DROUGHT ASSESSMENT IN YOLA, ADAMAWA STATE, NIGERIA

By

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ABSTRACT

In this paper, Standardized Precipitation Index (SPI) technique was employed to assess drought characteristics in Yola, Adamawa State using historical monthly rainfall data in Yola for a period of 75 years (1931-2005). The results obtained show that within the 75 years study period, Yola recorded 35 drought events. A decadal temporal analysis shows that the 1930 – 1939 and 1980 – 1989 decades recorded the highest frequency of 6 incidences each. Analysis of drought duration in Yola shows that the area had few cases of sporadic events and more of prolong back to back events. About 70% of drought incidences were stretched drought with low recovery tendency. However, drought magnitude analysis reveals that 57% of drought incidences were of the near normal class (0 to -0.99) on the SPI scale, 34% occurred with moderately dry conditions (-1.0 to -1.49) while 7 and 3% were of the severely dry and extremely dry conditions (-1.5 to -3.0). Implications of findings were thoroughly discussed as it affects food, animal security and the environment in general. It was concluded that in view of the recurrent incidences of droughts in Yola, the state government should intensify efforts at getting drought resistant seedlings, quick maturing varieties and the establishment of a drought monitoring and mitigation centre.

Keywords*: Assessment, Drought, Frequency, Magnitude, Duration and Mitigation.*

INTRODUCTION

Of all human endeavors, agriculture is perhaps the first sector for which humans recognized the strong relationship between crops and weather. Several attempts have been made both at federal and state levels to stabilized agricultural output but yield still remain variable especially in the savannah region.

Drought occurs as a result of the unavoidable result of our climate's variability; variability that sometimes leaves areas far short of their average water supplies for months or years at a time (AMS, 2004). It is a temporary aberration that occurs in high and low rainfall areas. It is classified based on types (Ayoade, 2004; Wilhite et al, 2007 and Prabhakar and Shaw, 2008) or based on duration (Ayoade, 2004 and Adebayo, 2010).

The four main types of drought are meteorological drought, agricultural drought, hydrological drought and socio-economic drought. Meteorological drought is usually defined by a precipitation deficiency threshold over a predetermined period of time. The threshold chosen, such as 75 percent of normal precipitation, and duration period, for example, six months, will vary by location according to user needs or application. Agricultural drought is defined more commonly by the availability of soil water to support crops and forage growth than by the departure of normal precipitation over some specified period of time. Hydrological drought is even further removed from the precipitation deficiency since it is normally defined by the departure of surface and subsurface water supplies from some average conditions at various points in time. Socio-economic drought differs markedly from the other types of drought because it reflects the relationship between the supply and demand for some commodity or economic good such as water, livestock forage or hydroelectric power that is dependent on precipitation.

Based on duration, drought is grouped into permanent, seasonal, contingent and invisible droughts. Ayoade (2004) explained permanent drought as that which exists in arid areas where in no season is precipitation enough to satisfy the water needs of plants. Crop cultivation in these regions can only be possible with irrigation assistance. Seasonal drought occurs in areas with well defined wet and dry seasons, as in most parts of the tropics. It can be expected every year owing to seasonal changes in atmospheric circulation pattern. Rainfed agriculture is possible during the wet season, but irrigation must be introduced during the dry season. Contingent and invisible drought results from the fact that rainfall is irregular and variable. Contingent drought occurs when rain fails to fall over a period of time. This type of drought is highly unpredictable; therefore it constitutes a serious threat to agriculture. Invisible drought as the name implies is less easily recognized unlike the other types that show on crop via wilting and reduced vegetative growth. Invisible drought occurs anytime the daily supply of moisture from the soil or falling precipitation fails to equal the daily water needs of plants. A slow drying of the soils result and crops fail to grow at their optimum rate. Crop yield is therefore less than the optimum. Seasonal drought occurs every year in areas characterized by well defined wet and dry season. Therefore the term drought is thus usually used to describe the shortage in rainfall amount arising from rainfall variability over time (Ayoade, 2004).

Drought impacts in various ways. The effect of drought may be direct or indirect, singular or cumulative, immediate or delayed. Droughts lead directly to poor crop yield, famine, deterioration of pasture, dead of live stock etc. The direct losses caused by drought are more complex and many. Some of them lead to changes of land use practices, abandonment of fertile lands, migration of rural

population, heavy pressure on urban areas and so on. These put severe strain on the economic development of a nation, either immediately or with a time lag (Appa, 1987).

Documentation on the extent and consequences of some drought events has well been well made, but with most limited in scope (Apeldoorn, 1981; Mortimore, 1973; Adefolalu, 1986; Khalil, 1974; Oguntoyinbo and Richard, 1977; Oladipo, 1991; 1993; 1995; Shuaibu and Oladipo, 1993). For example, Apeldoorn (1981) and Mortimore (1973) considered only the spatial coverage and socio-economic impacts of some drought events. Little or no efforts have so far been made by scholars to assess drought incidences in Yola, Adamawa State Nigeria. The present study hence assesses the characteristics of meteorological drought in the town. The area is characterized by marked rainfall variability both seasonally and annually, this makes the area highly susceptible to drought.

STUDY AREA

Yola is located on latitude 9^{o} 14'N and longitude 12^{o} 38'E of the Greenwich meridian. It has an average altitude of about 185 meters above sea level. Yola lies within the Benue trough consisting of undulating flood plains. It has an area of 8,068sq/km and a population of 3,166,101 inhabitants for the entire state (NPC, 2006) provisional census figure. Yola lies within the Sudan savannah vegetation classification characterized by tall grasses and sparsely distributed trees mostly of economic value such as shear butter, locus bean, baobab, gum Arabic, *balanite* etc. In terms of climate classification, Yola falls under the Koppen's Aw class. That is, tropical savannah climate with distinct dry season in the low sun period. The dry season is strongly developed for about five months, beginning from October ending to late March. Rainfall is about 958.99mm per annum with highest down pour occurring between August/September (Binbol and Zemba, 2007). Yola has an average minimum temperature of 15.2^{o}C and an average maximum of 39.7^{o}C. The hottest months are March/April with maximum temperature of 42.7^{o}C while the coldest months are November/December with minimum temperature of 11.11^{o}C (Binbol and Henry, 2009). Agriculture and cattle rearing are among the major economic activities of the people in the study area. Crops grown include Cotton, Groundnuts, Rice, Millet, Maize, Beans and Guinea corn. Cows, Sheep and Goats are reared while the river Benue is exploited for fishing and dry season cultivation.

Data Source

The study made use of secondary data in the form of monthly rainfall recordings for the study area. Data was acquired from the head office of Nigerian Meteorological Services Department Yola for a period of 75 years (1931 – 2005). Monthly rainfall figure is most appropriate for this study because of the nature of analytical technique employed to determine drought periods for this study.

DATA ANALYSIS

The rainfall data collected subjected to the standardized precipitation index (SPI) analysis. This technique which was developed by McKee et al, (1993) has been adjudged a good indicator of moisture supply (Wu et al, 2004). The SPL is base on statistical probability and was designed to be a spatially invariant indicator of drought. The nature of the SPL 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. The equation is summed up as:

SPI = (Xik-Xi) / o I…… (Equation 1)

Where o = standardized deviation for the ith station
Xik = rainfall for the ith station and kth observation
Xi = mean rainfall for the ith station

All negative SP1 values are taken to indicate the occurrence of drought, while all positive values show no drought. A table of SP1 cumulative probability used to determine drought intensity is presented in Table 1.

Table 1: SPI values and interpretation

Sp1 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

After: Mckee et al (1993)

RESULTS AND DISCUSSION

The results of analysis carried out on monthly rainfall data for Yola station over a period of 75 years (1931 to 2005) using the SPI technique in order to assess the nature of drought occurrence yielded interesting results pertaining to drought characteristics in the study area.

Temporal variation of Drought

The distribution of drought occurrence in Yola over time was examined using the 12 months Standardized Precipitation Index (SPI). The 12 months SPI was chosen because of its ability to capture all the precipitation occurring within a year in an area. Moreover, given the operational definition of drought in this context as precipitation deviation from the mean towards negative values, it becomes necessary that total precipitation be used for the analysis. Result of the analysis is presented in table 2.

Table 2: Temporal variation of drought in Yola

1930 to 1939	1940 to 1949	1950 to 1959	1960 to 1960	1970 to 1979	1980 to 1989	1990 to 1999	2000 to 2005
6	5	4	4	4	6	3	3

Results in table 2 shows that Yola has a peculiar drought frequency occurrence through time. The decade 1930 to 1939 recorded six incidences of drought events. This was followed by a gradual reduction through time up to about four events in the 1970 to 1979 decade. The decade 1980 to 1989 recorded a frequency of six droughts events also in Yola. The next decade had fewer events (3); on the overall, Yola had a total of 35 drought events in 75 years period. This finding agrees with the works of Akeh et al (2005) who did a drought frequency count for 21 selected stations (including) Yola across the country. They found out that all over Nigeria the decade 1980 to 1989 recorded the highest frequency of drought events. Also, in a similar study, Fasona and Omotala (2005) in a study involving 22 stations in the guinea, sudan and sahel savannah 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.

Drought Duration in Yola

Analysis of drought duration is important in the study of meteorological drought because it helps in the planning of mitigation strategies. Drought duration in Yola was determined by the analysis of SPI values. 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. Therefore, drought duration in Yola was analyzed using the SPI values generated.

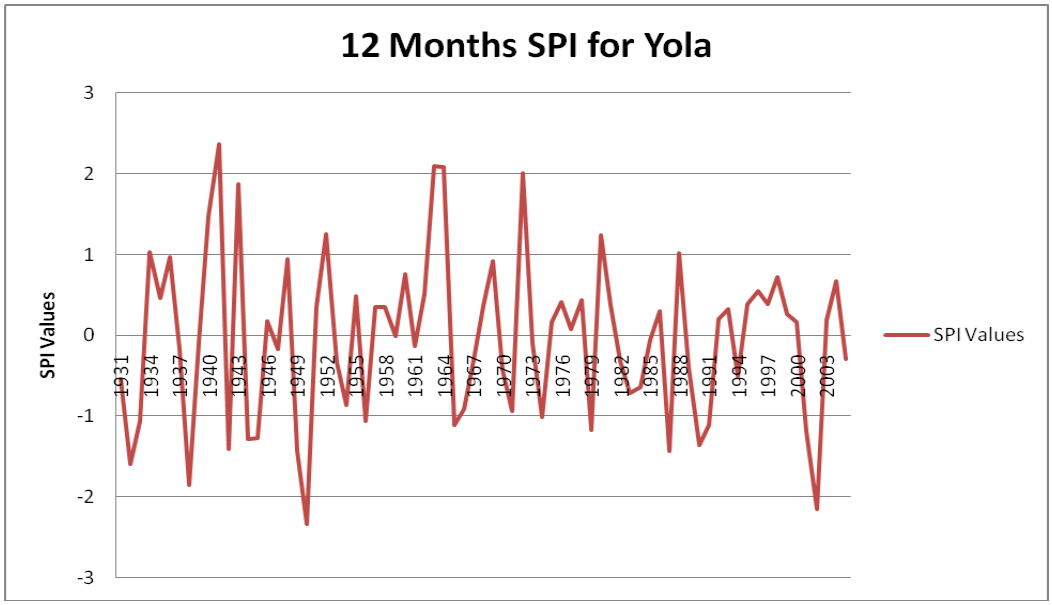

Figure 1: Showing drought frequency and duration for Yola

Table 3: Drought duration and frequency in Yola

S/N	Station	Duration	Frequency	Percentage
1	Yola (Sudan)	1 year drought 2 years drought 3 years drought 4 years drought	9 incidence 5 incidence 4 incidence 1 incidence	25.7% 28.6% 34.3% 11.4%

The results shows that out of the 75 years analyzed for the study area, only nine drought events were short sporadic annual happenings. These constitute 25.7% of the nature of drought events in Yola. 28.6% of drought occurrence in this area was of the two years duration, often referred to as back to back which occurs on five occasions. There were four incidences of three years drought events as a stretch. Comparing this figure to drought incidences in the sahel region, it is still

small. Binbol (2009) in an earlier drought studies for Borno found out that a 3 year drought stretch was lacking in this scanty rainfall region. In place of it was longer duration droughts, such as the 4 years droughts of 1970 to 1973, 1989 to 1992 and even before then, a longer 5 year stretch had occurred (1940 to 1944). Yola also witnesses a single four year drought episode that lasted from 1982 to 1985 (fig1).

Drought Severity and Magnitude in Yola

In order to analyzed drought severity and magnitude in Yola, a critical intensity study to determine the degree of precipitation short fall for each growing season was undertaken. It is generally measured by the departure from normal of long term mean precipitation of the growing season, which in this case is six months for Yola. Finding was then read against an SPI index as provided in table 1. Result of drought magnitude/severity is presented in table 4.

Results of the analysis for drought severity and magnitude for Yola shows that out of the 35 drought events recorded within the study period, 20 of them (57%) 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 output because of their likely time of occurrences. They may occur as a result of delay rains; however, rainfall during the crop growth state may not be affected. The water shortage associated with the occurrences is quite insignificant so that damage 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.

Table 4: Drought severity and magnitude in Yola

S/N	Agrozone /station	Study period	Drought events	SPI scale (Magnitude)	Freq/%	Severity
1	Yola	75	35	0 to -99 -1.0 to-1.49 -1.5 to-1.99 -2.0 to-3.0	20 (57%) 12 (34%) 2 (7%) 1 (3%)	Near normal Moderately dry Severely dry Extremely dry

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.

Moderately dry drought condition in Yola accounted for 12, 34% of the entire drought period. This may be as a result of reduce rainfall and rain days (Akeh *et. al.*, 2000). Severely dried and extremely dried drought conditions occur in Yola with a magnitude of between -15 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 precided by another drought year (1949) see fig. 1. 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 quality and quantity. 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.

CONCLUSION

The study demonstrates that SPI technique gives room for fine tuning drought studies because of its ability to accommodate specified time periods in the analysis. This is, even in a seemingly adequate rainfall area, drought conditions can be identified for a specific period that may coincide with a specific crop to identity drought disturbance in its growth cycle over the years. It also enables the assessment of drought issues such as frequency, duration, severity and magnitude on both spatial and temporal scales. Therefore the researches should be geared towards specific drought crop relationships. This will enable detection of possible periods of moisture deficiency and such periods can be augmented with additional water supply via irrigation. The research also reveals that drought events in Yola, Adamawa state are mostly mild event on the SPI magnitude scale. Therefore, there is the need for the state government to intensify efforts in acquiring drought resistant seedlings as well as quick maturing varieties. There is also the need to set up a drought monitoring and mitigation unit in the state.

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