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Drought occurrences and its implications on the households in Yobe state, Nigeria

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Abstract

The study assesses the extent of droughts and its implications on the households in the study area. This is to highlight the need to integrate drought adaptation options into the government development plans. Strategies for drought adaptation options in the study area have often been made without experimental foundations placed on the extent of drought and its implications on the households. To achieve this, the study employed Normalized Rainfall Index (NRI) to determine the extent of droughts and its implications on the households, which has much to offer in terms of policy decisions. The study also utilized questionnaire administrated to 400 households to determine the annual income from different occupations that yielded more income to the people in the study area using one-way analysis of variance (ANOVA). The NRI shows that the study area was characterized by mild to severe drought events. The first (1986–1995) and third (2006–2017) decades experienced high incidences of droughts, while the second decade (1996–2005), witnessed the least incidences of droughts. The result of the economic activities of the households reveals that 65% of the total household respondents were involved in farming, while 35% were involved in non-farming activities as their major source of livelihood. The analysis of variance on the economic activities that generated more income to the households in Yobe State shows that farming activities provided more opportunities for income generation. Consequently, agriculture in the study area is currently being constrained by the frequent occurrence of droughts. Thus, there is a need for integrated development schemes aimed at livelihood diversification and increasing the adaptive capacity of households to drought in the study area.

Keywords: Drought, Desertification, Vulnerability, Normalized rainfall index

Background

Drought is one of the most globally recognized hazards that damage an environment. It occurs when there is significant rainfall deficit that causes hydrological imbalances and affects the land productive systems. Drought practically occurs in all climatic regions with both high and low mean rainfalls (Um et al. 2017). It can result in damage to agricultural production as well as to the natural environment and human society (Gidey et al. 2018). Drought is considered to be a natural disaster that differs from other natural disasters because it has a gradual creeping feature (Ayoade 1988; Yue et al. 2018). Liu et al., (2018) opine that drought develops slowly with prolonged effects that gradually increases in severity and tends to persist over a long period of time even after it has stopped. Analysis of the orbital photographs from

National Aeronautics and Space Administration (NASA) shows that about 900,000 km2 of former savanna grassland in the region of Africa has been severely decertified between the early 1960s and 1986 due to persistent drought occurrences (O'Connor 1995). Moreover, Bates et al. (2008) state that one-third of African population lives in drought-prone areas. The drought has become a recurrent event in many parts of Africa, after the drought of the early 1970s that devastated the Sahel region. Dai et al. (2004) have shown that there is about 40% decline in annual rainfall total in West Africa, from the year 1968–1990 as compared with the 30 years between 1931 and 1960. Thus, frequent drought occurrences are threatening the human existence in African savanna regions and consequently making the households highly vulnerable to drought.

In Northern Nigeria, there are several records of drought occurrences which resulted in famines, such as the droughts of 1903 and 1911–1914 (Shiru et al. 2018).

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Other droughts occurred in 1919, 1924, 1935 (Tarhule and Woo 1997), 1951–1954, 1972–1973, 1984–1985 (Mortimore 1989), 2007 and 2011 (Abaje et al. 2013). Consequently, the situation is being exacerbated by the increasing human population, overgrazing, over-cultivation, and high poverty rate (Eze 2017). The predominant economic activity in the region is farming. Moreover, the region is known for its grain products such as maize, millet, sorghum, and wheat (Eze 2017). Agricultural production in Nigeria particularly in Northern Nigeria is mainly rain-fed and naturally prone to vagaries of rainfall variability (Tiamiyu et al. 2015). During the years of abundant rainfall, households in the region experience bumper harvest from both crop and livestock productions. Conversely, during the years with rainfall deficit, the households experience crop failure, poor crop yield, leading to famine, hunger, and death, including livestock (Eze et al. 2018). Khalil (1974) shows that about 300, 000 livestock died during the drought that occurred in the year 1972 to 1973. The number of livestock that died during this period represents about 13% of the total livestock population in the north-eastern part of Nigeria (Khalil 1974). Moreover, in the year 1987, towards the end of the growing season, huge crop losses to drought were recorded in many parts of northern Nigeria, particularly, in the Sahel region (Mortimore 1989).

Studies on the impact of drought have been undertaken in various parts of the world (Oladipo 1993; Obaje et al., 2013; Wu et al., 2015a, 2015b; Olagunju 2015; Hosseinizadeh et al. 2015; Um et al. 2017; LIU et al. 2018; Yue et al. 2018). Majority of the studies concentrated on the impact of drought on agriculture, health, water resources, causes and effects on the land, mitigation and the extent of drought. Little or no work has been done in the study area to determine quantitatively drought occurrences and its implications on the households using Normalized Rainfall Index (NRI), which has much to offer in terms of policy decisions. Oladipo (1993) argues that the degree of impact of a particular drought on the environment and the extent to which it may affect the households depends on the length of the period separating the drought event from the previous one. Moreover, Abaje et al. (2013) state that there is a need for appropriate techniques to be used to determine drought occurrence so as to reduce its impact on the environment. Against this background, the research seek to determine quantitatively the drought occurrences and its implications on the households, in order to provide the basis for the design and mainstreaming of drought adaptation into the development process in the study area.

Materials and methods

Study area

Yobe State is on latitudes 10°30′N to 13°25′N and longitudes 9°35′E and 12°30′E. It is bounded by the Nigerian States of Gombe to the southwest, Bauchi to the west, Jigawa to the northwest, Borno to the east, and to the North by the Niger Republic. The study area has a population of 2,532,395, according to 2006 census, and a land mass of 47,153 km^2. The density is thus 29.92 persons per square kilometre.

The climate regime of the study area is characterized by single long dry season followed by a shorter wet season. In the Sahel, mean annual rainfall is less than 500 mm and may fall to 250 mm (Ayoade 1988). In the Sudan savanna, it is 800 mm to 1000 mm. The number of wet months is about 4 months in the northern guinea savanna zone to less than 2 months in the Sahel savanna zone (Folland et al., 1986; Anyadike, 1993). Mean annual temperature is 26oC increasing towards the Sahel zone. Potential evapo-transpiration exceeds rainfall except for the few months. Vegetation of the study area is divided into the Wooded Tropical savanna, Mixed combrataceous woodland and wooded savannah. The Wooded tropical savanna also known as Sahel savanna is found in the northern part of the state, where rainfall is less than 500 mm per annum. The vegetation consists of thorn bushes and small trees which grow under dry conditions. Mixed combrataceous woodland covers the central part of the study area. It has more rainfall than the wooded tropical savanna and it consists of scrub vegetation interspersed with tall trees (Nwaka, 1991). The wooded savanna covers most of the southern part of the state, with a higher grass growth. It is also known as northern guinea savanna. The main trees are the isoberlina species. Administratively, there are seventeen Local Government Areas (LGAs) in Yobe State. The semi-arid zone in the study comprises of the Sudan and the Sahel regions, which by its nature and characteristics are susceptible to drought and desertification. These zones are most vulnerable to drought and desertification because the predominant economic activity of the people in the communities is farming (Musa and Shaib 2010).

Study design

The study adopted the survey design. The study population consists of 443,375 households in Yobe State (National Population Commission 2006). Out of this number, 400 households were proportionally selected and interviewed based on the relative population of each of the 17 LGAs using Yamane (1967) sample size selection method (Table 1).

The data utilized for this study were obtained from primary and secondary sources. The primary data were obtained through an administered questionnaire and in-depth interviews. Purposive sampling technique was employed to select the key informants and communities studied while the simple random sampling technique was employed to select the households. Ten key

Table 1 Sample Size of the Household Respondents in the Study Area

Local Govt Area	Number of Households per LGAs	Sample Size of Respondents per LGA
Bade	26,193	24
Busari	21,435	19
Damaturu	17,212	15
Fika	24,622	23
Fune	52,489	52
Geidam	31,243	27
Gujba	22,430	22
Gulani	20,396	18
Jakusko	43,585	39
Karasuwa	20,752	18
Machina	12,583	11
Nangere	15,807	17
Nguru	29,200	26
Potiskum	36,341	35
Tarmuwa	16,394	13
Yunusari	27,478	22
Yusufari	25,215	19
Total	443,375	400

Source: National Population Commission

informants were selected for in-depth interviews in each LGA giving a total of 170 respondents. The secondary data utilized were climatic data on rainfall, from 1986 to 2017.

Data analysis

The data collected were analysed using descriptive statistics (standard deviation, the coefficient of variation, skewness and kurtosis), percentages and Analysis of Variance (ANOVA). Normality of the annual rainfall series for Nguru, Potiskum, and Maiduguri was tested using the standardized coefficients of Skewness (Z1) and Kurtosis (Z2) statistics as defined by Brazel and Balling (1986). The standardized coefficient of Skewness (Z1) was calculated as:

$$Z_1 = \lceil\{ \sum_{i-1}^{N} (xi-\bar{x})^{3/N}\}/\left\{ \sum_{i-1}^{N} z \left(Xi-\bar{x}\right)^{2/N}\right\}^{3/2} \rceil/(6/N)^{1/3} \quad (1)$$

However, the standardized coefficient of Kurtosis (Z2) was determined as

$$Z_2 = \lceil\{ \sum_{i-1}^{N} (xi-\bar{x})^{4/N}\}/\{ \sum_{i-1}^{N} z (Xi-\bar{x}))^{2/N}\} \rceil -3/(24/N)^{1/2} \quad (2)$$

Where $\bar{x}$ is the long term mean of x_i values and N is the number of years in the sample. These statistics were used to test the null hypothesis that the individual temporal samples came from a population with a normal

(Gaussian) distribution. If the absolute value of Z_1 or Z_2 is greater than 1.96, a significant deviation from the normal curve is indicated at the 95% confidence level.

Normalized Rainfall Index (NRI), as defined by Türkes (1996) was used to show periods of different drought intensities in the study area. This index uses annual rainfall totals and the standard deviation to indicate the shortage of rainfall in any given year. The Index for a given station was computed for each year from 1986 to 2017 (Table 4). The Annual rainfall amount (R_{tsy}) expressed in millimeters, Long term mean (L_{tm}) and the Standard deviation (S_{td}) as recorded in Table 3 has been used in calculating the *NRI*. The classification was based on Türkes (1996) modified version of classification of normalized rainfall index.

$$\mathbf{NRI} = (\mathbf{R_{tsy}} - \mathbf{L}_{tm})/\mathbf{S}_{td} \quad (3)$$

Where R_{tsy} = the rainfall total for the station during a year (or season).

L_{tm} = the long term mean (of the period specified for the station) and.

S_{td} = Standard deviation of the annual (or seasonal) rainfall total for that station.

The Table 2 below is the Türkes (1996) modified version of the normalized rainfall index classification. In this very study, the modified classification of NRI was adopted.

Data on the annual income from the different occupation of the respondents were collected to determine the occupation that yielded more income to the people in the study area using one-way analysis of variance (ANOVA). Hypotheses (H_o and H_1) therefore, were formulated and tested as shown below.

Hypotheses for the income generated from various occupation

H_0: *There is no significant difference in income generated from the various occupation of the study population in the study area.*

H_1: *There is significant difference in income generated from the various occupation of the study population in the study area.*

Table 2 Modified Classes of NRI Values

Index	Character of Rainfall	Vulnerability level
1.31 or more	Very wet	Highly vulnerable
0.86 to 1.30	Moderately wet	Vulnerable
0.51 to 0.85	Mildly wet	Slightly vulnerable
0.50 to −0.50	Near normal	Not vulnerable
−0.51 to −0.85	Mild drought	Slightly vulnerable
−0.86 to −1.30	Moderate drought	Vulnerable
−1.31 or less	Severe drought	Highly vulnerable

Source: Adapted from Turkes (1996)

Table 3 Summarized rainfall statistics for the study area (Maiduguri, Nguru and Potiskum stations)

Stations	Number of Years	Total amount of Rainfall	Long term Mean	Std deviation	Variance	Skewness	Kurtosis
Maiduguri	31	1554.60	50.15	11.47	131.64	0.63	0.16
Nguru	31	1082.90	34.93	6.34	40.19	0.52	−0.87
Potiskum	31	1700.20	54.85	8.30	68.81	−1.01	1.15

Source: Computed by the author

Results

Tests for normality of rainfall in the study area

The results of the coefficient of Skewness and Kurtosis both show that rainfall series had no significant deviation from the normal curve (1.96) at 95% confidence level. Therefore, the rainfall sequence was normally distributed. The Standard Deviation (Std) decreased below the Meanwhile the Coefficient of Variation (CV) was considerable (Table 3).
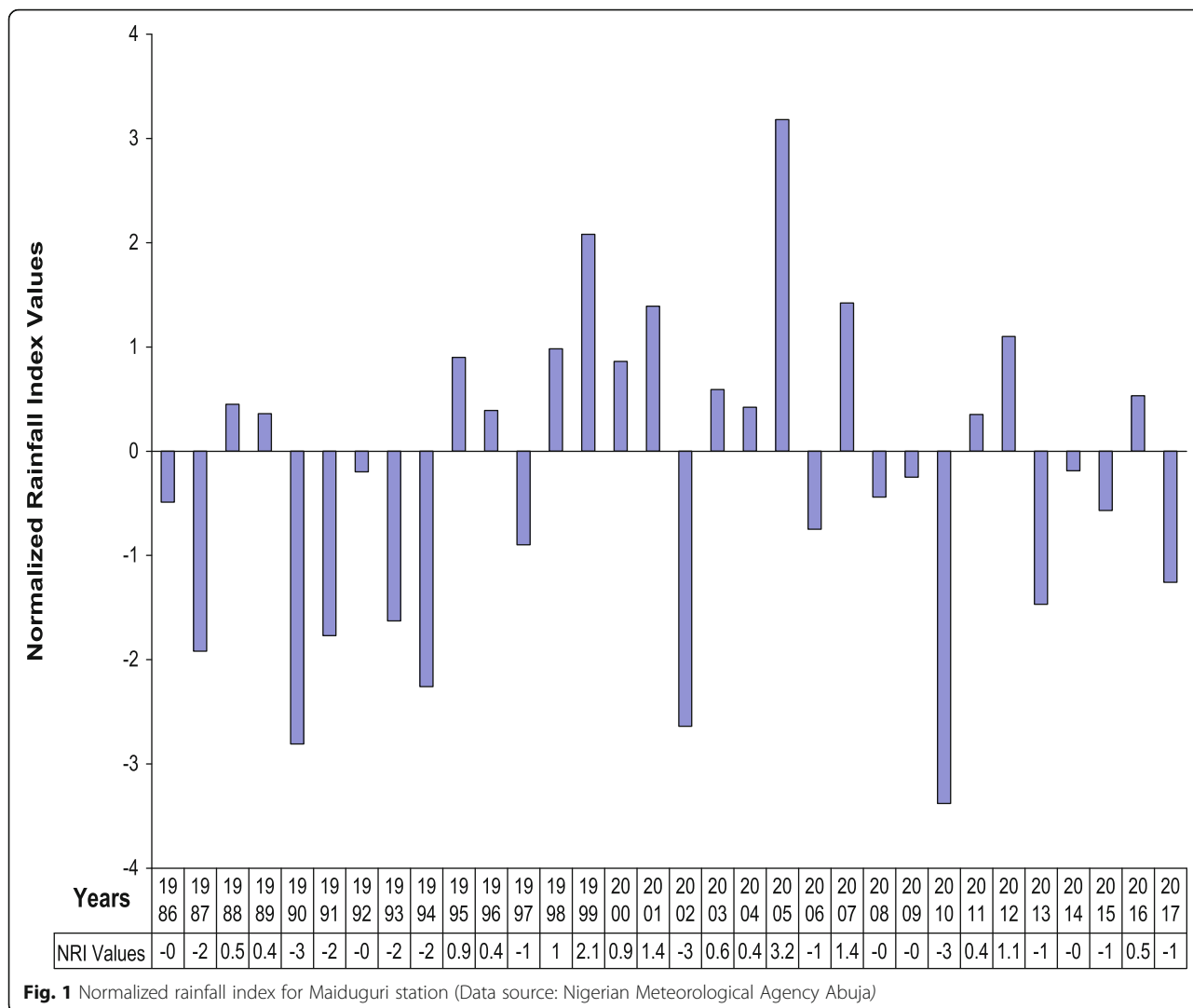
Normalized rainfall index (NRI)

NRI = (Rtsy − Ltm)/ Std for Potiskum station for 1986 = 811.4–720/100.2 = 0.91.

Table 4 Computation of Normalized Rainfall Index (NRI) for the study area (Maiduguri, Nguru and Potiskum Stations)

Years	NRI for Potiskum	Character of rainfall	NRI for Nguru	Character of rainfall	NRI for Maiduguri	Character of rainfall
1986	0.91	Moderately wet	−0.41	Near normal	−0.49	Near normal
1987	−1.36	Severe drought	−2.11	Severe drought	−1.92	Severe drought
1988	0.38	Near normal	0.14	Near normal	0.45	Near normal
1989	2.05	Very wet	−2.27	Severe drought	0.36	Near normal
1990	− 0.37	Near normal	0.15	Near normal	−2.81	Severe drought
1991	−1.17	Moderate drought	− 1.72	Severe drought	− 1.77	Severe drought
1992	− 1.18	Moderate drought	0.54	Mildly wet	−0.2	Near normal
1993	−1.45	Severe drought	−2.21	Severe drought	−1.63	Severe drought
1994	0.68	Mildly wet	2.78	Very wet	−2.26	Severe drought
1995	−1.15	Moderate drought	−0.77	Mild drought	0.90	Moderately wet
1996	0.26	Near normal	0.99	Moderately wet	0.39	Near normal
1997	0.29	Near normal	1.58	Very wet	−0.90	Moderate drought
1998	1.02	Moderately wet	0.72	Mildly wet	0.98	Moderately wet
1999	0.24	Near normal	0.39	Near normal	2.08	Very wet
2000	−1.65	Severe drought	−1.6	Severe drought	0.86	Moderately wet
2001	0.55	Mildly wet	−0.45	Near normal	1.39	Very wet
2002	−0.29	Near normal	0.58	Mildly wet	−2.64	Severe drought
2003	0.22	Near normal	1.01	Moderately wet	0.59	Mildly wet
2004	−2.16	Severe drought	−2.84	Severe drought	0.42	Near normal
2005	0.47	Near normal	0.56	Mildly wet	3.18	Very wet
2006	−0.91	Moderate drought	−0.14	Near normal	−0.75	Mild drought
2007	−0.48	Near normal	0.83	Mildly wet	1.42	Very wet
2008	1.02	Moderately wet	−1.94	Severe drought	−0.44	Near normal
2009	−0.54	Mild drought	−1.02	Moderate drought	−0.25	Near normal
2010	−1.53	Severe drought	0.88	Moderately wet	−3.38	Severe drought
2011	−0.53	Mild drought	−0.98	Moderate drought	0.35	Near normal
2012	1.02	Moderately wet	0.87	Moderately wet	1.10	Moderately wet
2013	−0.13	Near normal	−0.63	Mild drought	−1.47	Severe drought
2014	0.90	Moderately wet	0.61	Mildly wet	−0.19	Near normal
2015	−0.33	Near normal	−1.21	Moderate drought	−0.57	Mild drought
2016	0.57	Mildly wet	0.69	Mildly wet	0.53	Mildly wet
2017	−1.27	Moderate drought	−0.97	Moderate drought	−1.19	Moderate drought

Source: Computed by the Author using Microsoft Excel

Fig. 1 Normalized rainfall index for Maiduguri station (Data source: Nigerian Meteorological Agency Abuja)

The NRI calculations for the rest of the stations per year followed the same procedure. The results are shown in Table 4.
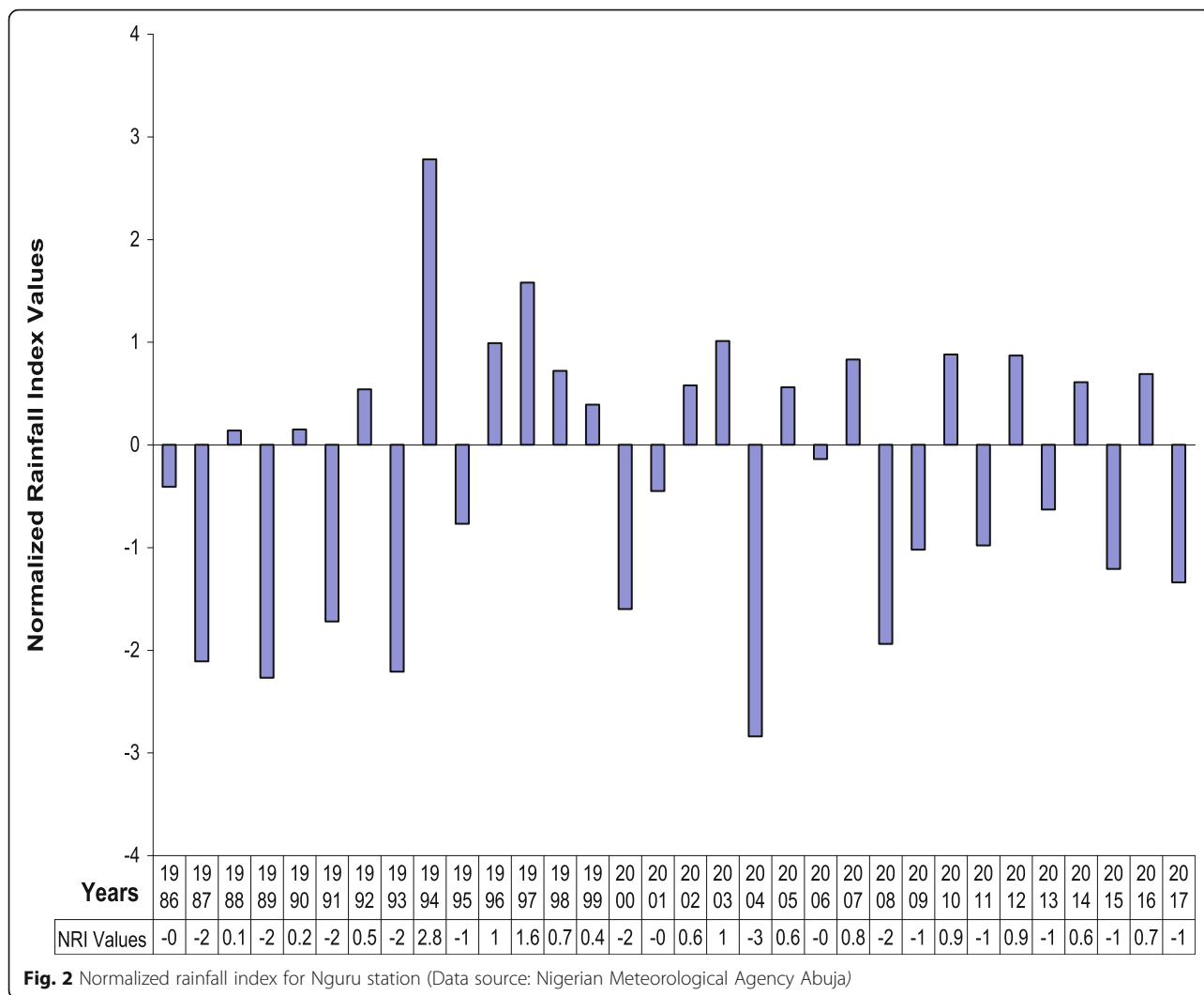
The incidence of droughts in the study area
The results on the Normalized Rainfall Index analysis in the study area are also presented graphically in Figs. (1–3) for Maiduguri, Nguru and Potiskum stations. The results show that the study area experiences mild to severe drought events. Severe drought conditions occurred in the northeastern and central parts of the study area (Maiduguri station) in 1987, 1990, 1991, 1993, 1994, 2002, 2010 and 2013 with a moderate drought that occurred in 1997 and 2017, including mild droughts of 2006 and 2015 (Fig. 1). In the Northwestern part of the study area (Nguru station), severe droughts occurred in 1987, 1989, 1991, 1993, 2000, 2004 and 2008 with moderate droughts in 2009, 2011, 2015 and 2017 and also mild droughts in 1995 and 2013 (Fig. 2). In the southern

parts of the study area (Potiskum station), severe droughts occurred in 1987, 1993, 2000 and 2010, with moderate droughts that occurred in 1991, 1992, 1995, 2006 and 2017, while mild droughts occurred in 2009 and 2011(Fig. 3).

Economic activities of the households in the study area
The survey on the economic activities of the households reveals that the study population is involved in five major economic activities that influence their livelihood security (Table 5). The result shows that 65% of the total household respondents were involved in farming as their major source of livelihood. However, 35% of the total population was involved in non-farming activities such as trading (15%), civil service (11%), artisan (6%) and fishing (3%). Table 5 also shows the percentage variations in household respondents involved in different economic activities in the seventeen LGAs in the study area. The result shows that Bade, Damaturu, Nguru,

Years	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NRI Values	-0	-2	0.1	-2	0.2	-2	0.5	-2	2.8	-1	1	1.6	0.7	0.4	-2	-0	0.6	1	-3	0.6	-0	0.8	-2	-1	0.9	-1	0.9	-1	0.6	-1	0.7	-1

Fig. 2 Normalized rainfall index for Nguru station (Data source: Nigerian Meteorological Agency Abuja)

Potiskum, Fika, Gujba and Gulani have 56%, 77%, 81%, 71%, 44%, 46%, 49% of the total household respondents that were engaged in non-farming activities respectively. Moreover, Karasuwa, Jakusko, Machina, Yunusari, Yusufari, Busari, Fune, Nangere, Geidam and Tarmuwa have 28%, 26%, 27%, 27%, 21%, 27%, 28%, 30%, 30% and 28% of the total household respondents that were engaged in non-farming activities respectively.

### Income status of the respondents in relation to their economic activities

The result on the mean annual income of the respondents generated from five different occupations was farming (N121, 450), Trading (N58, 741), Civil service (N33, 000), Fishing (N28, 064) and Artisan (N28, 737) (Table 6). However, the analysis of variance to determine which occupation that yielded more income to the people of Yobe State produced an F-ratio of 13.77 and *p*-value of .00001 (Table 7). Since the calculated F-ratio

is greater than p-value at 0.05 level of significance, Ho was rejected and H1 was accepted. Thus, there is a statistically significant difference in the income of the respondents from different occupations in the study area. This implies that occupation with higher mean income level provides more opportunities to the people for income generation.

Discussion
The impact of droughts on the environment and human comfort in the study area

The incidences of drought in the study area indicate that, out of 32 years under study, only 12 years were free from drought. The first (1986–1995) and third (2006–2017) decades experienced very high incidences of droughts, particularly mild to severe droughts, thus making the decades the driest period. However, the second decade (1996–2005), witnessed the least incidences of droughts, thus making the period relatively wet
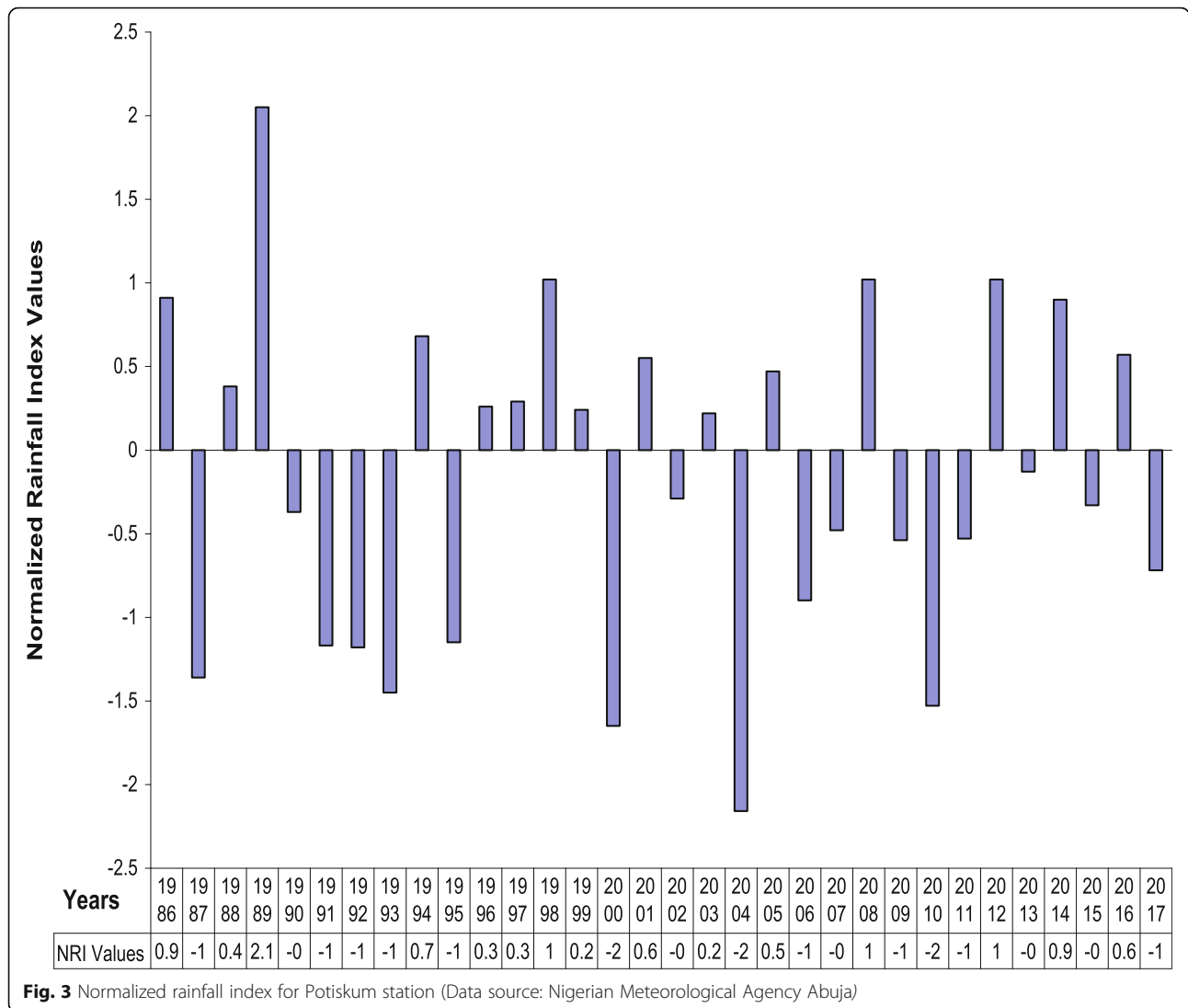
Fig. 3 Normalized rainfall index for Potiskum station (Data source: Nigerian Meteorological Agency Abuja)

Years	19 86	19 87	19 88	19 89	19 90	19 91	19 92	19 93	19 94	19 95	19 96	19 97	19 98	19 99	20 00	20 01	20 02	20 03	20 04	20 05	20 06	20 07	20 08	20 09	20 10	20 11	20 12	20 13	20 14	20 15	20 16	20 17
NRI Values	0.9	-1	0.4	2.1	-0	-1	-1	-1	0.7	-1	0.3	0.3	1	0.2	-2	0.6	-0	0.2	-2	0.5	-1	-0	1	-1	-2	-1	1	-0	0.9	-0	0.6	-1

compared to other decades. Some of the droughts that occurred during the period of study were localized, while other incidences of droughts affected the entire study area with serious negative consequences on the vital life support systems (rivers, wetlands and rangelands) that provide means of livelihood to the households.

However, the researcher observed that the respondents were predominantly involved in 5 major economic activities. The greater percentage of the total respondents was engaged in farming activities (65%) than non-farming activities (35%) for the purpose of generating income which was used to enhance their livelihood. The study observed that most respondents from other employment such as trading, civil service, artisan and fishing activities were also involved in farming. Moreover, the analysis of variance on the economic activities that generated more income to the households in the study area shows that farming activities provided more

opportunities for income generation. Apart from trading with few manufactured goods, most of the industries in the study area use the raw materials sourced locally especially from farm produce. Therefore, the livelihood of the households living in the study area predominantly depends on agriculture. Consequently, poor regions of the world, such as Africa, which depends on agriculture, have been described as one of the most vulnerable regions to the impacts of climatic and environmental changes, particularly drought, desertification and flood (Reid and Vogel 2008, Tschakert 2007). Thus, in-depth interviews with the key informants show that water scarcity due to the occurrence of droughts affects the agricultural outputs in the study area. There were food shortages resulting from an abnormal reduction in crop yield due to droughts. Irrigation projects which would have served to mitigate these problems were also affected by water shortages as most of the dams dried up

Table 5 Major economic activities of the respondents in the study area

LGA's	Farming	Trading	Civil Service	Artisan	Fishing
Bade	11 (44%)	5 (22%)	2 (8%)	4 (16%)	2 (10%)
Busari	14 (73%)	2 (12%)	1 (4%)	1 (5%)	1 (6%)
Damaturu	4 (23%)	3 (20%)	6 (40%)	2 (17%)	0 (0%)
Fika	13 (56%)	6 (26%)	2 (10%)	2 (8%)	0 (0%)
Fune	37 (72%)	4 (8%)	3 (6%)	5 (10%)	2 (4%)
Geidam	19 (70%)	3 (12%)	1 (5%)	1 (4%)	2 (9%)
Gujba	12 (54%)	3 (15%)	3 (13%)	2 (7%)	2 (11%)
Gulani	9 (51%)	5 (23%)	2 (12%)	1 (8%)	1 (6%)
Jakusko	29 (74%)	4 (10%)	3 (8%)	2 (5%)	1 (3%)
Karasuwa	13 (72%)	3 (15%)	1 (7%)	1 (6%)	0 (0%)
Machina	8 (73%)	1 (10%)	1 (9%)	1 (8%)	0 (0%)
Nangere	12 (70%)	3 (18%)	2 (7%)	1 (5%)	0 (0%)
Nguru	5 (19%)	9 (35%)	6 (23%)	4 (15%)	2 (8%)
Potiskum	10 (29%)	15 (43%)	6 (17%)	4 (11%)	0 (0%)
Tarmuwa	9 (72%)	1 (9%)	2 (12%)	1 (5%)	0 (2%)
Yunusari	16 (73%)	2 (9%)	2 (8%)	1 (4%)	1 (5%)
Yusufari	15 (79%)	2 (10%)	1 (5%)	0 (6%)	0 (0%)
Total	260	59	44	24	13
%	65	15	11	6	3

Source: Fieldwork 2017

Table 6 Annual Income of the Respondents from different Occupations

LGA's	Farming	Trading	Civil service	Fishing	Artisan
Bade	111,650	56,000	34,000	29,564	37,135
Busari	53,770	27,250	25,000	30,560	27,000
Damaturu	85,670	167,450	51,000		46,553
Fika	149,450	45,325	30,000		26,972
Fune	119,630	32,745	26,000		21,126
Geidam	79,820	27,000	27,000	32,675	23,000
Gujba	193,240	69,000	36,000	24,530	31,704
Gulani	188,467	57,000	32,000	28,225	30,567
Jakusko	75,550	26,125	26,000		17,500
Karasuwa	69,450	36,000	28,000		19,350
Machina	82,650	31,000	31,000		21,235
Nangere	128,725	34,000	34,000		31,075
Nguru	162,770	139,765	48,000	39,435	46,600
Potiskum	356,540	156,000	49,000		42,750
Tarmuwa	94,950	42,000	33,000		22,840
Yunusari	57,670	27,815	27,000	21,645	23,450
Yusufari	54,650	24,115	24,000	17,875	19,670
Mean	121,450	58,741	33,000	28,064	28,737
STD	75,290	47,572	8551	6724	9465

Source: Fieldwork 2017

during droughts, thus, exacerbates the impact of droughts on the environment and human comfort. Abaje et al. (2013) state that during drought periods, the land is under increased stress from both human beings and livestock, through unsustainable agricultural practices, leading to increasing desertification (Oyekale 2009; Eze et al. 2018). Mortimore et al. (2009) have shown that overgrazing becomes destructive during drought, when large areas that would normally have been available for grazing dry up, animals are forced to feed on any available edible vegetation they could find. This may be harsh enough to cause severe damage to the environment, particularly in the study area. Nyong et al. (2003) argue that once the unsafe balance of the plant communities adapted to the characteristically variable climate is upset by persistent drought, complete ecological recovery may be impossible, even when the rains return leading to severe desertification.

The increasing drought occurrences in the study area, therefore, have great implications for the household livelihoods. The occurrence of mild drought results in a reduction in crop yield and cattle weight loss, whereas the occurrence of severe drought results in total crop loss, in increased mortality rates of livestock (Abaje et al. 2013; Wu et al. 2015a, 2015b). The reduction in crop yield and livestock loss affects revenue generation and household income. Consequently, about 65% of the total respondents depends primarily on farming, thus increasing drought occurrences affects household revenue generation and food availability in the study area. Eze et al. (2018) argue that households whose livelihood depends on farming suffer losses during drought because the crop yield and livestock production are reduced and also, the weight and strength of cattle for the purpose of draught power is drastically reduced. Moreover, the frequent incidences of droughts resulted to the lowering of water table and sustenance of few rivers. Thus, developmental projects that depend on water from rivers and groundwater sources suffer a great setback during and after drought. The lowering of water table has a negative effect on the construction of wells and boreholes. This is because the depth of the water table increases, and may not be reached depending on a place, thus reducing water availability for the household uses, particularly those that depend on surface and groundwater sources. Therefore, dependency on agriculture increases the vulnerability of the households to drought. Moreover, persistent and substantial reduction in the provision of ecosystem services as a result of the incidence of droughts possesses great threats to agricultural productivity.

Recommendations

To address the impact of drought on households, food systems have to become more efficient and resilient (Eze et al. 2018). Moreover, climate-smart practices aim to improve food security, help communities adapt to

Table 7 Analysis of variance of income of respondents from different occupations in Yobe state

Source of Variation	Sum of Squares	Degree of Freedom (DF)	Mean Sum of Squares	F-ratio	P-Value
Between Groups	100,736,213,073	4	25,184,053,268	13.77243	.00001
Within Groups	129,829,514,017	71	1,828,584,704		
Total	230,565,727,090	73			

Significant at 0.05 confidence level (Source: Fieldwork 2017)

drought and contribute to drought mitigation by adapting to appropriate practices, developing enabling policies and mobilizing needed finances. Therefore, we recommend the short and long-term measures to protect the households against the disaster and problems of drought through the following:

(i) Establishment of irrigation system: Irrigation system (Tube-well) will help households that are dependent on farming to cultivate and harvest crops during drought or shortfall in rainfall amount. This can be done by providing tube-well for every registered farmer in the state, by the government.

(ii) Use of improved crop varieties: Making early maturing and drought resistant crops available and affordable will enable farmers to cultivate and harvest crops within a short period, while drought-resistant crops should be able to survive and grow with little water available in the soil. The new improved crop varieties enhance the reduction of drought impacts on farmers.

(iii) Livelihood diversification: Government should create economic activities that will generate non-farm employment to reduce the impact of drought on the households. These could be achieved through finance and technical assistance such as loans and capacity building. When finance and technical assistance are given to the households, it could motivate them to venture into small and medium scale businesses such as skill acquisition, (such as production of local briquettes, tailoring, cake making, trades and others, which on its own will generate employment

Conclusion

In conclusion, there are high incidences of drought in the study area. The frequent occurrence of droughts has impacted negatively on the environment and human comfort. However, the predominant households in the study area are highly dependent on agriculture. Consequently, agriculture is, however, currently being constrained by the frequent occurrence of drought, in the study area. Moreover, dependency on farming has contributed to the high level of households' vulnerability to drought in the study area. Thus, there is a need for integrated development schemes aimed at livelihood diversification and increasing the adaptive capacity of households to drought in the study area. Although the results of this study indicate the specific features of a State, future research should focus on a national level, which is highly aggregated. More capacity and work is needed particularly at the national level to assess the extent of drought and its impact on the households.

Finally, the study has successfully used Normalized Rainfall Index and Analysis of variance to determine the extent of drought occurrences and its implications on the households, which has much to offer in terms of policy decisions.

Author's contributions
The whole research work (design of the study, data collection, analysis, interpretation and writing the manuscript) were carried out by the author alone. The author read and approved the final manuscript.

Competing interests
The author declares that he has no competing interests.

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