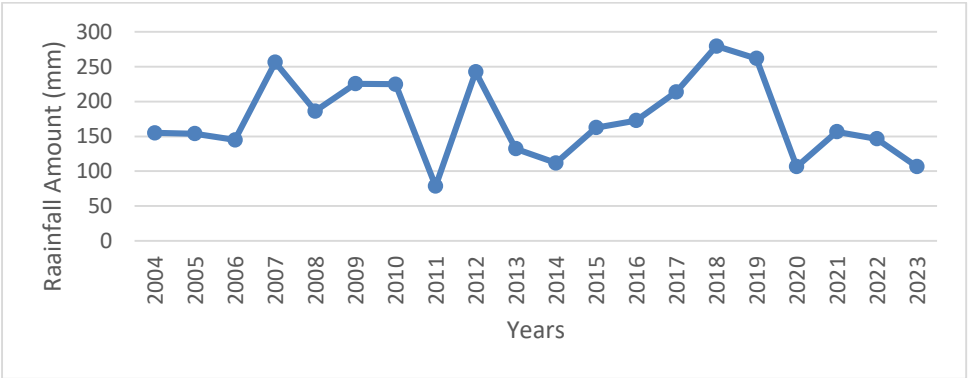

Figure 9: Onset Rainfall Amount in the study area

the 4th day of December (first week of December). This indicates that rainfall ends in Uyo in October and December. The results showed that rainfall can either end early, normal or late in the study area. From the study, rainfall occurring below 310 Julian days is an early retreat period, those occurring on the 300 - 315 Julian days is considered as normal retreat while those that end above 315 Julian days are considered late in the study area.

Figure 10 shows the distribution of early, normal and late cessation period of rain in Uyo within 2004 and 2023. Most of the years (55 %) had early retreat, 10 % had normal retreat dates while 35 % had late retreat. Early retreat 2004 – 2010 and 2018 - 2013 while late retreat was obtained in 2011 - 2017. Figure 11 shows the cessation of rainfall in Uyo. The least retreat rainfall was 2866.6 mm occurring in 2004 while the highest retreat rainfall was 4530.82 mm occurring in 2022. The mean cessation rainfall is 3743.99 ± 458.8 mm. The result shows that there is a negative correlation between rainfall amount and retreat dates. The negative relationship implies that rainfall decreases as retreat dates increase and vice versa.

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The precise onset and cessation dates as well as the amount and the distribution of rainfall each year are usually some of the needs of agriculturists to ensure that they realize a bumper harvest of crops. The information is strongly dependent on the unique characteristics of high seasonal, monthly, and daily variability in its moisture content and the vertical depth. Therefore, the onset, cessation dates, and length of rainy/growing season as well as the amount and the distribution of rainfall each year could show high variability in subsequent years. Result obtained in this study agrees with Omotosho *et al.* (2013) who reported that variation of onset dates of the rainy season at any station could be up to 70 days from one year to another.

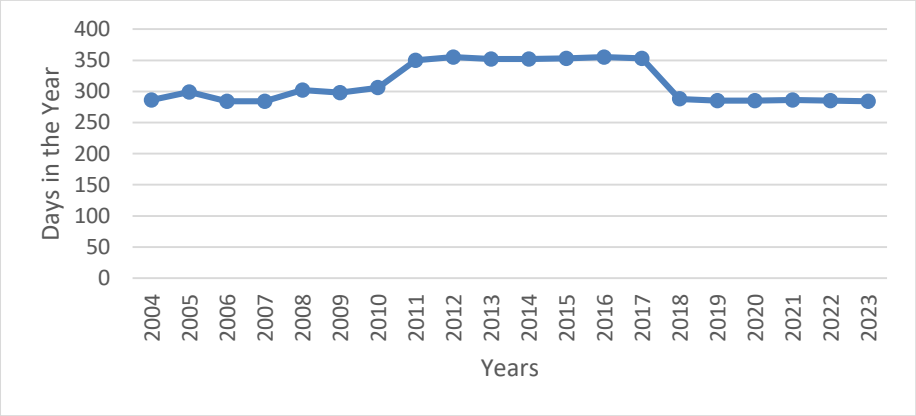

Figure 10: Rainfall retreat date in Uyo between 2004 and 2023

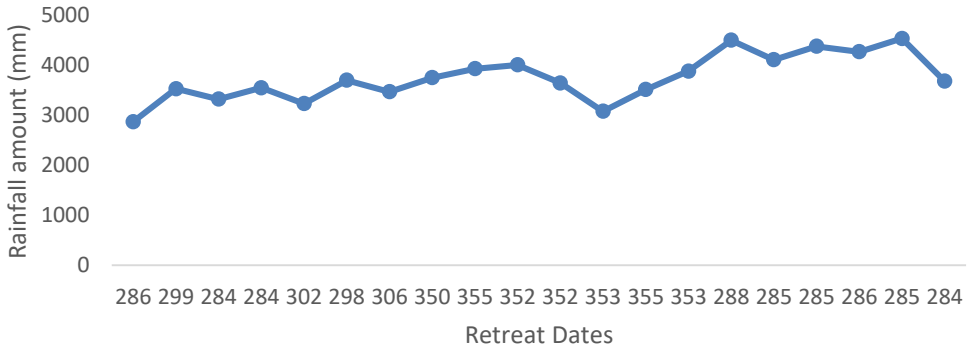

Figure 4.11: Cessation rainfall amount in Uyo

Length of Growing Season in Uyo

Length of growing season was determined from the difference between onset dates and retreat dates and is as shown in Figure 12. The minimum length of growing season in Uyo is between 173 and 293 Julian Days with a mean of 234.5 ± 35.1 Julian days. Rainfall is the most important single meteorological parameter that conditions agriculture as it provides the water necessary for the functioning of the soil-plant-atmosphere-system. Results for analysis of the length of growing season indicate that out of the 20-year period that only 2 years had short rain. This implies that the majority of the period had long rain which implies that farmers can successfully grow a second short maize crop. The length of the growing seasons for Uyo range from 173 days (5.7 months) to 293 days (9.8 months), which are sufficient for a second maize crop.

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Rainfall regulates the flow of sap through the plant and the elaboration of the dry matter, which can be harvested as products. In addition to a general characterization of agro-ecological zones, based on average rainfall, potential evapotranspiration, and water balance, the variability of rainfall is extremely important, as it is mainly responsible for wide fluctuations in agricultural production. This is particularly of a serious concern in developing nations which do not yet have the mechanism to obviate serious food crises. Regular rainfall measurement is also an essential requirement in many aspects of agriculture, forestry, industry, education, and other activities. Rainfall is rarely uniform in intensity or duration across a wide area, so continuous data on local conditions are of particular importance to farmers and those concerned with irrigation, scientists researching crop performance and soil erosion and to water and river authorities in respect of reservoir supplies and ground water feeding into rivers.

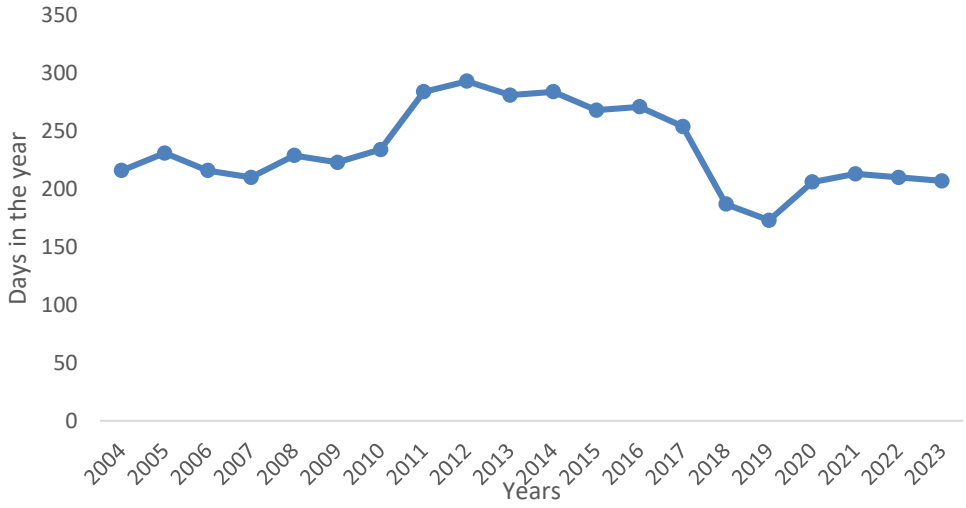

Figure 12: Length of Growing season in Uyo

CONCLUSION

The study was conducted on determining the Onset of Farming Season in Uyo Local Government Area. The study analyzed the annual rainfall trend in Uyo from 2004 - 2023, investigated the trend in temperature within the study period, determined the onset and cessation dates of rain in the study area and determined the length of the growing season of maize in Uyo. Daily rainfall and monthly temperature were pulled from the University of Uyo weather station from 2004 – 20023 for the study. The data were analyzed using descriptive and inferential statistics. Results showed that mean annual minimum rainfall was 3095.3 mm obtained in 2023 while annual maximum rainfall amount was 4594.82 mm obtained in 2022. The mean annual rainfall in the area within the study period was 3868.91 ± 428.96 mm. The variability of annual and mean rainfall within this study period is 11.09 %. Inter-annual rainfall variability clearly showed that the period between 2004 and 2016 was characterized by a decreasing rainfall amount while the period between 2017 and 2022 recorded an increasing rainfall pattern. The annual trend of rainfall showed an increased trend at an annual rate of 41.53% with R^2 of 32.81 %. This indicates that time variability in rainfall is significant in the study area. Annual temperature showed a decreasing trend at an annual rate of 0.045 and R^2 of 19.19 %. The results showed that rainfall commences in Uyo between 62 and 112 Julian days

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with a mean of 77.6 ± 12.9 Julian days. The coefficient of variability was 16.6 % which showed that yearly onset period differs moderately in Uyo. Similarly, rainfall ceases in Uyo between 264 and 355 Julian days with a mean of 309.6 ± 34.2 Julian days for the individual years between 2004 and 2023. The coefficient of variability was 11.0 % which showed that yearly retreat periods in Uyo differ slightly. The minimum length of growing season in Uyo is between 173 and 293 Julian days with a mean of 234.5 ± 35.1 Julian days. This implies that the majority of the period had long rain which implies that farmers can successfully grow a second short maize crop.

The precise onset and cessation dates as well as the amount and the distribution of rainfall each year are usually some of the needs of agriculturists to ensure that they realize a bumper harvest of crops. The study has shown that climate variability has significant influence on onset and cessation dates of rainfall in the study area. The identified onset and cessation dates and the lengths of the growing season are quite valuable for planning of rain fed agricultural activities. Analysis of onset results indicate that there exists organized progression of rainfall onset within the Uyo region indicating that the South west air mass has influence on the rainy season. Correlation analysis of onset and cessation with rainfall amount indicate that early onset translates to short rains and late cessation, while, early onset translates to a longer length of growing season. This information is very important to farmers in the region in deciding on crop types to be cultivated and on planning sowing dates as a function of observed onset dates.

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