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DROUGHT CHARACTERISTICS IN THE SAVANNAH REGION OF NIGERIA

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ABSTRACT

Drought impacts both directly and indirectly and it is capable of causing socio – economic and environmental damages. The need to examine drought characteristics therefore forms the main thrust of this paper. Drought characteristics examined in this study include frequency, temporal distribution, duration and severity/magnitude of drought. Monthly rainfall data from 15 stations was obtained from the Nigerian Meteorological Services Department spanning a period of 80 years (1930 – 2010). The Standardized Precipitation Index (SPI) was used to established drought characteristics. Simple descriptive statistics was used to present findings. Result obtain showed that drought frequency seems to increase with increasing latitude. A temporal analysis showed no definite pattern, but was explicit in revealing 1980 – 1989 as the decade with highest frequency of drought occurrence in the studied period in the region. In terms of drought duration, 25% of total drought occurrences accounting for 162 episodes were single year drought events. This is classified as Near Normal (NN) occurrence and therefore harmless to agriculture. In the same vein, protracted back to back droughts stretching up to 10 years also accounted for 15% of total drought in the studied period. Analysis of drought severity/magnitude shows that 72% of occurrences were of magnitude -0.0 to -0.99 while only 3% were classified as extreme drought condition (-2.0 to -3.0). Implications of findings were discussed and suggestions proffered.

KEYWORDS: Drought, Savannah, SPI, Frequency, duration, severity/magnitude

INTRODUCTION

Throughout the course of human history, drought has been a problem affecting our welfare and food security. Droughts are complex natural hazards with multifaceted effects that can cause significant socio – economic and environmental impacts (Lennard *et al*, 2014). Of all human endeavors, agriculture was perhaps the first sector for which humans recognized the strong relationship between crops and weather. In Nigeria, several attempts have been made both at federal and state levels to stabilize agricultural output but yield still remain variable especially in the savanna region due in most cases to the impact of metrological drought (Binbol and Edicha, 2012).

All forms of droughts are initiated by natural climate variability. All droughts originate from a deficiency of precipitation or meteorological drought; therefore, all other forms of drought derive their origin from meteorological drought. Meteorological droughts are first noticed because of their sensitivity to precipitation deviations, especially in terms of amount of precipitation, precipitation intensity and even deviation from timing of precipitation may reduce infiltration capacity and increase runoff. A deviation in meteorological elements observed, especially tending towards higher values is capable of initiating meteorological drought thereby lowering deep percolation and ground water recharge capacity. For example, an increase in temperature and sunshine couple with high wind velocity, lower relative humidity and less cloud cover will definitely lead to an increase in evaporation and transpiration processes. The overall effect of this is lost of soil water moisture. This is overtly translated into plants that are water stressed manifesting reduced yield and biomass production. This is what encapsules agro climatic drought. When these observed conditions persist, the situation may degenerate to the level of hydrological drought. This is characterized by reduced stream flow, inflows to lakes, reservoirs and ponds may even cease. Finally it may be followed by reduced wetlands and wild life habitat. This processes lives in its wake severe impacts covering economic, social and environmental.

In as much as no region of the world can be said to have escaped the wrath of drought of some intensity at some time or other, drought however seems to be more common in the tropics and subtropics of the world. In order to combat drought incidences, proper and timely planning is very essential and this can only be obtained through a critical analysis of meteorological drought characteristics with a view to understanding its nature and scope.

MATERIALS AND METHODS

The Savanna region of Nigeria lies within the geo-coordinates of Latitude 6^0 27'N to 14^0 N and Longitude 2^0 44'E to 14^0 42'E (fig. 1). It constitute a bulk segment of the northern part of Nigeria covering about 730,000 km^2 or about 78% of the total landmass of the country (Oladipo, 1995). The region consists of nineteen states that form the northern part of Nigeria. It is bounded in the North by Niger republic in the east by the Cameroon republic and Benin republic in the west.

The climate in the Savanna region of Nigeria is characterized by two distinct seasons, wet and dry. The duration of each season varies from the south to the extreme north of the Savanna. There, however, seems to be a general increase in the dry season period of 5 months in the southern part of the savanna to about 8 months in the extreme north. Precipitation also decreases northwards; this is because some southern part of the Savanna region enjoys double maxima rainfall, while the Northern part experiences a single maximum regime. Mean annual rainfall in the region ranges between 630.3mm in the Sahel Savanna region, 720.8mm in the Sudan Savanna region and 1,430.1mm in the guinea Savanna region (Oladipo, 1995).

Temperature is generally high in the Savanna region; this is partly due to the fact that the region lies within the topics where the apparent movement of the sun is limited. Secondly, the long period of dry season associated with the region means a clear sky without the moderating influence of cloud. There is however a noticeable spatial variation in temperature within the Savanna region. The highlands and plateau e.g. Jos plateau records mean annual temperature of about 21^0C to 25^0C, while the plain, basin and lowlands generally have mean annual temperature of about 27^0C. There is also a seasonal or temporal variation component to temperature within the Savanna region. The rainy season ushers in low temperature because of the influence of cloud cover and the cooling effect of the rains especially in August when the Savanna regions tend to receive its highest rainfall.

Temperature picks up in September increasing through to November and dropping again in December/January because of the influence of the harmattan winds. The harmattan wind originates across the Sahara deserts. It is a dry dusty, cool wind that develops when the low pressure belt shift to the southern part of the country.

Sunshine pattern for the Savanna region shows a general increase in sunshine hours from the south-northwards. Sunshine hour also varies with seasons in the Savanna region. Sun hours are high in January, averaging 6.2 hours. It decreases gradually from then to a minimum of 3.9 hours in August when the Savanna region records its highest rainfall and cloud formation are more regular.

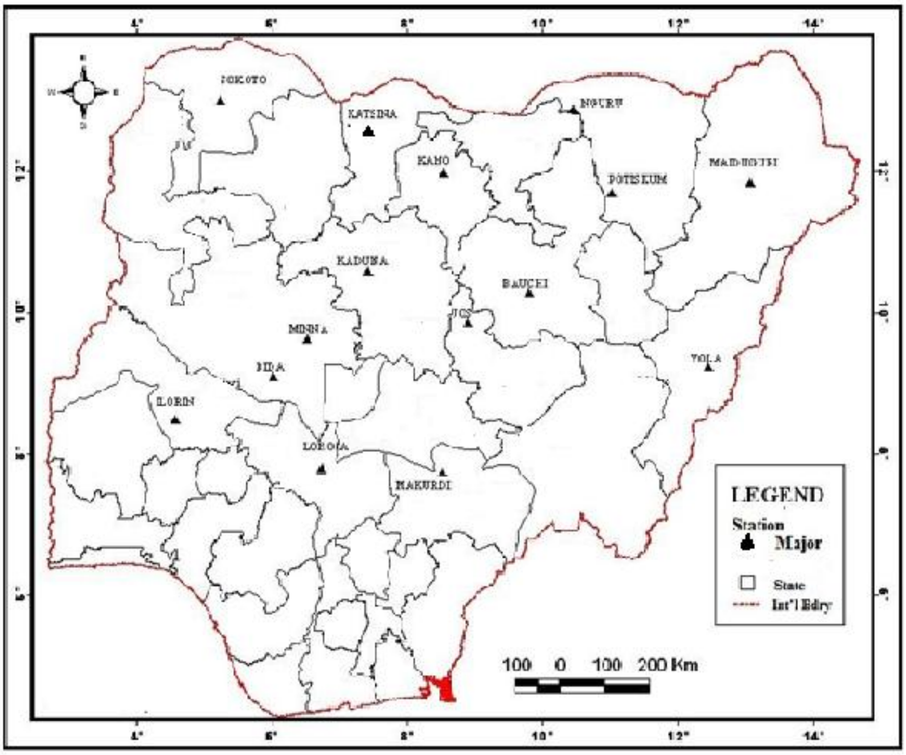

Figure 1: Map of Nigeria showing data collection points

Data Type and Sources

The research made use of secondary data in the form of monthly rainfall recordings for selected stations in the study area. All data were collected for as long a period as consistent records allow. Purposive sampling technique was adopted in selecting data collection points. This technique is necessary so that only stations with relatively long and consistent records were considered. Secondly, station selection was done to ensured maximum spatial coverage of the entire region. In all 15 rainfall stations were used for the study. All data required for this study was obtained from documented records by Akintola (1983) and the headquarters of the Nigerian Meteorological Services Department, Abuja.

Data Analysis

The research adopted SPI 12 In order to accommodate all the precipitation occurring in the year. This technique has been adjudged a good indicator of moisture supply (Wu *et al*, 2004). The SPI is based on statistical probability and was designed to be a spatially invariant indicator of drought. The nature of the SPI allows an analyst to determine the rarity of a drought or an anomalously wet event at a particular time scale for any location in the world that has precipitation records. All negative SPI values were taken to indicate the occurrence of drought, while all positive values show no drought. A table of SPI and cumulative probability presented in tables 1 was used to determine drought intensity. Stations and rainfall duration used are presented in table 2.

Table 1: SPI Values and Interpretation

SPI Value	Interpretation
2.0+	Extremely wet
1.5 to 1.99	Very wet
1.0 to 1.49	Moderately wet
-.99 to .99	Near normal
-1.0 to -1.49	Moderately dry
-1.5 to -1.99	Severely dry
-2.0 and above	Extremely dry

Source: after McKee et al (1995)

The monthly rainfall data for the major stations were entered into an SPI programme via an input file. The SPI 12 output file was used for the analysis of drought characteristics because it accommodates total rainfall for the year. Some of the drought characteristics observed and discussed from the SPI 12 values include; the temporal distribution of meteorological droughts in the savanna region of Nigeria, duration of drought events, its severity/magnitude and the frequency of occurrences of drought class. Simple descriptive statistics was used to present results.

Table 2: List of Stations and Rainfall Duration

S/no	Major stations	Period	Duration
1.	Bauchi	1908 – 2011	104yrs
2.	Bida	1928 – 2011	84yrs
3.	Ilorin	1927 – 2011	85yrs
4.	Jos	1927 – 2011	85yrs
5.	Kaduna	1931 – 2011	81yrs
6.	Kano	1925 – 2011	87yrs
7.	Katsina	1925 – 2011	87yrs
8.	Lokoja	1931 – 2011	81yrs
9.	Maiduguri	1915 – 2011	97yrs
10.	Makurdi	1927 – 2011	85yrs
11.	Minna	1916 – 2011	96yrs
12.	Nguru	1916 – 2011	96yrs
13.	Potiskum	1936 – 2011	76yrs
14.	Sokoto	1915 – 2011	97yrs
15.	Yola	1931 – 2011	81yrs

RESULTS AND DISCUSSION

Temporal Distribution of Meteorological Drought in the Savanna Region of Nigeria

The temporal variation of meteorological drought in the savanna region of Nigeria was done based on the towns' latitudinal positions. Result of the analysis is presented in Table 3. Table 3 shows that the entire region has been recording drought incidences with increasing frequency towards the extreme north. Makurdi station located on latitude 7^0 44'N and longitude 8^0 32'E has the least incidences of 33 drought occurrences within the period of 80 years (1930 to 2010). Nguru station located on latitude 12^0 53' and longitude 10^0 28' has the highest drought frequency of 58 occurrences within the same period. Temporal analysis divided the study period into decadal period (10 years period) and the total drought occurrences for each decade was summed up.

The result presented in Table 3 shows that drought incidences were fewer in 1930s up to the 1950s. The decades 1970 to 1979, 1980 to 1989 and 1990 to 1999 witnessed the highest incidence of drought in the savanna region. This finding agrees with the works of Akeh *et al.,* (2005) who did a drought frequency count for 21 selected stations across the country. They found out that all over Nigeria the decade 1980 to 1989 recorded the highest frequency of drought events. In another development, Fasona and Omotola (2005) in a study involving 22 stations in the Guinea, Sudan and Sahel Savanna noted that on the overall the 1950 to 1959 decade recorded the highest rainfall, while the decade 1980 to 1989 had the least rainfall from the total decadal means.

In order to present a clearer picture of the pattern of drought frequency over the decades, the total drought occurrences for all stations in each decade was summed up and presented in graphical form as shown in Figure 2. The result presented in Figure 2 shows that drought incidences recorded a gradual increase from the 1930 to 1939 decade to a peak period in 1980 to 1989 decade. Thereafter, total drought occurrence started decreasing. The lowest decade with 52 occurrences was the 1930 – 1939 decade, while the highest drought occurrences were recorded in the 1980 to 1989 decade.

Drought Duration in the Savanna Region of Nigeria.

Analysis of drought duration is important in the study of meteorological drought because it helps in the planning of mitigation strategies. Negative SPI values denotes a drought year, therefore the sequential following of negative SPI values back to back determines the duration of that particular drought. Table 4 provides a drought duration result for stations in the savanna region of Nigeria.

Result from Table 4 shows that a total of 651 drought episodes were recorded in the study area for the period under consideration. 162 occurrences were the single year drought which accounted for 25% of the total drought. Drought events occurring back to back and lasting two years occurred 65 times and accounted for 20% of drought duration. There were 32 three years drought stretch event, this accounted for 15% of drought events in the study area. The four years drought stretch occurred 25 times, thereby accounting for 9% of total drought event. The five, six, seven, eight, and nine years drought stretch occurred 6(5%), 2(2%), 4(4%), 3(4%) and 1(1%) respectively. The longest drought duration of ten years stretch occurred 10 times and accounted for 15% of drought occurrences in the savanna region of Nigeria (Table 4). The implication here is that while the savanna region of Nigeria like any other part of the globe is not spared the menace of drought, its nature and type can be said to range from mild and of short duration or rather sporadic to very long and protracted droughts (Binbol *et al*, 2015). The mild type (especially) the single year drought may occur this year and much rainfall will neutralized its effect the next year. Recovery rate in this type of drought incidence is always fast and it leaves no lasting impact.

Table 3: Temporal Variation of Meteorological Drought in the Savanna Region of Nigeria.

S/n	Station/coordinates	1930-39	1940-49	1950-59	1960-69	1970-79	1980-89	1990-99	2000-10	Total
1.	Makurdi (7.44/8.32)	2	4	4	3	4	5	5	6	33
2.	Lokoja (7.47/6.44)	6	8	6	3	4	5	4	4	40
3.	Ilorin (8.29/4.35)	5	7	2	4	7	3	5	3	36
4.	Bida (9.06/6.01)	3	5	6	4	5	7	6	4	40
5.	Yola (9.14/12.28)	5	5	4	4	4	5	3	6	36
6.	Jos (9.52/8.45)	4	1	2	2	3	10	8	9	39
7.	Minna (9.56/6.54)	7	6	5	4	6	10	7	6	51
8.	Bauchi (10.7/9.49)	4	5	5	5	8	9	4	5	45
9.	Kaduna (10.36/7.27)	4	3	5	3	2	6	5	5	33
10	Potiskum (11.42/11.02)	0	5	2	4	7	7	6	9	40
11.	Maiduguri 11.51/13.05)	4	7	3	3	5	8	6	4	40
12.	Kano (12.03/8.12)	2	6	4	6	8	9	3	1	39
13.	Nguru (12.53/10.28)	0	5	6	10	10	10	7	10	58
14.	Sokoto (13.01/5.15)	6	2	4	5	8	9	5	4	43
15.	Katsina (13.02/7.68)	0	6	1	4	7	7	10	4	39
Total		52	75	59	64	88	110	84	80	612

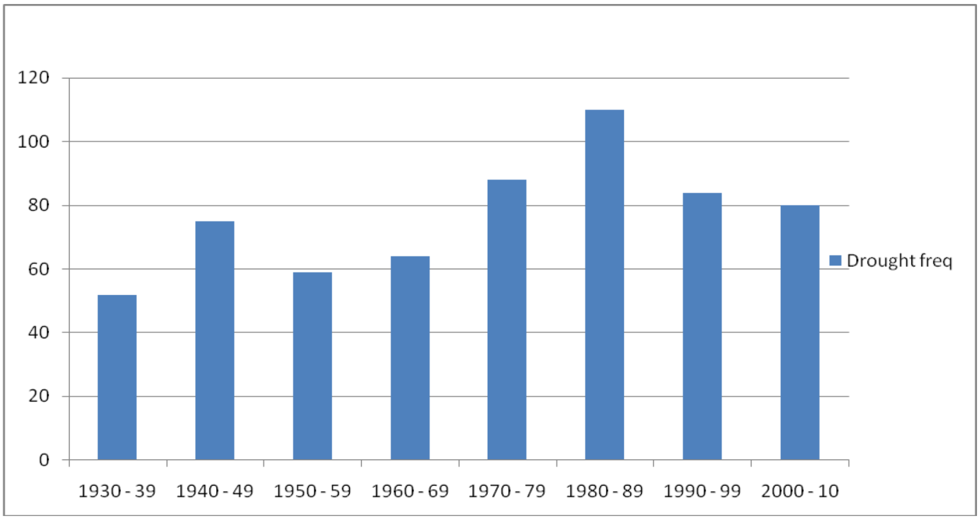

Figure 2: Decadal Total Drought Trend

A clear observation of Table 4 reveal detail information on drought duration and frequency for major stations. It will be noted that Nguru and Katsina have the lowest number of single drought events of 2 and 3 respectively. This means that drought occurrences in these locations are mostly prolonged because of low precipitation and high temperatures. For example, Nguru has the highest 10 year back to back drought occurrences for the study area. Figure 3 gives a detail graphical presentation of drought duration and frequency for stations used in the study.

In order to properly understand and appreciate the effect of drought duration and frequency in any location, the total annual rainfall for the study period for the station was plotted and fitted with a trend line. The trend line helps to show the general direction of rainfall pattern in the station. This can either be towards a rising or decreasing tendency. The trend line for the stations under study are presented along side SPI 12 graph for the locations in Figure 3.

The analysis of drought duration in this study has revealed that while drought is a phenomenon affecting the entire savanna region, its duration differs spatially. The southern (Guinea) savanna has more single (short) duration drought years. This maybe because of the relatively adequate rainfall amount in the area and the prolong number of rain days. This makes recovery from drought event easier, quicker and less stressful. The central (Sudan) savanna is characterized by two and three year's drought stretch events. Here recovery is not easy and impacts are felt much more than in the southern savanna. The northern (Sahel) savanna has the longest incidences of drought. Although there are a few sporadic drought events, most events here last between two to five years at a stretch. In fact, the longest drought duration of ten years at a stretch occurred in this region. In the Sahel, impacts are hard hitting as recovery tendencies are very low. This region from the foregoing analysis seems to be the worst affected by both frequency and duration as shown in Table 4 and Figure 3.

Drought Severity and Magnitude in the Savanna Region of Nigeria

In order to analyze drought severity and magnitude in the savanna region of Nigeria, a critical study of the SPI severity scale as provided in Table 1 was undertaken and the result is presented in Table 5. Analysis of SPI values for Makurdi for the 78 years under study shows that the zone recorded 35 drought events. 22 of these events constituting 63% of drought occurrence measured between 0 to -0.99 on the SPI scale. This means they were near normal events (refer to Table 1), the water shortage associated with the occurrences is quite insignificant so that damages caused by this type of drought event does not create panic. Recovery rate from this type of drought event is quite fast if precipitation situation appreciates upward slightly. This type of drought hardly occurs back to back as the shortage of rainfall in any particular year is easily corrected by normal precipitation the next year (Binbol *et al*, 2014). The next class of drought with magnitude of -1.0 to -1.49 on the SPI scale is classified as moderate drought. Makurdi recorded six incidences constituting 17% of drought events within the study period. In spite of the relatively high rainfall associated with this region, it also recorded drought with severe dry conditions measured on the SPI scale of between -1.5 to -1.99. This type of drought seems to have a connection with the El Niño southern oscillation because of its 10 years cyclic period within the first three decades (1936, 1946 and 1956). It also re-occurred on the same magnitude in 1973 and 1988. However, the worst drought event with magnitude -2.0 to -3.0 on the SPI scale occurred twice in this region, in 1958 and 2003 (Figure. 3(m)). Drought event of this magnitude are associated with extremely dry conditions. The resultant effect is the lost of agricultural output, reduced biomass production and a great reduction in animal quality and quantity.

Table 4: Drought Duration and Frequency for Major Stations in the Study Area

S/n	Station	Period	1yr	2yrs	3yrs	4yrs	5yrs	6yrs	7yrs	8yrs	9yrs	10yrs	Total
1.	Makurdi	1927-2010	13(37%)	5(29%)	4(34)	-	-	-	-	-	-	-	35
2.	Lokoja	1931-2010	10(24%)	6(29%)	1(7%)	2(19.5	-	-	-	1(19.5	-	-	41
3.	Ilorin	1927-2010	7(19%)	5(27%)	5(41%)	-	1(13%)	-	-	-	-	-	37
4.	Bida	1928-2010	11(27%)	5(24%)	5(37%)	-	1(12%)	-	-	-	-	-	41
5.	Yola	1931-2010	9(26%)	5(29%)	4(34%)	1(11%)	-	-	-	-	-	-	35
6.	Jos	1927-2010	8(20%)	2(9.5%)	-	1(9.5%	-	-	1(17%)	1(24%	-	1(24%)	41
7.	Minna	1916-2010	12(24%)	5(20%)	1(6%)	1(8%)	1(10%)	1(12%)	-	-	-	1(20%)	51
8.	Bauchi	1908-2010	16(30%)	7(26%)	2(11%)	2(15%)	-	-	-	-	-	1(18%)	54
9.	Kaduna	1931-2010	14(42%)	6(36%)	1(9%)	1(12%)	-	-	-	-	-	-	33
10	Potiskum	1936-2010	15(36%)	-	1(7%)	2(19%)	-	-	1(17%)	-	1(21%	-	42
11	Maiduguri	1915-2010	16(40%)	-	2(15%)	-	2(25%)	-	-	1(20%	-	-	40
12	Kano	1925-2010	10(24%)	4(19%)	1(7%)	1(10%)	-	-	1(16%)	-	-	1(24%)	42
13	Nguru	1916-2010	2(3%)	1(3%)	2(10%)	2(13%)	1(8%)	-	-	-	-	4(63%)	63
14	Sokoto	1915-2010	13(27%)	10(41%)	-	-	-	1(12%)	-	-	-	1(20%)	49
15	Katsina	1925-2010	4(10%)	2(10%)	3(21%)	2(19%)	-	-	1(17%)	-	-	1(24%)	42
Total			162	130	96	60	30	12	28	24	09	100	651
Percentage			25	20	15	09	05	02	04	04	01	15	100

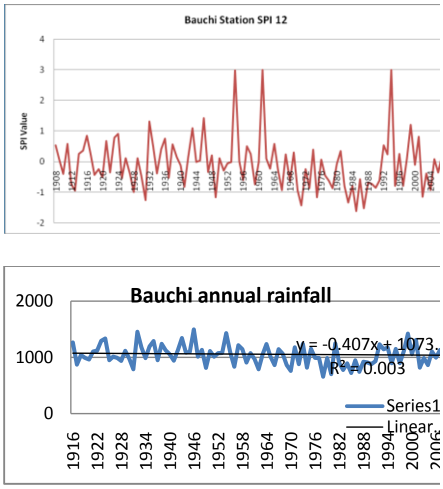

Figure 3(a): SPI 12 graph and annual rainfall with trendline for Bauchi station

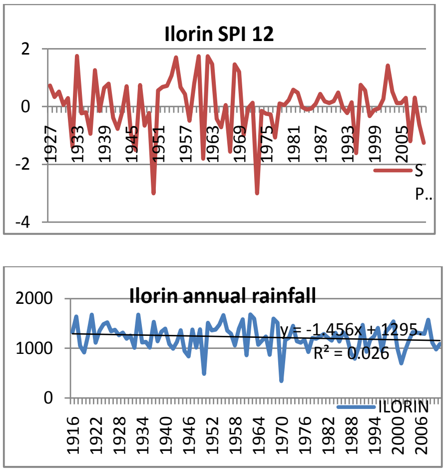

Figure 3(c): SPI 12 graph and annual rainfall with trendline for Ilorin station

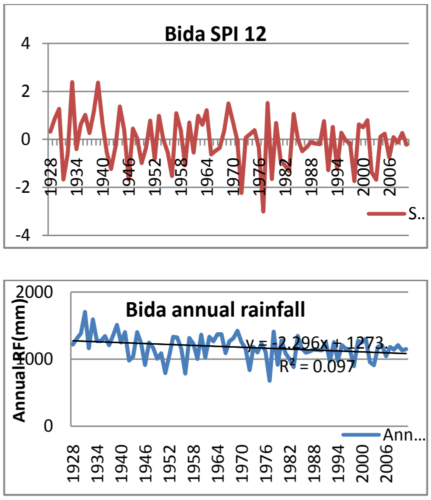

Figure 3(b): SPI 12 graph and annual rainfall with trendline for Bida station

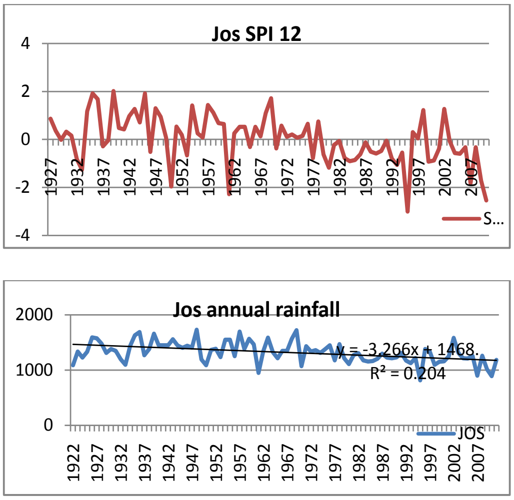

Figure 3(d): SPI 12 graph and annual rainfall with trendline for Jos station

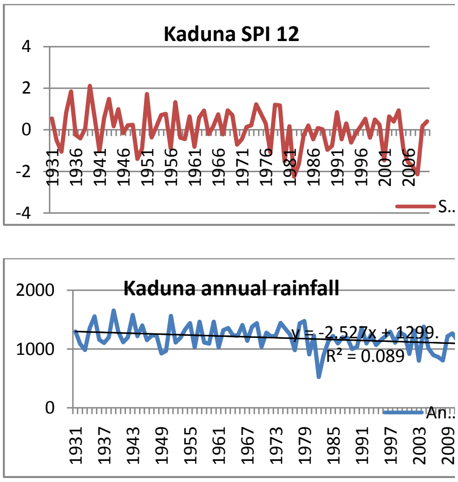

Figure 3(e): SPI 12 graph and annual rainfall with trendline for Kaduna station

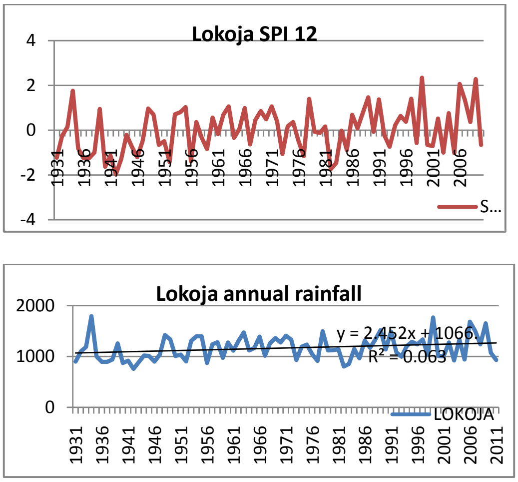

Figure 3(g): SPI 12 graph and annual rainfall with trendline for Lokoja station

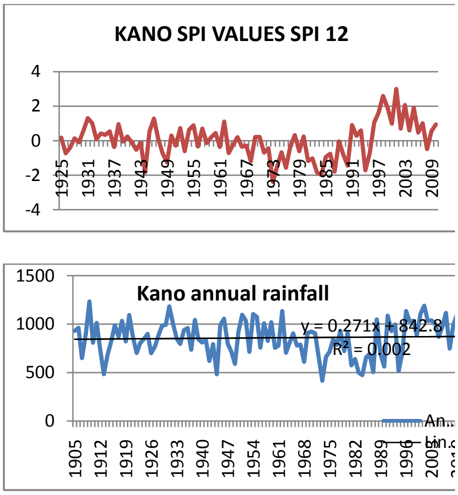

Figure 3(f): SPI 12 graph and annual rainfall with trendline for Kano station

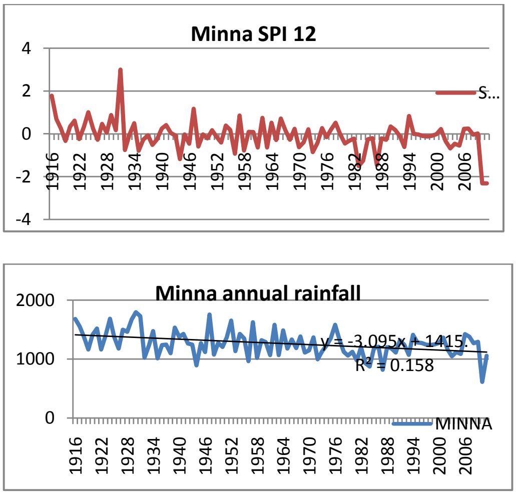

Figure 3(h): SPI 12 graph and annual rainfall with trendline for Minna station

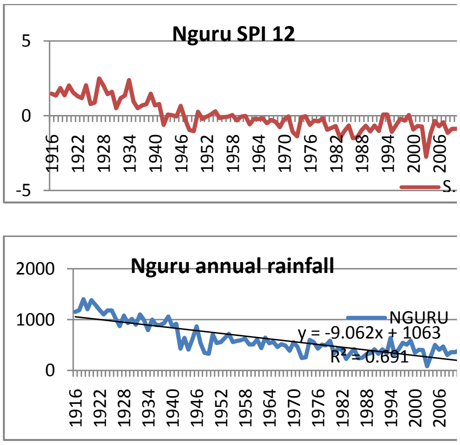

Figure 3(i): SPI 12 graph and annual rainfall with trendline for Nguru station

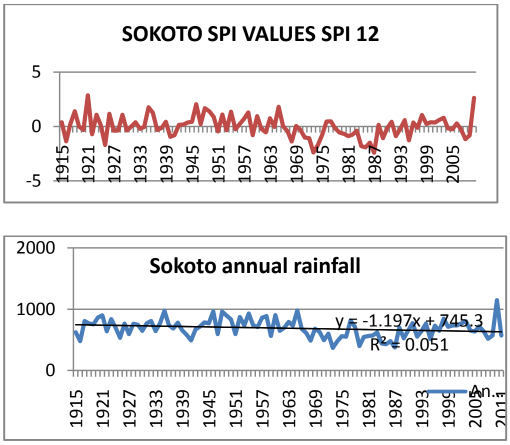

Figure 3(k): SPI 12 graph and annual rainfall with trendline for Sokoto station

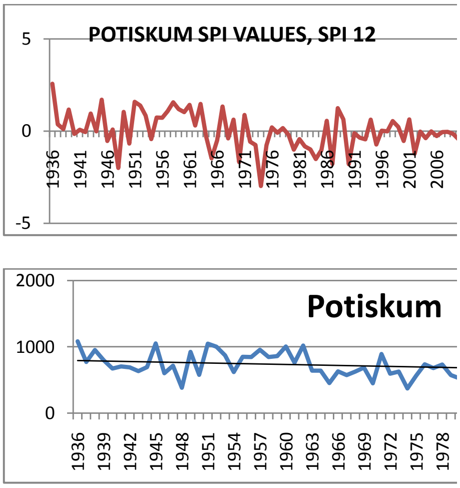

Figure 3(j): SPI 12 graph and annual rainfall with trendline for Potiskum station

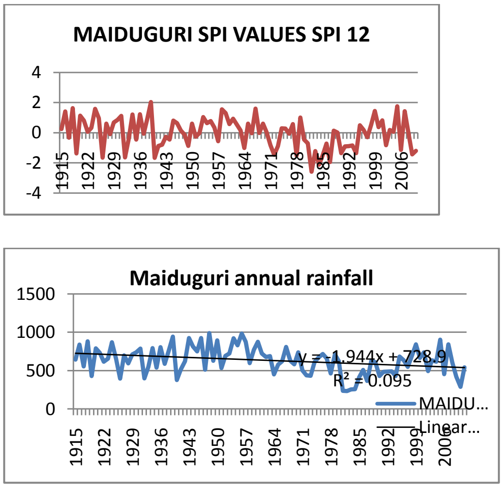

Figure 3(l): SPI 12 graph and annual rainfall with trendline for Maiduguri station

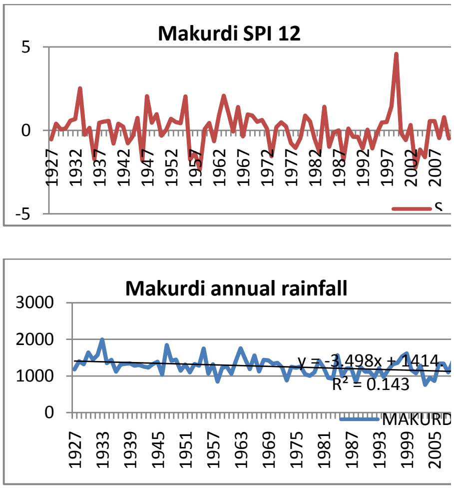

Figure 3(m): SPI 12 graph and annual rainfall with trendline for Makurdi station

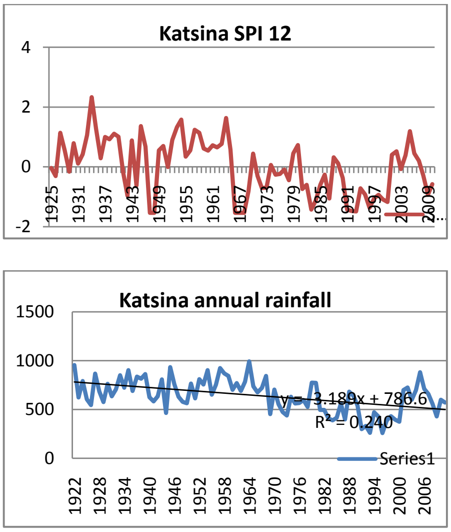

Figure 3(n): SPI 12 graph and annual rainfall with trendline for Katsina station

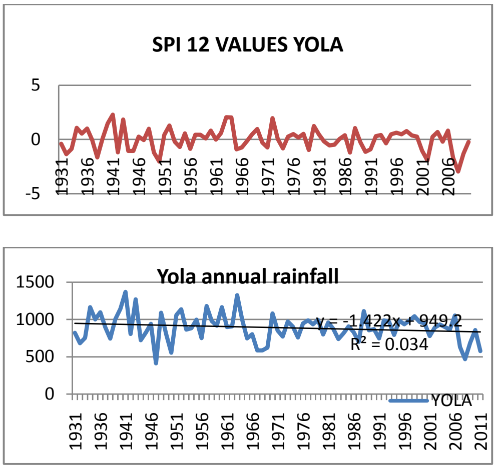

Figure 3(o): SPI 12 graph and annual rainfall with trendline for Yola station

Figure 3 (a – o): SPI graphs and annual rainfall with trendline for major stations in the savanna region of Nigeria.

These types of droughts are known to have caused outright migration and abandonment of farmlands (Appa, 1987). Indirectly, it may lead to change in land used practices and heavy pressure on urban areas thereby putting severe strain on the economy of the region.

Results of the analysis for drought severity and magnitude for Yola representing the Sudan savanna ecological zone is in Table 5. The results shows that out of the 35 drought events recorded within the study period, 23 of them (66%) were mild droughts measuring less than -1.0 on the SPI magnitude scale. The severity nature of droughts of this type is also referred to as near normal situation. Since the drought in question is a deviation of annual precipitation slightly below the mean in the area. This type of drought has little or no effects on agricultural out puts because of their likely time of occurrences.

Table 5: Drought severity and magnitude in the major stations

S/No	Station	-0.0 -0.99	-1.0 -1.49	-1.5 - 1.99	-2.0 -3.0	Total
1.	Makurdi	22(63%)	6(17%)	5(14%)	2(6%)	35
2.	Lokoja	24(59%)	14(34%)	3(7%)	0(0%)	41
3.	Ilorin	28(76%)	4(11%)	3(8%)	2(5%)	37
4.	Bida	26(63%)	7(17%)	6(15%)	2(5%)	41
5.	Yola	23(66%)	8(23%)	3(9%)	1(2%)	35
6.	Jos	32(78%)	4(10%)	3(7%)	2(5%)	41
7.	Minna	46(90%)	3(6%)	1(2%)	1(2%)	51
8.	Bauchi	45(83%)	7(13%)	2(4%)	0(0%)	54
9.	Kaduna	22(67%)	5(15%)	4(12%)	2(6%)	33
10.	Potiskum	32(76%)	5(12%)	4(10%)	1(2%)	42
11.	Maiduguri	28(62%)	10(22%)	5(11%)	2(4%)	45
12.	Kano	29(69%)	6(14%)	6(14%)	1(2%)	42
13.	Nguru	50(79%)	11(17%)	1(2%)	1(2%)	63
14.	Sokoto	35(71%)	7(14%)	5(10%)	2(4%)	49
15.	Katsina	27(67%)	10(24%)	5(12%)	0(0%)	42
Total		469(72%)	107(16%)	56(9%)	19(3%)	651

They may occur as a result of delay rains; however, rainfall during the crop growth stage may not be affected. Moderately dry drought conditions were twice higher in this zone (8, 23%) than the guinea savanna because of its reduced rainfall and rain days (Akeh *et al.*, 2000). Severely dried and extremely dried drought conditions occur in the Sudan savanna with a magnitude of between -1.5 to -2.33 on the SPI scale. The highest in terms of magnitude is the 1950 drought event in this region with a magnitude of -2.33.This may be explained by the fact that, that year was preceded by another drought year (1949), see Figure, 3 (o).

The highest drought magnitude measuring -2.67 on the SPI scale in the entire savanna region was recorded within the Sahel agro ecological zoon as represented by Maiduguri. This occurred in 1982, and because of extremely dry conditions associated with it, recovery was very difficult. It therefore set a chain of drought event series covering 1982 to 1985 of various scale between moderately dry to extremely dry conditions (Figure 3 (l)). There was a slight recovery in 1986 only to relapse into another extremely dry drought condition the next year. On the average it would be noticed that drought events severity and magnitude are highest in this region. This cannot be unconnected to the fact that this region experience very scanty rainfall with fewer rain days (Binbol *et al*, 2014).

CONCLUSION

Droughts are complex natural hazards with multifaceted effects that can cause significant socio-economic and environmental impacts. Droughts are becoming a recurrent feature of the savannah climate. The need to understand meteorological drought goes beyond agricultural planning to water resource perspective. The drought characteristics observed in the present study include frequency, temporal variability, duration, severity and magnitude. Finding shows that drought frequency tends to increase with increasing latitude. This might not be unconnected with higher temperature and reduced precipitation. There was no uniform pattern established with the temporal variability. Drought duration analysis was undertaken because of its importance in the planning of drought mitigation strategies. Near normal droughts were commonly associated with stations around the Guinea Savannah, while stations around the Sahel exhibited prolonged back to back drought of higher severity. On the overall it was observed that single drought episodes had the highest frequency of occurrences. The research therefore concludes that in view of the rising population trend in the region more researches should be geared towards specific drought crop relationship studies. This will enable detection of possible periods of moisture deficiency and such periods can be augmented with additional water supply via irrigation.

REFERENCE

Akeh, LE; Nnoli, N; Gbuyiro, S; Ikehua, F; and Ogunbo, S (2005) Meteorological Early Warning System (EWS) for drought Preparedness and Drought Management in Nigeria. *Drought network news*

Akintola, J. O. (1983) Rainfall Distribution in Nigeria 1892 – 1983. Longman ltd, Ibadan.

Appa, RG (1987) Drought Probability Maps.WMO CAgm No. 24.Tech note no 207.

Binbol, NL and Edicha, JA (2012) Drought Assessment in Yola, Adamawa State, Nigeria. *Katsina Journal of Natural and Applied Sciences.* 2 (2), 1 – 9.

Binbol. NL, Adebayo. AA, Oduwale. HK, Lohor. AA, Gana. JN and Wakayi, TA (2014) A Geo-Locational Analysis of Drought Severity/Magnitude in the Savannah Region of Nigeria. *NSUK Journal of Science and Technology (NJST)* 4(1 & 2) 254 – 262.

Binbol. NL, Adebayo. AA and Zemba, AA (2015) Drought Probability Mapping for Northern Nigeria. 56th ANG Conf. on Climate Change and Human Security. 22nd – 25th March, Osun State University, Osobgo.

Fasona, M. J and Omojola, A. S. (2005) Climate Change, Human Security and Communal Clashes in Nigeria. June 21st – 23rd, Asker, Oslo. http://www.gechs.org/downloads/

Lennard. AT, MacDonald. M and Hooke, J (2014) Analysis of Drought Characteristics for Improved Understanding of a Water Resource System. Evolving Water Resource System: understanding, Predicting and Managing water – society interaction. Proceedings of ICWRS 2014, Bolagna, Italy, June 2014 (IAHS Publ. 364, 2014)

Oladipo, EO (1995) Some Statistical Characteristics of Drought Area Variatiovs in the Savanna Region of Nigeria.*Theor.Climatol*. 50, 147-155.

Wu, H; Hubbard, KG and Wilhite, DA (2004) An Agricultural Drought Risk-Assessment Model for Corn and Soybeans. *Int. J. Climatol*. 24: 723-741.