

Mild and Moderate Droughts in Savanna Ecological Zone of Nigeria

Dr. Adewale Francis Olatunde

Department of Geography, Federal University, Lokoja

Dr, James K, Aremu

Department of Geography, Nigerian Defence Academy, Kaduna.

Abstract

Although drought studies have been carried out by many scholars in the Savanna Ecological zone of Nigeria over the years, few if any has been able to carry out the detailed year to year, decade to decade, and subperiod to subperiod analyses of the occurrences of mild and moderate droughts in this region over the years. This is because they are seen as not been destructive and therefore of not interest as the catastrophic extreme drought or the creepy invisible drought. This gap in study is what this study has tried to fill through the use of the Bham and Mooley Drought Index (BMDI) as earlier used for extreme drought by Olatunde and Aremu, 2014. The results of the study show that there is no definite pattern of occurrence of mild and moderate droughts in the study zones during the study period. This emphasise the need for people of the zones to be always on the lookout for droughts of these magnitudes and others.

Keywords: Mild, Moderate, Drought, Zone, Decade, Subperiod,

INTRODUCTION

Drought can be defined as dryness caused by lack of or inadequate moisture from precipitation in all its forms, for examples, rain, snow, ice, dew e.t.c. This affects the activities of man in several sectors of the economy that include agriculture, sports, manufacturing and so on [16]. Drought severity and intensity depend on the degree of moisture deficiency and the duration of the drought in an area. There are several types of drought recognised depending on the different uses of water made by man and the researcher or scientist concerned. Some of the types are meteorological, hydrological, agricultural, ecological and socio-economic drought [18; 16]. However, the classification into intensities of drought varies from the drought type to the indices used for study. For instance, meteorological drought recognises two types: Absolute drought that is taken as a period of about 15 days with none up to 0.2mm or more of rainfall, while partial drought is seen as a period of at least 29 consecutive days with average rainfall not exceeding 0.2mm. Climatologists use various percentage deviations from the average rainfall over a period of time and area to show different intensities of drought. However, on a general note, a deviation of about 11-25% is taken as a slight drought, 26-45% as a moderate drought, 46-60% as a severe drought and a deviation that is more than 60% is seen as a disastrous drought. Agricultural drought has following types /intensities: permanent, seasonal, contingent and invisible (incipient)[16;19]. As said earlier some indices especially those that have been used in the study area also have various drought intensity classifications, for example, The Normalized Rainfall Index (NRI) depict periods of different drought intensities from - 0.51 to -0.85 (mild drought) to - 1.31 or less (severe drought)[20], the Rainfall Anomaly Index with drought severity from - 1.00 to -1.99 as mild drought and -

3.00 or less as severe drought. The Standard Precipitation Index (SPI) has drought severities from -0.00 to -0.99 as mild drought and to -2.00 or less as extreme drought. The Bame and Mooley Drought Index (BMDI) also has intensities varying between - 1.00 to - 1.99 (mild drought) and -4.00 or less (extreme drought) [12].

Various studies have been done by scientists to look at drought intensities worldwide [7;13] and to a lesser extent in the study area [1;3;10;11;12;13;14;15;16]. However, these studies appear scanty and superficial especially on mild and moderate drought therefore, there are no detailed studies of the occurrences of mild and moderate droughts in the study region. This is the aim and purpose of this study. That is to look at the occurrence and reoccurrence of mild and moderate droughts as defined by BMDI in the study region over a period of seventy years (1941-2010).

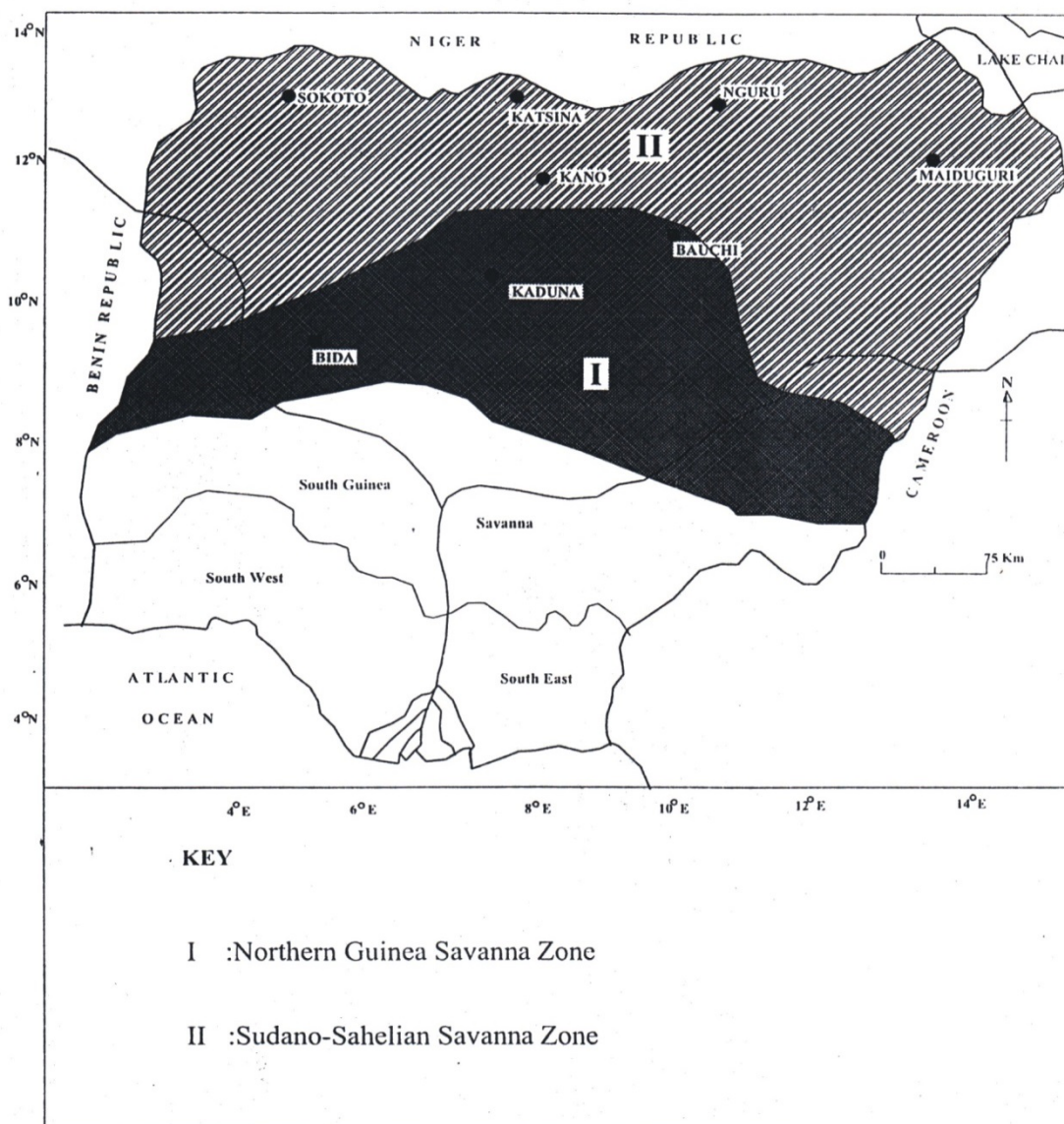


Fig. 1: Study Stations with Vegetation Map of the Study Area.

The study area is located in the Savanna ecological zone of Nigeria between latitudes 6° 27' N to 14° 01' N of the equator and longitudes 4° 11' E to 14° 21' E of the Greenwich Meridian

(Fig. 1). It covers about 729,500 km² and is about 78% of the total landmass of Nigeria (923,768 km²) [16]. It extends from the Sokoto plains passing through the northern central highlands to the Chad Basins [8]. The climate of the area is dominated by Tropical continental to the north and Tropical hinterland to the south. The average annual rainfall of about 500 mm prevail in the extreme north eastern part while about 1500 mm in the southern part [16]. The rainfall takes place between the months of March to October. The pattern of rainfall in the zone is highly variable spatially and temporally with inter-annual difference of between 15 and 20%. Due to this large inter-annual difference in rainfall, the study zone has been subjected to frequent dry spells resulting in severe and widespread droughts [9; 11]. The vegetation is the Savanna type and is made up of the Guinea, Sudan and Sahel with the density of trees and plants diminishing towards the north [6]. The upper two zones (Sudan and Sahel) are together known to as the semi-arid and arid zones of Nigeria. The study area constitutes the main grazing land for animals such as cattle, goats' sheep, donkeys and camels in Nigeria.

MATERIALS AND METHODOLOGY

The data, period and method used for this study are the same as those used by [4] in their study on drought intensities, [16] in his study on invisible drought and [17] in their study on extreme drought. These studies as mentioned earlier did not look at mild and moderate droughts in detailed like this study has done by analyzing their year to year, decade to decade, and subperiod to subperiod occurrences. The same data, period and method of analysis were also used so as to put this study on the same platform as those studies to allow for easy comparison as they relate to other drought intensities (invisible and extreme) during the same occurrence period. The data were obtained from the Nigerian Meteorological Agency (NIMET) Oshodi, Lagos and covered a period of 70 years (1941-2010) for eight stations (Table 1). The synoptic stations used were with long and continuous period of daily, monthly and annual rainfall record data of at least 70 years.

Details of the method used can be found in [5] and are given below, while the applicability of the method can also be found in [18]. The Bhalme and Mooley Drought Index (BMDI) is an empirical one that uses monthly rainfall as the sole climatological input. The index has been shown to perform comparatively well in depicting periods and intensities of drought [10].

Monthly growing seasonal rainfall (April to October) values for the eight (8) selected stations were used to derive the Bhalme and Mooley Drought Index (BMDI) for the assessment of drought severity [18]. For agricultural purposes, the months of April to October (the growing season) are considered to be the most important in drought study. This is because they are said to be the months when more than 95% of the annual rainfall total is received in the study area and also in the Savanna region of Nigeria[2].

In its general form, the BMDI for a given month K is calculated using this formula

$$IK = (MK / d) + (1 + C) IK \dots\dots\dots(1)$$

Where;

C is a constant

d is a constant

IK = drought intensity for the Kth month.

Ik-1= drought intensity for the (K-1) month.

M, the moisture index is given by

$$M = 100 (X - \bar{X}) / S \dots\dots\dots(2)$$

In equation (4),

X = the monthly rainfall value,

\bar{X} = the long term mean monthly rainfall,

S = the standard deviation for the initial month under consideration (K-1).

. Equation (1) is then given as;

$$I = M / d \dots\dots\dots(3)$$

The values of C and d in equation (3) for northern Nigeria are 0.43 and 38.84 respectively. These are constant values [18]. These values were used in equations (1) and (3) to generate monthly values of BMDI for the stations under study. From these monthly values, the means or seasonal drought index (SDI) series were obtained for each year studied in the stations. The seasonal indices were then used to classify a year into any of the following wetness/ dryness categories using B.M.D.I classification chart [18].

RESULTS AND DISCUSSIONS

Results of analyses of Mild Droughts Using Decades

Table 1: Frequency and Percentages of Mild Drought during the Decades in Stations

STATION	1941- 50	1951- 60	1961- 70	1971-80	1981- 90	1991- 2000	2001- 2010	Total
Bauchi	1	2	3	-	6	1	1	14
Bida	4	1	1	1	1	3	1	12
Kaduna	-	2	1	1	2	3	3	12
Kano	3	2	2	5	4	1	-	17
Maiduguri	4	-	1	1	1	1	-	8
Sokoto	-	1	2	1	3	1	-	8
Nguru	1	-	-	1	2	3	2	9
Katsina	1	-	-	2	3	6	-	12
Total (%)	14(15.22)	8(8.70)	10(10.87)	12(13.04)	22(23.91)	19(20.65)	7(7.61)	92(100)

Bida and Maiduguri experienced four years of mild drought between 1941 and 1950, Kano three years, while Bauchi, Katsina and Nguru experienced just a year (1 year) each of mild drought (Table 1.0). Kaduna and Sokoto did not experienced mild drought in the decade 1941 to 1950. Katsina and Nguru were the stations that did not experienced mild drought in the decade 1951 to 1960. Bauchi, Kaduna and Kano each experienced two years of mild drought, while Bida and Sokoto each experienced one year of mild drought (Table 1.0). In the decade 1961 to 1970, Bauchi experienced three years of mild drought, Bida, Kaduna Maiduguri had one year each, while Kano and Sokoto each experienced two years of mild drought. Katsina and Nguru had no mild drought (Table 1.0). Bida, Kaduna, Maiduguri, Sokoto and Nguru each had one year of mild drought in the decade 1971 to 1980. Katsina had two years, while Kano experienced five years of mild drought.

The decade with most years of mild drought was 1981 to 1990 with 22 years representing 23.91% of mild drought out of the 92 years of mild drought for all stations during the period of study (Fig.). This was followed by the decade 1991 to 2000 with 19 years (20.65%). Next was

the decade 1941 to 1950 with 14years of mild drought (15.22%). The least decade in terms of the occurrence of mild drought was 2001 to 2010 with seven years (7.61%)(Table 1 and Fig. 2).Other decades frequency of occurrences and corresponding percentages for mild droughts are as shown in Table 1 and Fig. 2.

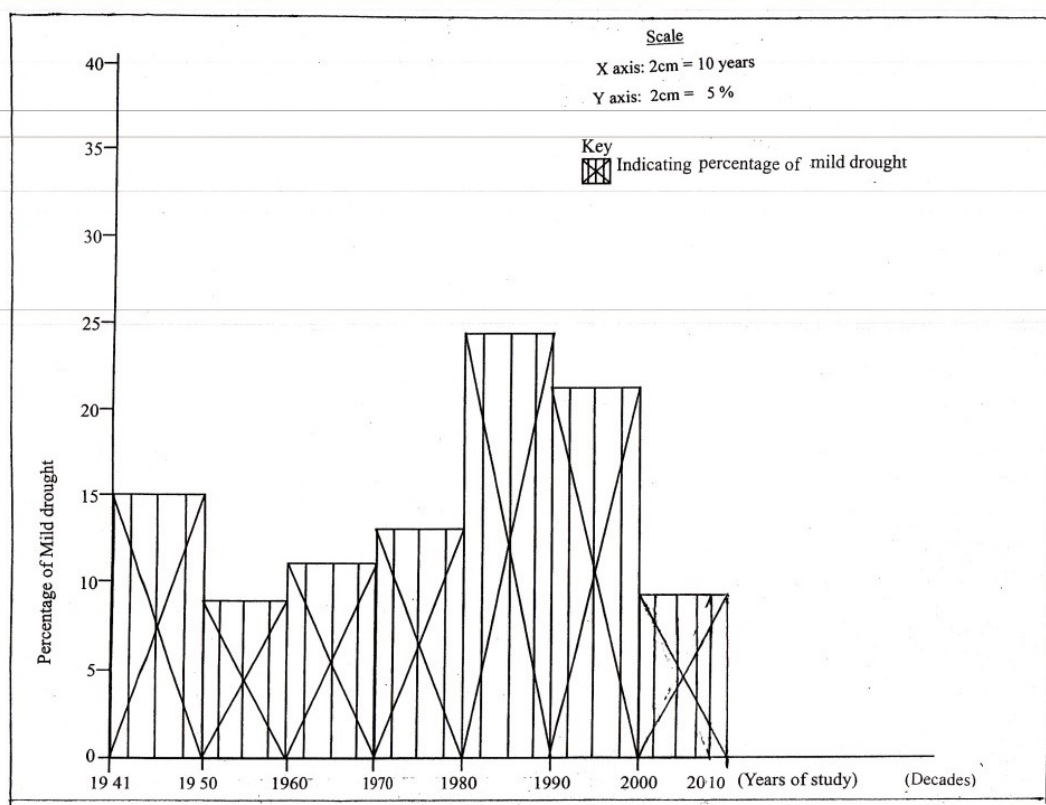


Fig. 2: The Decadal Percentages of Mild Drought during the Study Period.

Mild drought occurred in 92 years representing 32.62% out of 282 years of all drought intensities for stations used during the study period (Table 1). This indicates that out of every 10 years of drought during the study period three years were those of mild drought.

Results of analyses of Moderate Droughts Using Decades

Table 2: Frequency and Percentages of Moderate Drought during the Decades in Stations

STATION	1941-50	1951-60	1961-70	1971-80	1981-90	1991-2000	2001-2010	Total
Bauchi	-	-	-	2	1	-	-	3
Bida	1	-	1	-	2	-	1	5
Kaduna	1	1	1	-	3	-	-	6
Kano	1	-	1	1	4	-	-	7
Maiduguri	-	-	-	1	5	1	-	7
Sokoto	-	-	-	2	2	-	-	4
Nguru	1	-	-	2	3	1	1	8
Katsina	1	-	1	1	4	-	-	7
Total (%)	5(10.64)	1(2.13)	4(8.51)	9(19.15)	24(51.06)	2(4.26)	2(4.26)	47(100)

Three stations namely, Bauchi, Maiduguri and Sokoto did not experienced moderate drought between 1941 and 1950. All other stations experienced a year each of moderate drought. In the decade 1951 to 1960, only Kaduna experienced one year of moderate drought, others did not

(Table 2). The decade 1961 to 1970 had Bida, Kaduna, Kano and Katsina experiencing moderate drought of one year each, others experienced no moderate drought.

Three stations, Bauchi, Sokoto and Nguru experienced two years of moderate drought in the decade 1971 to 1980. Kano, Maiduguri and Katsina each had a year of moderate drought while Bida and Kaduna experienced no moderate drought (Table 2). The decade 1981 to 1990 had all the stations with moderate drought of various years; Bauchi one year, Bida and Sokoto two years, Kaduna and Nguru three years, Kano and Katsina four years and Maiduguri five years. The decade 1991 to 2000 had Maiduguri and Nguru with one year of moderate drought each, others did not experienced moderate drought. Between 2001 and 2010, Bida and Nguru were the only stations with moderate drought (Table 2 and Fig.3)

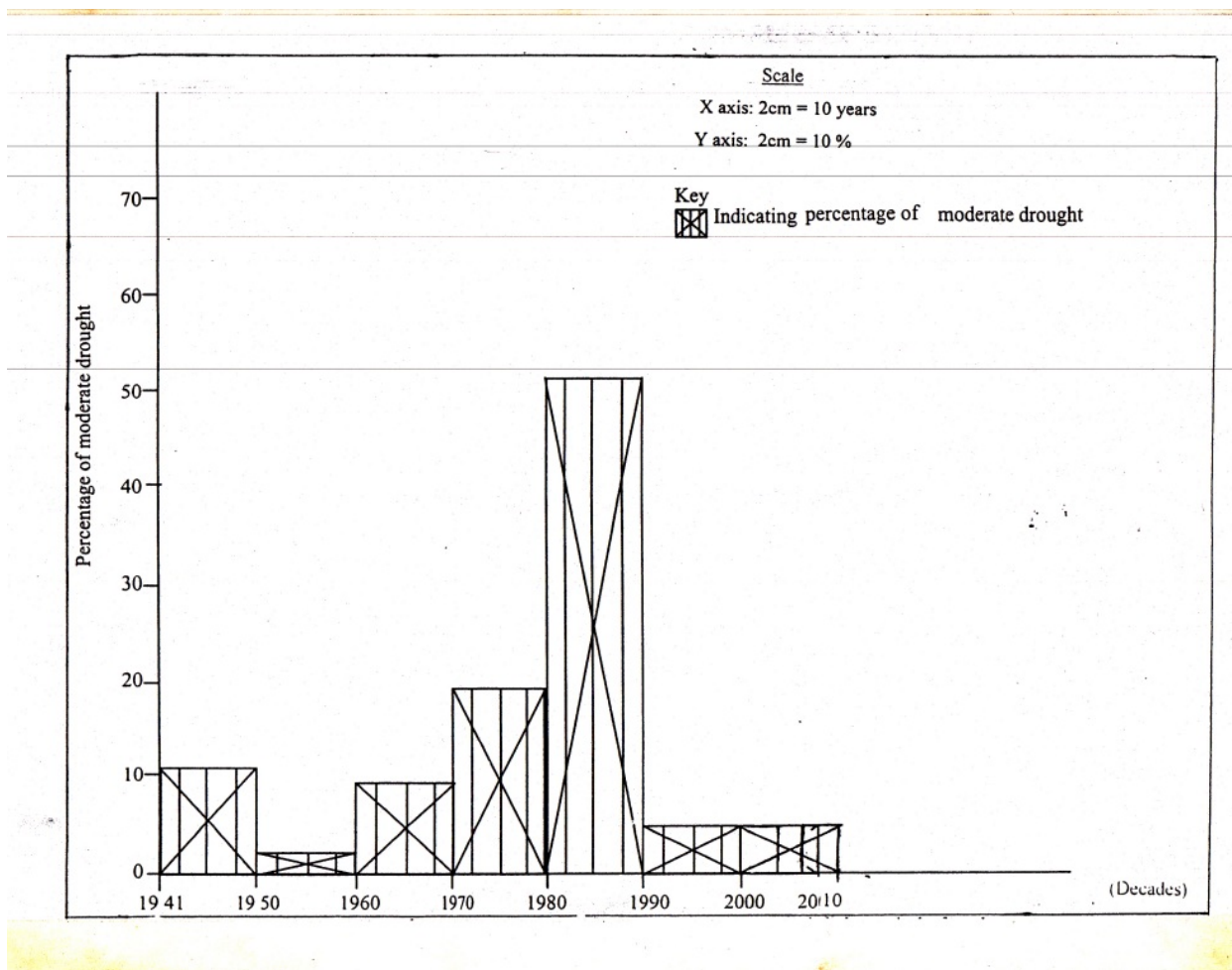


Fig. 3: The Decadal Percentages of Moderate Drought during the Study Period.

The decade with the highest years of moderate drought was 1981 to 1990 with 24 years representing 51.06% out of 47 years of moderate drought for all the stations during the study period (Fig.). The next decade being 1971 to 1980 with nine years (19.15%), this was followed by the decades in this order; 1941 to 1950 with five years (10.64%), 1961 to 1970 with four years (8.51%), 1991 to 2000 and 2001 to 2008 with two years (4.26%) each. The decade 1951 to 1960 had the least moderate drought of one year (2.13%)(Table 2 and Fig.3). The existence of 47 years of moderate drought (16.67%) (Fig.3) out of 282 drought years for all stations indicate that for every 10 years of drought, one year and seven months were those of moderate drought.

Results of Analyses of Drought Intensities Occurrence Using Over Lapping Sub-periods (Mild Drought)

Table 3: 30 Year Overlapping Sub-Periods for Mild Drought.

STATION	1941- 1970	1951- 1980	1961- 1990	1971- 2000	1981- 2010	TOTAL (%)
Bauchi	6	5	9	7	8	35(16.91)
Bida	6	3	3	5	5	22(10.63)
Kaduna	3	4	4	6	8	25(12.08)
Kano	7	9	11	10	5	42(20.29)
Maiduguri	5	2	3	3	2	15(7.25)
Sokoto	3	4	6	5	4	22(10.63)
Nguru	1	1	3	6	17	18(8.70)
Katsina	1	2	5	11	9	28(13.53)
Total	32	30	44	53	48	207(100.00)

In the 30 years sub-period (overlapping) of 1941 to 1970 there were 32 years of mild drought for all the stations. Kano station had the largest number of mild drought with seven years (21.88%). Next were Bauchi and Bida with six years (18.75%) each. They were followed by Maiduguri with five years (15.63%), Sokoto with three years (9.38%), Katsina and Nguru with one year (3.13%) each (Table 5.35). The sub-period 1951 to 1980 (overlapping) again had Kano with the largest mild drought years with nine years (30.00%). Nguru again had the least mild drought years with one year (3.33%). Other stations mild drought frequency of occurrence and the corresponding percentages are as shown in Table 3. Again Kano with 11 years (25.00%) of mild drought was the largest for the sub- period 1961 to 1990. It was followed by Bauchi with nine years (20.45%), Sokoto with six years (13.64%), Katsina with five years (11.36%), Kaduna had four years (9.09%) and Bida, Maiduguri and Nguru all had three years (6.82%) of mild drought (Table 3).

In the sub-period 1971 to 2000, Katsina emerged the station with the highest number of years with mild drought in this sub-period that is 11 years (20.75%), though closely followed by Kano with 10 years (18.87%). The station with the least years of mild drought was Maiduguri with three years (5.66%). Other stations experienced mild drought of various frequencies (Table 3).

In the most recent sub-period of 1981 to 2010, Katsina also emerged the station with the highest years of mild drought in this sub-period with nine years (18.75%). It was closely followed by Bauchi and Kaduna with eight years (16.67%) each. Maiduguri had the least of years for mild drought with two years (4.17%). Other stations experienced mild drought of various years (Table 3). Results of analyses of sub-periods show that the sub-period 1971 to 2000 experienced the most years of mild drought with 53 years (25.60%). The least years of mild drought were experienced in the sub-period 1951 to 1980 with 30 years (14.49%). Other sub-periods experienced mild droughts of various years (Table 3).

From the results obtained Kano was the station most hit by mild drought when overlapping sub-periods were taken into consideration. It had the largest or second largest mild drought years in most of the sub-periods (Table 3). In Kano the 1961 to 1990 sub-period experienced the highest years of mild drought with 11 years (26.19%). It was followed by the sub-period 1971 to 2000 with 10 years (23.81%). The least number of years was experienced by the sub-period 1981 to 2010 with five years (11.91%). Other sub-periods experienced various years of mild drought (Table 3). Kano also had 42years (20.29%) of mild drought across the sub periods. It was followed by Bauchi with 35 years (16.91%), Katsina with 28 years (13.53%), Kaduna with 25years (12.08%), Bida and Sokoto with 22years (10.63%) each, Nguru with 18years (8.70%) and Maiduguri with 15years (7.25%)(Table 3).

The sub-period with the highest number of years for mild drought in Bauchi was 1961 to 1990 with nine years (25.71%). The least years of mild drought occurred in the sub-period 1951 to 1980 with five years (14.29%). Mild drought occurred for various years in other sub-periods (Table 3). The sub-period 1941 to 1970 had the highest number of years of mild drought in Bida at six years (27.27%). It was followed by 1971 to 2000 and 1981 to 2010 with five years each (22.73%). The least years of mild drought occurrence for the station took place in the sub-periods 1951 to 1980 and 1961 to 1990 with three years (13.64%) each (Table 3). The last sub-period of study 1981 to 2010 experienced the highest number of years of mild drought in Kaduna with eight years (32.00%). The sub-period 1941 to 1970 had the least years of mild drought of three years (12.00%). Other sub-periods experienced various years of mild drought (Table3). Maiduguri had the first sub-period of study 1941 to 1970 with the highest number of mild drought of five years (33.33%). The sub-periods 1951 to 1980 and 1981 to 2010 had two years (13.33%) while the sub-periods 1961 to 1990 and 1971 to 2000 had three years (20.00%) each (Table 3).

For Sokoto station six years (27.27%) of mild drought in the sub-period 1961 to 1970 was the highest occurrence. The sub-period 1941 to 1970 experienced the lowest number of mild drought years at three (13.64%). Other sub-periods experienced various years of mild drought and percentages (Table 3). For Nguru, the first two sub-periods had the lowest mild drought years at one year (5.56%) each. The highest mild drought years were experienced by the most recent sub-period of study, 1981 to 2010 with seven years (38.89%). Other sub-periods had various years of mild drought occurrences (Table 3). In this station there was an increase from the first sub-period of study with one year to seven years of mild drought in the most recent sub-period of 1981 to 2010 (Table 3). In Katsina, the first sub-period of study, 1941 to 1970 had the least years of mild drought in this station with one year (3.57%) occurrence. The sub-period 1971 to 2000 had 11 years (39.29%) to make it the sub-period with the highest occurrence of mild drought. Other sub-periods experienced mild drought of various years (Table 3).

These results above indicate more of mild drought years in the earlier sub-periods of Maiduguri than in the last two sub-periods (Table 3). The reverse were the cases, that is more mild drought years in the last two sub-periods than the earlier two in Bauchi (15years to 11years), Kaduna (14years to 7years), Sokoto (9 to 7 years),Katsina (20 to 3 years) and Nguru (13 to 2 years). In Bida and Kano the numbers of years in the first two and the last two sub periods were close (Bida 9 to 10 years and Kano had 16 to 15 years)(Table 3).

Results of Analyses of Drought Intensities Occurrences Using OverLapping Sub-Periods (Moderate Drought)

Table 4: 30 Year Overlapping Sub-periods for Moderate Drought.

STATION	1941-1970	1951-1980	1961-1990	1971-2000	1981-2010	TOTAL (%)
Bauchi	-	2	3	3	1	9(7.26)
Bida	2	1	3	2	3	11(8.87)
Kaduna	3	2	4	3	3	15(12.10)
Kano	2	2	6	5	4	19(15.32)
Maiduguri	-	1	6	7	6	20(16.13)
Sokoto	-	2	4	4	2	12(9.68)
Nguru	1	2	5	6	5	19(15.32)
Katsina	2	2	6	5	4	19(15.32)
Total	10	14	37	35	28	124(100.00)

Among the sub-periods (overlapping) used, the sub-period 1961 to 1990 had the highest years of moderate drought occurrence with 37 years (29.84%). It was followed by 1971 to 2000 with 35 years (28.23%), 1981 to 2008 with 28 years (22.58%), 1951 to 1980 with 14 years (11.29%) and 1941 to 1970 sub-period was the least with 10 years (8.06%) of moderate drought (Table 4). In Bauchi, two sub-periods 1961 to 1990 and 1971 to 2000 had three years (33.33%) of moderate drought each, 1951 to 1980 had two years (22.22%) and 1981 to 2010 had one year (11.11%). There was no moderate drought in the sub-period 1941 to 1970 (0%). Bida station had the sub-periods 1961 to 1990 and 1981 to 2010 with three years (27.27%) of moderate drought. It also had 1941 to 1970 and 1971 to 2000 with two years (18.18%) each while the sub-period 1951 to 1980 had one year (9.09%). The following sub-periods in Kaduna 1941 to 1970, 1971 to 2000 and 1981 to 2010 had three years (20.00%) of moderate drought respectively. The sub-period 1961 to 1990 had four years (26.67%) while 1951 to 1980 had two years (13.33%) of moderate drought.

The first two sub-periods in Kano (1941 to 1970 and 1951 to 1980) had two years (10.53%) each of moderate droughts. The highest moderate drought for this station (Kano) occurred in the sub-period 1961 to 1990 with six years (31.58%). This was followed by the sub-period 1971 to 2000 with five years (26.32%) and 1981 to 2010 with four years (21.05%) of moderate drought. The sub-period 1971 to 2000 (overlapping) had seven years (35.00%) of moderate drought in Maiduguri. The two sub-periods of 1961 to 1990 and 1981 to 2010 each had six years (30.00%) of moderate drought, while the sub-period 1951 to 1980 had one year (5.00%). The sub-period 1941 to 1970 had no moderate drought (0%). Sokoto had two sub-periods (1951 to 1980 and 1981 to 2010) with two years (16.67%) of moderate drought. It also had two sub-periods (1961 to 1990 and 1971 to 2000) (overlapping) of four years (33.33%) each of moderate drought. The sub-period 1941 to 1970 had no moderate drought (0%) like those of Maiduguri and Bauchi.

Two sub-periods, 1961 to 1990 and 1981 to 2008 were with five years (26.32%) of moderate drought in Nguru. The sub-period 1971 to 2000 had six years (31.58%) of moderate drought; the sub-period 1941 to 1970 had one year (5.26%), while the sub-period 1951 to 1980 had two years (10.53%) of moderate drought. Katsina had two sub-periods (overlapping) of 1941 to 1970 and 1951 to 1980 with two years (10.53%) of moderate drought. The sub-period 1981 to 2010 had four years (21.05%), 1971 to 2000 sub-period had five years (26.32%), while the sub-period 1961 to 1990 had the largest moderate drought years of six (31.58%).

Results of analyses of moderate drought using the 30 years overlapping sub-periods show that out of the 10 years of moderate drought for the sub-period 1941 to 1970, Kaduna experienced the highest number of moderate drought of three years (30.00%). Bida and Kano experienced two years (20.00%) of moderate drought and Nguru had one year (10.00%). Other stations did not experienced moderate drought during this sub-period. In the 1951 to 1980, the following stations; Bauchi, Kaduna, Kano, Sokoto, Nguru and Katsina all experienced two years (14.29%) of moderate drought respectively. The remaining two stations used for study experienced one year (7.14%) each. In the sub-period 1961 to 1990, three stations experienced six years (16.22%) of moderate drought. Those stations were Kano, Maiduguri and Katsina. Nguru had five years (13.51%) while Kaduna and Sokoto had four years (10.81%) of moderate drought. Bauchi and Bida both had three years of moderate drought each. The sub-period 1971 to 2000 had Maiduguri with the highest years of moderate drought occurrence at seven (20.00%). Nguru had six years (17.14%) while Kano and Katsina experienced moderate drought for five years (14.29%). Bauchi and Kaduna had three years (8.57%) and Bida the least years of moderate drought of two years (5.71%) (Table .4).The last sub-period of study 1981 to 2010 had Maiduguri with six years (21.43%) as the station with the most moderate drought in this sub-period. Nguru experienced five years (17.86%) of moderate drought, while Kano and Katsina had four years (14.29%) each. Bida and Kaduna had three years (10.71%).Sokoto with two years (7.14%) and Bauchi experienced the least year of moderate drought of one year (3.57%) (Table 4).

Across the sub-periods (overlapping) Maiduguri had 20 years (16.13%) being the station with the highest years of moderate drought. Kano, Katsina and Nguru each had 19 years (15.32%), Kaduna had 15 years(12.10%), Sokoto with 12 years(9.68%), Bida had 11 years(8.87%) while Bauchi had nine 9 years(7.26%) to be the station with the least years of moderate drought (Table 4). Ratio of occurrence of moderate drought years between the first two sub-periods and the last two sub-periods were as follows for the stations; Bauchi (2:4), Bida (3:5), Kaduna (5:6), Kano (4:10), Maiduguri (1:13), Sokoto (2:6), Katsina (4:9) and Nguru (3:11). Except for the ratio of relationship of Kaduna that was close, all other stations showed more moderate drought occurrence in the later sub-periods than the first two earlier sub-periods (Table 4). This suggested the presence of more moderate drought in the last thirty (30) or more years.

Results of Analyses of Drought Intensities Occurrences within the Sub-Periods 1941 to 1975 and 1976 to 2010

Table 5: Mild and Moderate droughts Occurrence in Two Sub periods 1941-1975 and 1976-2010

MILD DROUGHT			
Station	1941 to 1975	1976 to 2010	Total
Bauchi	6	8	14
Bida	6	6	12
Kaduna	3	9	12
Kano	8	9	17
Maiduguri	6	2	8
Sokoto	3	5	8
Nguru	1	8	9
Katsina	2	10	12
Total	35 (38.04%)	57 (61.96%)	92 100%)

MODERATE DROUGHT			
Station	1941 to 1975	1976 to 2010	Total
Bauchi	1	2	3
Bida	2	3	5
Kaduna	3	3	6
Kano	3	4	7
Maiduguri	1	6	7
Sokoto	2	2	4
Nguru	3	5	8
Katsina	3	4	7
Total	18 (38%)	29 (62%)	47 (100%)

Mild Drought

The sub-period 1976 to 2010 had more years of mild drought with 56 years (60.87%) than the earlier sub-period (1941 to 1975) with 36 years (39.13%) of mild drought (Table). For mild drought, the ratio between the two non-overlap sub-periods include Bida (6:6 or 1:1), Kaduna (3:9 or 1:3), Kano (8:9) and Nguru (1:8). Other stations ratio of mild drought also varied (Table 5).

Moderate Drought

The total number of years for moderate drought during the study period was 47 years; the sub-period 1976 to 2010 had a higher percentage of 62% with 29 years, while the sub-period 1941 to 1975 recorded 38% with eighteen years. Moderate droughts ratio of occurrences between the two non-overlapped sub-periods ranged from Bauchi (1:2), Maiduguri (1:6), Kano and Kaduna (3:4) and Nguru (3:5). Other stations moderate drought ratio also varied (Table 5).

CONCLUSIONS

Although, mild and moderate droughts had their peaks of occurrences at various times during the decades and sub periods as shown in Tables 1 to 5. Nonetheless there occurrences have been without definite pattern. This means that they can show up anytime within a drought cycle. This is because the intensity of the prevailing drought in an area is determined to a large extent by the force(s) causing it. If the force(s) it is very intense, the drought is likely to be intense while if the force(s) is mild, the drought is also likely to be mild. As a result, stakeholders such as farmers, government at various should always be prepared for droughts of various magnitudes including mild and moderate droughts. This means that early warning systems should be functioning faultlessly in the study region so as to provide warnings as soon as possible in order to avoid and reduce the adverse effects [see 16] associated with drought of all magnitudes.

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