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Abstract

The study examines the effects of climate change on the length of growing season (LGS) in Uyo. Daily rainfall value for a period of 30 years (1977 – 2006) was obtained from the meteorological station of University of Uyo, Uyo Akwa Ibom State. The daily rainfall was then grouped into 5 days intervals known as pentad. The cumulative of the pentads was graphed annually to determine the onset and cessation periods. Results obtained shows that there is a significant increase in the length of the growing season from 1977 to 2006, with the exception of 1981, 1983 and 1987 with 43,42 and 43 pentads respectively. The year 2004 and 2005 which are in the last decade of the study recorded the highest length of growing seasons which is above the base year (1977). The variable nature of the increase was therefore subjected to statistical application of measure of dispersion and central tendency. Findings revealed that the mean LGS for Uyo in days is 235 days with a standard deviation of ±20 days. The daily rainfall data was computed to annual total and 4 years moving average was computed and fitted with a trend line to give the direction of impact of climate change on rainfall in the study area. it was observed from the trend line, the length of growing season was directly affected by the frequency (rainy days) than rainfall amount. Implications of findings were discussed and solutions proffered for the study area.

Keywords: Climate Change, Growing Season, Onset, Cessation, Uyo

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Introduction

Climate is an important factor of agricultural production; therefore, a change in the mean value of climatic elements will equally exert a proportional change in agriculture. Climate change effect on agriculture will differ across the world. Determining how climate change will affect agriculture is complex because varieties of effects are likely to occur. Changes in temperature as well as changes in rainfall patterns and the increase in carbon dioxide levels projected to accompany climate change will have important effects on global agriculture, especially in the tropical region. It is expected that crop production will alter due to these changes in climate and due to extreme weather events and changes in pattern of pest and diseases (Audu, 2010). The suitable land areas for cultivation of key stable crops will undergo geographic shifts in response to climate change. The hydrological growing seasn (HGS) is determine by temperature in temperate areas, while, in the tropics, it is determine by rainfall. For instance, in the city of North Dakota, United States of America, the length of the growing season depends on the first and last day of a based temperature above which plants will grow.

In this study, the length of rainy season (LRS) is defined as the number of days that span between the onset and cessation date of the rains in any cropping season. It defines the number of days within the cropping season in which soil moisture condition is adequate to support health growth of plants and livestock in an area, especially in the tropics (Marengo et al, 2001). Researcher's investigation of the hydrologic growing season is best seen in its significance in crop ecological zonation and optimizing of crop yield. In addition it has been observed that in Nigeria like in many other part of the tropics, the HGS varies not only spatially but also temporally [NIMET, 2008; oguntoyinbo, 1983] On its spatial variation, the length of the rainy season varies between 250 – 290 days in the southern states of Nigeria to 90 – 130 days in the northern extremes especially states such as Borno, Katsina, Kano and Sokoto (NIMET, 2008; Walter, 1968). This no doubt brings about wide difference on the types of crops that are grown in the northern extremes and those favourable to the south. While the south grows those crops with higher crop water requirement and longer life cycle of 120 – 270 days such as maize, cassava and yam, the north with very short hydrological growing season grows grains whose life cycle are often completed between 90 – 120 days (Adefolalu, 1981). This makes it difficult to grow crops that are not acclimatized to the environment whose length of rainy season is either too long for them or is in essence too short for them to do well. This explains why root crops are dominant in the south and grain crops in the north.

Reliable knowledge of the influence of climate change on hydrological growing season or length of growing season is pertinent and critical for good crop yield. Global climate change is a reality, manifesting it self in various forms. Global warming and its attendant effect on precipitation require critical analysis on regional basis. The effects of climate change on various aspect of agriculture have been studied both nationally and internationally (Umar, 2009; Binbol, 2009; Adebayo, 2010 and Houghton et al, 1990). However, the effect of climate change per say on the HGS has received very little attention in the literature, especially Nigeria. The need to fill this gap in knowledge especially from a rainfall endowed region like Uyo forms the main thrust of this paper.

Materials and Method

The study area Uyo is located on latitude 05^0 01N, longitude 07 56 ^{0} E. It lies 60 Meters above sea level. Uyo is located about 60 kilometers from the coast of Atlantic Ocean and administrative capital of Akwa Ibom State dike has a tropical rainy climate classified as Af base on Koppen's climatic classification. The rainfall is of the double maxima regime with a break occurring in August. Mean annual rainfall stands at about 2400mm. Temperatures are generally high with a mean high of about 28 ^{O}C recorded between March/April, while the mean low of about 25 ^{O}C is recorded around August. Temperature range stands at 30^OC for the study area. Relative humidity is equally high with a seasonal variation component. The lowest relative humidity of about 54% is recorded in January and it keeps increasing to about 84% in July. The high relative humidity in the area can be attributed to its proximity to the Atlantic Ocean.

The study made used of daily rainfall data for the period of 30 years (1977 – 2006). A rainy day was adopted after Ayoade (1988) to be a period of 24 hours in which at least 0.2mm of rainfall is received. This choice is appropriate for the region because of its high relative humidity and low rate of evapotranspiration (Audu *et al*, 2006). The data was collected from the University of Uyo meteorological station Uyo. Daily rainfall is particularly suitable for this study because it enable the analysis of onset and cessation period of rainfall. It is this parameter that will be used for the determination of the length of growing season in the study area.

For the determination of onset, cessation and the length of growing season or hydrological growing season of Uyo, a 5 day pentad was used to compute the running sum for each year from 1977 – 2006. The cumulative rainfall associated with each pentad was then calculated and plotted. The major point of 1^{st} and last inflexion automatically constitute the onset and cessation periods. The precise date is determine by considering the first date in the pentad number for onset and the last date in the pentad number for the cessation. This method has been successfully used by Walter (1967) and Olaniran (1984). The research further used the measure of dispersion and central tendency to compute the mean LGS and its standard deviation in days.

Results and Discussion

Analysis of rainfall data for Uyo shows a high level of variability. A ten year decadal mean was calculated for the 30 years period and the result obtained shows a rather U shaped fluctuation. Total annual rainfall was then plotted as shown in figure 3. The variability was also observed to be characterized by extreme high and low values. It therefore became necessary to impose a 4 year moving average on the highly variable data so as to smoothen the extreme values. Results obtained showed 'U' shaped pattern rainfall swing in the study area. A trend line was then auto fitted on the annual variation to determine the direction of rainfall swing in Uyo. The result obtain is presented in figure 3. The trend line shows that rainfall is on the in Uyo area. This clearly supports the work of Ojo (2003) who stated that climate change evidence will reveal increased rainfall in the south with a corresponding decrease in the north. Although Landsberg (1979) in Adebayo (2010) argued that for a definite pronouncement of climate change to be made over any region, there should be unbroken data observation for at least 150 years. This should be equally accompanied by a shift from mean values of observed elements to a new equilibrium. For this study, analysis of a 30 years data (1977 – 2006) constituting a climatic period using the 4 years moving average and trend line shows that rainfall pattern in Uyo is changing towards higher values. This therefore makes it imperative to critically analyze the length of growing season for corresponding changes.

The length of growing season for Uyo was determined via the calculation of onset and cessation dates annually. The period between onset date and cessation date constitute the LGS. The LGS was further divided into 5 days interval with each representing a pentad (period of 5 days). The LGS was then calculated in pentads. In order to determine the length of the LGS in days, the total number of pentads in the given LGS is multiplied by 5.

Result of analysis of length of growing season for Uyo was carried out on annual basis and the result is presented in Table1. The year 1977 is taken as our base year of study; therefore comparison was done with the base year. Results in table 1 shows that in the year 1977, the onset date for Uyo fell on pentad 14th while the cessation fell on pentad 58. The LGS for the year 1977 therefore is 44 pentads which is equivalent to 220 days. This LGS period did not remain stagnant in the study area. Further analysis of Table 1 show that the LGS has been on the increased with a variable nature except for the years 1981, 1983 and 1987 when it drops down to 43, 42, and 43 respectively pentads again. Thereafter, it was a steady increase to the year 2006.

In order to test the reliability of the increasing yet variable nature of the LGS, an inferential statistics was carried out on results generated in Table 1 to determine the mean LGS for the study period and its standard deviation. The result obtain is presented in Table 2. Result in table two shows that for the study period, average LGS for Uyo stands at 235 days with a standard deviation of± 20 days. This implies that the actual LGS in Uyo can be as long as 235 days ±20 days. That is, between 255 days and 215 days.

The LGS depicts a crop ecological zone that will be favourable for crops whose life cycle lies within the lower limit of 215 days to 255 days. Crops with LGS within this range can do better in this zone. Researches have shown that this environment is by far much more suitable for root and tuber crops such as cassava, cocoyam and vegetables than of the grains whose life cycle do not exceed 120 days (Chukwu, 2004). Thus crops such millet and sorghum may not be suitable in this ecological zone. The production and maturity of every crop must be met within its unique optimum crop water requirement. Deviations above or below such limits will lead to decline in yield (Chukwu, 2004).

Conclusion and Recommendations

Significant shift in rainfall pattern has been used to argue for climate change in many regions of the globe. It was observed that total annual rainfall in Uyo has been variable over the past 30 years. The effect of this variability on the length of growing season in the study area was investigated using daily rainfall record. The research was conscious of the double maxima rainfall regime in the study area. Therefore it adopted the cumulative pentad graph in determining the onset and cessation dates for Umudike. Using 1977 as the base year for comparison, it was observed that the length of the hydrological growing season has been on the increase but with a slight variability. Statistical application of measure of variability and central tendency shows that Uyo has a mean HGS of 230 days with a standard deviation of – 20 days. Comparing the HGS for the base year (1977) of 210 days with the mean for the study period (1977 – 2006) of 230 days, the research therefore concludes that the length of growing season is on the increase in Uyo, which could be attributed to climate change. The research also recommends the planting of more water loving crops in the area. This research is not exhaustive as there is the need to carry out similar studies in other location around the region in order to validate the present research findings.

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Table

Table 1: Computed Pentad Onset, Cessation Date and Hydrological Growing Season (HGS) and their deviations in Uyo

Year	Pentad onset	Onset pentad deviation	Pentad cessation	Cessation pentad deviation	Pentad HGS	HGS pentad deviation	Rainfall (mm)
1977	14	3	58	7	44	4	3855.8
1978	14	3	63	2	49	-1	3270.7
1979	14	3	64	1	50	-2	3825.4
1980	15	2	65	0	50	-2	2863.4
1981	21	-4	64	1	43	5	2422.7
1982	16	1	65	0	49	-1	2442.5
1983	22	-5	64	1	42	6	1599.4
1984	18	-1	64	1	46	2	1878.7
1985	15	2	63	2	51	-3	2132.6
1986	15	2	66	-1	47	1	1905.6
1987	17	0	64	1	43	5	2251.7
1988	16	1	63	2	47	1	1915.1
1989	22	-5	62	3	40	8	2631.7
1990	22	-5	66	-1	44	4	2243.7
1991	19	-2	63	2	44	4	2243.7
1992	16	1	66	-3	50	-2	2256.8
1993	17	0	64	-1	47	1	2229.5
1994	21	-4	65	0	44	4	2668.7
1995	16	1	64	1	48	0	2264.4
1996	13	4	63	2	50	-2	2520.7
1997	19	-2	66	-1	47	1	1921.3
1998	18	-1	69	-4	51	-3	2033.8
1999	13	4	67	-2	54	-6	1915.2
2000	17	0	66	-1	49	-1	1840.8
2001	14	3	66	-1	52	-4	2317.2
2002	17	0	65	0	48	0	2331.5
2003	14	3	65	0	51	-3	2194.8
2004	14	3	67	-2	53	-5	2221.6
2005	13	4	66	-1	53	-5	3030.5
2006	15	2	63	2	48	0	
Mean	17		65		48		2387.2
SD	3		2		4		

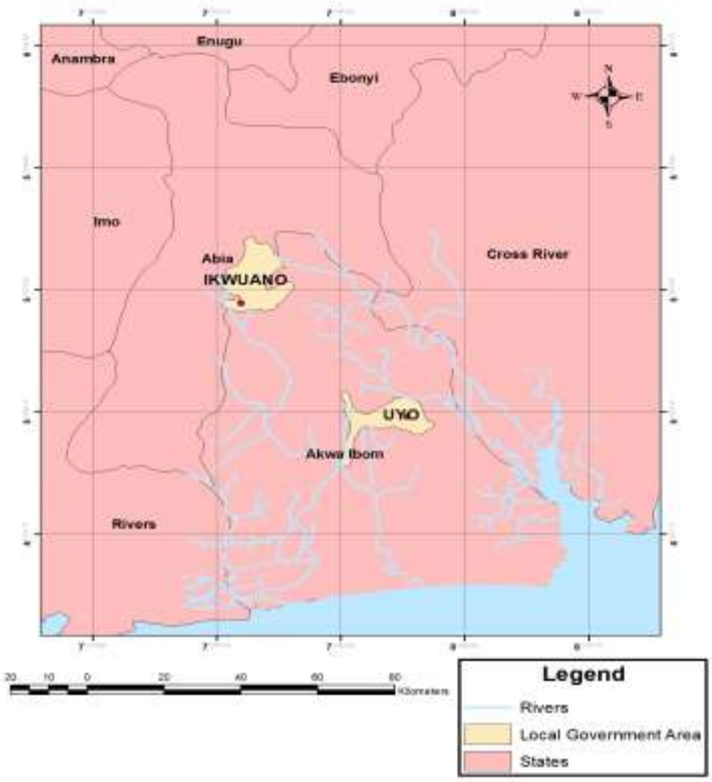

Figure 1: Location of Uyo on map of Akwa Ibom and Abia States

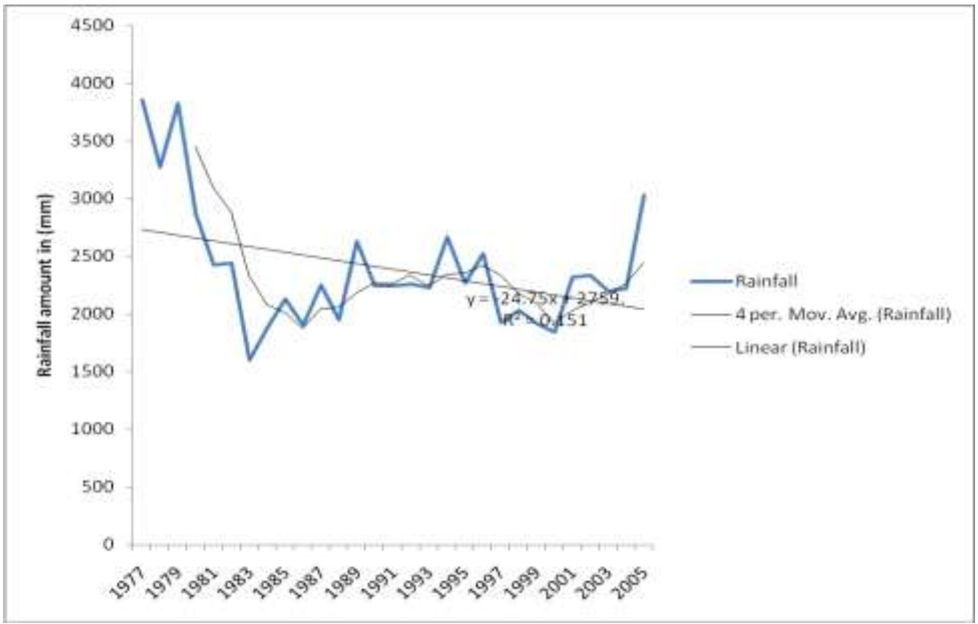

Figure 3: Four years Moving Average and Trend line for Uyo