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Rainfall Variability related to Global Climate Change: Its Effects on the Economic Activities in the North-Eastern Part of Nigeria

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Abstract: This study analyses the impacts of rainfall variability caused by climate change in the north-eastern region of Nigeria. The study determined the trends and variation in rainfall at four stations for thirty years period, 1980-2009. Rainfall variability in the region was analysed in terms of spatial and temporal distribution. The study also examined the different sources of water, determined the changes in water availability from these sources, identify activities affected by climate change and determined adaptation strategies to cope with climate change. Secondary and primary (questionnaire survey of households in the area) data was used. A sample of 210 households from seven rural communities in North-eastern region of Nigeria was extracted from the data set for analysis. Both qualitative and quantitative statistical techniques were used to present and analysed the data respectively. The results revealed that rainfall variability have occurred in north-eastern region of Nigeria during the study period, exhibiting significant spatial and temporal variations. A drought occurred in the region when the annual rainfall is less than 85% of the long term mean. In conclusion, in order to adapt to rainfall variability, farmers adopted high yield varieties and crop and livestock diversifications.

Keywords: Climate Change, Water, Environment, Variability

Introduction

Recent growth in the world economy is even more remarkable. During the last half of the twentieth century, the world economy expanded sevenfold. Most striking of all, the growth in the world economy during the single year of 2000 exceeded that of the entire nineteenth century. Economic growth, now the goal of governments everywhere, has become the status quo. Stability is considered a departure from the norm. As the economy grows, its demands are outgrowing the earth, exceeding many of the planets natural capacities. Water use tripled, but the capacity of the hydrological system to produce fresh water through evaporation change little (Lester, 2004). This is why water tables are now falling in countries that contain more than half the world's people. While there is a broad replication that are facing a future of water shortages, not everyone has connected the dots to see that a future of water shortages will be a future of food shortages (Dimento and Doughman, 2007).Also, as global temperatures rise, rainfall will decline in already dry areas such as the air and semi-arid Sahel. Africa is thus particularly vulnerable to global warning because of its heavy dependence on rainfall agriculture. Global warning will reduce water availability for agriculture, affecting both crop yields and the carrying capacity of land in respect of livestock (Devereux, 2001).

Over the course of the twentieth century, decreasing rainfall in the semi-arid region has pushed northern pastoralists southwards into land occupied by sedentary farmers, leading to conflicts and widespread destruction of farmland and cattle. Meanwhile, to meet the growing needs for food, farmers are expanding into marginal lands traditionally used by pastoralists, heightening competition between livestock and agricultural production (Nyong, 2007). The livelihoods of dry-land producers who lack access to irrigation are particularly sensitive to fluctuations in precipitation (Kurukulasuriya and Mendelsohn, 2007).In addition to high inter-annual variability, the rainfall regime of the north-eastern Nigeria is characterized by high concentration in few months usually from August-September, which is not only intermittent but with storms. Thus, the region is prone to recurrent and sometimes intense period of drought especially within Borno and

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Yobe states which share a common boundary with the Sahara desert in the extreme end of Nigeria.It is on this background that the study looked at the rainfall variability and its effect on the economic activities in the North-eastern region of Nigeria.

Statement of the Problem

Rainfall in the north-eastern part of Nigeria has been fluctuating over the specified study period. The data gotten from the Nigerian Meteorological Agency showed that analysis of rainfall data (1980-2009) revealed that there had been high and reduced annual amount of rain in the study areas. For instance, Potiskum had the highest amount of rainfall of 967.1 mm in 1988 while the lowest amount of 368.5mm was recorded in 1987. The concern is likely to affect the agricultural sector because over 80% of Nigerians' depend on rain-fed agriculture.

Objectives of the Study

To examine rainfall variability in the region over the years of study

To identify and examine activities affected by these changes.

To determine the adaptation strategies the people have used to cope with water scarcity and climate change.

The Study Area

The study area is the North-eastern region of Nigeria. It covers part of Bauchi, Borno and Yobe States and is a futureless plain, gently sloping east and north-eastward toward lake Chad. The many rivers and streams that flow through the study area are seasonal. Most of them on the way to Lake Chad flow into marshy areas and disappear by evapotranspiration before searching the lake. The area is the home land of the Kanuris' the Shuwars' and fulanis'.

Climate of the Study Area

The climate of the area is hot, semi-arid and like the rest of Nigeria, dominated by two main air masses. This brings with them the rain bearing south western winds, and the cold dry and dusty northeastern winds, locally known as the harmattan. At different times of the year, one or the other of the winds prevail and the area experiences either rainfall or the dry harmattan depending on the advance or retreat of the other yearly extremes in temperature range from 150c during the harmattan months to 40oc during the months of April and May. Evaporation rates are very high, particularly during the dry, hot season. The wet season last about three months and annual rainfall averages about 600mm.

Method of Data Collection

Types and Sources of Data

The secondary data was drawn strictly from the Nigerian Meteorological Agency, for the rainfall data for 30 years 1980-2009 and the Assessment of Impacts and Adaptations to Climate Change (AIACC) project conducted in Northern Nigeria by the Center for Environmental Resource and Hazards Research in the Department of Geography and Planning, University of Jos.

Sample and Sampling Technique

This research was an offshoot of the AIACC project conducted in Northern Nigeria by the Center for Environmental Research and Hazard Research in the Department of Geography and Planning, University of

Jos. The questionnaire was the major tool for data collection. Systematic random sampling technique was used to select communities and households included in the survey. A total of 7 rural communities across the North-eastern region of Nigeria were selected for the survey. Copies of the questionnaire were then administered to 30 households in each of the selected communities given a total of 210 responses. The selected communities include: Badrama, Buniyadi, Chigowa, Damask, Kubani, Madara and Maimallamari. Through retrospective questioning, information on sources of water was as it helped us to determine the main surface of water and observed changes in water availability from water sources. Information on drought was useful as it told us which activities were affected most by water scarcity and climate change. Information on adaptation gave strategies for adaptation.

Techniques for Data Analysis

The descriptive statistical technique was used for the study. The descriptive statistics included data summaries in form of frequencies and percentages presented in tables.

Results and Discussion

The result showed that the North-eastern region of Nigeria generally experienced fluctuations in rainfall during the period of study (1980-2009), with the highest amount of 3438.6mm experienced in 1999 and the lowest amount of 1729.6mm experienced in 1987. The study period began with a wet phase of 2630.2mm, which lasted to 1981. A dry phase started in 1982 and lasted for three years. In 1986, another wet period was experienced followed by another dry periods in 1987, which interrupted the wet period from 1986-1989. After a dry spell in the 1990, the region continues to experience a wet phase up to 2009. Table 1 depicts the situations at the various stations.

Table 1: Total Annual Rainfall (in mm) for Four Stations in North-eastern Region of Nigeria (1980-2009)

	STATIONS				
Year	Potiskum	Nguru	Maiduguri	Bauchi	Total
1980	682.1	339.6	621.3	988.2	2630.2
1981	733.5	428.9	461.4	1250.8	2874.6
1982	575.3	409.3	355.9	897.1	2237.6
1983	524.7	236.7	263.5	773.3	1798.2
1984	462.3	332.4	348.1	893.7	2036.5
1985	543.5	419.2	414.1	725.6	2102.4
1986	810.4	240.6	509.5	946.1	2506.6
1987	368.5	250.2	366.3	744.6	1729.6
1988	967.1	320.6	622.8	920.7	2831.2
1989	784.3	338.6	610.3	909.4	2642.6
1990	410.5	418	426.5	879.6	2134.6
1991	676.2	333.9	486.1	949.6	2445.8
1992	624.6	415.1	584.6	1230.4	2854.7
1993	556.8	298.3	490.7	1141.9	2487.7
1994	785.2	491.4	317.1	1121.1	2714.8
1995	568.5	383.3	630.6	961.4	2633.8
1996	747.5	358.2	630.5	1140.6	2876.8
1997	697.6	548.3	549.7	896.7	2692.3
1998	820.8	467	692.2	1122.6	3102.6
1999	746.5	446.8	844.6	1400.7	3438.6
2000	593.8	355.6	677.4	1247	2873.8

2001	777.3	416	770.3	1318.2	3281.6
2002	669.2	442.9	368.3	819.1	2299.5
2003	703	450.3	653.3	989.5	2796.1
2004	616.9	293.5	616.1	865.5	2392
2005	683.9	501.7	901.9	1047.3	3134.8
2006	648.9	407.9	519.5	949	2524.9
2007	563.7	487.6	1076.3	1136.9	3264.5
2008	694.1	338.9	622.9	1133.1	2789
2009	676.1	366.5	694.1	1531.3	3168

Spatial Variability of Rainfall in Northeastern Region of Nigeria

To assess the variability in the rainfall distribution within the study area during the study period, table 1 above has been used in the study and for the entire study area during the 30 years study period to assess the spatial variability of rainfall.The standard deviations and coefficients of variability were calculated on annual bases. From the table below, it can be observed in Table 2:

Table 2: Total, Mean values, Standard Deviation and Coefficient of Variation for Annual Rainfall (mm) for four stations in North Eastern Region of Nigeria.

Stations	Postiskum	Nguru	Maiduguri	Bauchi
Total	19712.4	11537.3	17125.9	30931
Mean	657.08	384.58	570.86	192.75
Standard	125.87	77.92	179.08	192.75
Coefficient of Variation	19.16	20.26	31.37	18.69

Source: Author's Analysis

From the analysis, Bauchi recorded the highest annual standard deputation of 192.75 while Nguru experienced the least value of 77.92. The coefficient of variation which expresses the relative deputation in rainfall amount, are also presented in the table above. During the thirty year period of study, Bauchi has the least coefficient of variation in rainfall of 18.69% followed by Potiskum with 19.16%, Nguru 20.26% and Maiduguri with 31.37%. From the results of these analyses, it is suggested that spatial variations in rainfall in the study area are attributed to the total amount of rainfall received at each location where the annual rainfall was low, the coefficient of variation was high and vice-versa.

The following section will reveal the perception of respondent for the past 10 years (1992-2003).

Table 3: Perception of Drought Responses

What is drought	Frequency	Percentage
Lack of rain in rainy season	93	48.4
Insufficient rainfall after planting	38	19.8
Absence or shortage rain	32	16.7
Dryness due to lack or shortage of rain	9	4.7
When your crops dries up or not producing anything	20	10.4
Total	192	100

Source: AICC-AF; 92, Data Base summarized by author, 2020

From the trends of rainfall in the four stations used for the study, a number of drought periods were discovered and presented in table 1and 2. This is in line with the perception of the respondents on drought for the past 10 years (1999-2003) when the questionnaire for rural households and droughts in theSahel region of West Africa; Vulnerability and Effective Adaptation Measures (AIACC-FC: 92) data was collected.

Table 4: Sources of water in North-eastern Region of Nigeria

Water sources	Frequency	Percentage
Rain	98	27.8
Pond	3	0.9
River	2	0.6
Well	149	42.3
Boreholes	55	15.6
Pipe	45	12.8
Total	352	100

The response showed that the major source of water is the well, which can be seen by the responses. 42.3% of the respondent affirmed to this.

Furthermore, observed changes in rainfall under these conditions were asked (total amount, time of onset, time of cessation, frequency of rain events and intensity of rain events), Ground water under the following conditions (level of water table, timing of recharge (rise) and timing of discharge (fall) and stream flow with respect to the following conditions (level of stream flow, time of recharge, time of cessation and frequency of floods. The data obtained in the field are summarized and presented in table 5.

Table 5: Drought and Environmental concerns in the North-eastern region.

Changes observed over the 10 years								
Sources of Water	Increase		%	Decrease		%	No changes	%
Rainfall								
Total Amount	86	43.2	86	44.7	24	12.1		
Time on set	49	24.6	99	49.7	51	25.6		
Time of cessation	43	21.6	126	63.3	30	15.1		
Frequency of rain events	59	29.6	111	55.8	29	14.6		
Intensity of rain events	42	21.1	127	63.8	30	15.1		
Ground water								
Level of water table	45	22.6	89	44.7	65	32.7		
Timing of recharge (rise)	66	32.2	96	48.2	37	18.6		
Timing of discharge (fall)	41	20.6	100	50.3	58	26.1		
Stream flows								
Level of stream flows	45	22.6	86	43.2	68	34.2		

Time of recharge		35		17.6	99		49.7	65	32.7
Time of cessation		29		14.6	109		54.8	61	30.7
Frequency of floods	36		18.1	82		41.2	81	40.7	

Source: AIACC-AF; 92, Data Base Summarized by the author, 2020

From the above table, the data revealed that the general amount of rainfall in the study area has decreased along with the time of commencement by 44.7% and 49.7% respectively. The period, in which it normally stopped to mark the commencement of the dry season, the frequency of the rainfall events and its intensity has also decrease over the years by 63.3%, 55.8% and 63.8% respectively in the study area. The ground water table level, its recharge and discharge decreased by 44.7%, 48.2% and 50.3%. This can be attributed to the fact that the principal source of natural recharge for ground water is rainfall. This is because decrease in total amount of rainfall has led to decrease in groundwater recharge.

Adaptation Strategies Adopted by People in the North East to Respond to Rainfall Variability

From the analysis of the survey data, a number of coping strategies have been identified. The coping strategy is divided into two categories, past and present. Past coping strategies are strategies adopted by the respondents during droughts that occurred in 1994 or earlier, while present coping strategies are more recent strategies adopted by the respondents after 1994.

Table 6: Respondents Coping and Adaptation Strategies

Strategy		Past	%	Present		%		Total
Drought resistant variety		61	54	52		46		113
Crop diversification	47	38.2	76		61.8		123	
Livestock diversification		60	57.1	45		42.9		105
Early matured crop varieties	43	29.3	104		70.7		147	
High yield varieties	38	25.3	112		74.7		150	
Low input varieties	41	42.3	56		57.7		97	
Irrigated crops	27	64.3	15		35.7		42	
Replanting	83	72.2	32		27.8		115	
Herd movement	25	54.3	21		45.7		46	
Herd supplementation	23	41.8	32		58.2		55	
Culling animals	18	41.9	25		58.1		43	
Labour migration		29	59.2	20		40.8		49
Selling assets	71	70.3	30		29.7		101	
Herds sedentarization	40	63.5	23		36.5		63	
Farm relocation	74	74	26		26		100	
Herd/farm sizes	35	53.8	30		46.2		65	
Water exploitation method		33	60	22		40		55
Water use	69	78.4	19		21.6		88	
Water storage methods	49	57.6	36		42.4		85	
Food storage	118	78.1	33		21.9		151	

Source: AIACC-AF: 92, Data Base Summarized by Author, 2020

Food storage was the coping strategy adopted by the largest number of the respondents in the past, followed by replanting of crops when they are lost; farm relocation; selling of assets; varieties of strategies for water use; cultivation of drought resistant varieties and livestock diversification. Recently, the number of people using food storage, replanting of crops when they are lost and farm relocation have declined from 78.1% to 21.9%, 72.2% to 27.8% to 26% respectively. Other strategies that have declined in use are selling of assets, varieties of strategies for water use, cultivation of drought resistant varieties and livestock diversification. These strategies have declined from 70.3% to 29.7%, 69% to 21.6%, 54% to 46% and from 57.1% to 42.9% respectively. Nonetheless, some coping strategies have increased in use, most notably, adoption of high yield varieties, early mature crop varieties and crop diversification. These strategies have increased from 25.3% to 74.7%, 29.3% to 70.7% and from 38.2% to 61.8% respectively. Others are low input varieties from 42.3% to 57.7%, herd supplementation, from 41.8% to 58.2% and culling animals from 41.9% to 58.1%.

Conclusion

As it was observed, there was a significant variation in climate in rainfall. This is because, the research revealed that there was an all-round decrease in the total amount of rainfall, time of on-set, time of cessation, frequency of rain events and intensity of rain events. The above indication showed the changes in the climate of the north-eastern region of Nigeria. We were able to discover periods of wet phase always alternating with dry spell periods. Coping and adaptation strategies presently used (high yield varieties, culling animals planting crops when they are lost, crop and livestock diversifications etc) were also discovered. The variation in rainfall in the four stations used in the study area and the water sources, the decreased observed in rainfall, groundwater and streams flows were indications of climate change and its adverse impact on the economic activities of the people in the North-eastern region of Nigeria.

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