An Analysis of Temporal Rainfall Variability in Argungu Area over the Last Half Climatic Year (1995-2012): Implication on Rainfed Crop Production

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Doi:10.5901/ajis.2013.v2n12p117

Abstract

This paper analyzes rainfall variability in Argungu area. Data for half climatic year 1995-2012 were obtained from Argungu station of Kebbi Agriculture and Rural Development Authority. Analysis of variance (ANOVA) was used to analyze the data. The results show that there is statistically significant difference in annual rainfall over the years. Analysis further revealed that the month of August, 2010 has the highest rainfall amount of 1066mm with the year 1996 receiving the least annual rainfall amount within the period under study respectively. The study recommends that since annual rainfall in the area is characterized by fluctuations, irrigation agriculture should be developed and supported by government to compliment rain-fed agriculture to encourage crop production in the area.

Keywords: *Rainfall, Variability, Significant, Analysis, Rain-fed*

1. Introduction

Rainfall is an important aspect in both climatic and geomorphic studies. The amount of rainfall in a given region is influenced by many factors among them relief, wind speed and direction (relative to coastal orientation) and distance from the ocean. For instance when humid air masses moving across a region are forced to rise over highlands/plateau tends to bring heavy rainfall (Ayoade, 1988 in Yusuf et al, 2012).

Rainfall variability which is the degree to which rainfall amounts vary across an area or through time is an important characteristic of the climate of an area. There are two types of rainfall variability; areal (spatial) and temporal. The study of the latter is important in understanding climate change. Areal variability is the variation of rainfall amounts at various locations across a region for a specific time interval while temporal variability is the amounts at a given location across a time interval. Both temporal and areal variability of precipitation may be measured in various ways. The resulting numerical value can be used to characterize the climate of a region and to deduce evidence of climate change.

According to Food and Agriculture Organization (FAO, 2002), rainfall variability from years to days is as much a characteristic of climate as the total amounts recorded. Low values, however, do not necessarily lead to drought, nor is drought necessarily associated with rainfall. Agricultural droughts occur when water supply is insufficient to cover crop or livestock water requirements. In addition to reduced rainfall, a number of factors may lead to agricultural drought some of them not always obvious (FAO, 2002).

Generally, water availability is the most critical factor for sustaining crop productivity in rain-fed agriculture. Even if a drought tolerant crop is introduced, water is not available to crops when there is no water in the soil. Rainfall variability from season to season greatly affects soil water availability to crops and thus poses crop production risks (Jawoo, 2010). Agricultural production is affected by many uncontrollable climatic factors, the number one being rainfall. The role of rainfall in crop production has been an area of interest to many researchers (Rukman et al, 2008).

However, the impact of rainfall on crop production can be related to its total seasonal amount. In the extreme case of droughts, with very low seasonal amounts, crop production suffers the most. But more subtle intra-seasonal variations in rainfall distribution during crop growing periods, without change in total seasonal amount can also cause substantial reduction in yields. This means that the number of rainy days during the growing period is as important if not more as that of the seasonal total (Jacson, 1989).

Agricultural productions in the study area suffers from the effects of rainfall variability due to fluctuations, unreliable nature coupled with uneven spread during crop growing periods often resulting in crop failure over past one and half decade. Sometimes, not even the introduction of early maturing seeds could help the situation as in most cases rainfall start late and terminate early.

The aim of this paper therefore is to analyze rainfall variability and impact of such on crop production in Argungu.

2. Data Sources and Method of Analysis

The data used for this study is secondary. Rainfall records of Argungu for eighteen year period (1995-2012) were collected from Kebbi Agricultural and Rural Development Authority zone 1 weather station. Analysis of Variance (ANOVA) was used to analyze monthly rainfall.

2.1 Study Area

Argungu is located between latitude $12^0$30'33"N to $12^0$40'54"N and longitude $4^0$20'54"E to $4^0$30'54"E covering an area of 428 KM^2 and elevation of 241 meters above sea level. It is bounded by Yabo Local Government area of Sokoto state to the North-East, in the South by Gwandu and Birnin Kebbi Local Government areas, while to the North and West by Augie and Arewa Local Government areas respectively.

The study area enjoys tropical continental type of climate, which is largely controlled by two air masses namely; tropical maritime and tropical continental blowing from Atlantic and Sahara desert respectively. The air masses determined the two dominant seasons, wet and dry. Humidity is 27% while wind blow at 11Km/h in ESE direction.

Argungu receive a mean annual rainfall of 800mm between May to September with a peak period in August, the remaining period of the year is dry. The average temperature is 26^0C and can rise up to 40^0C in the peak of hot season (March-July). However, during harmattan, (December – February) temperature falls to 21^0C.

Two groups of soils can be identified in the study area, the upland and Fadama soils. The Fadama consist of two distinct phases: wet and dry season operations. These two soil groups are generally characteristic of Sokoto Rima Basin. While the upland soils are generally sandy and well drained, the Fadama soils are generally clayey and hydromorphic which range from deep well drained soils, loamy sand, sandy loam, clay and clay loam.

The study area is mostly affected by desertification, which manifest itself by incidence of wind erosion and exposure of lateritic iron stone on the land scape. Desertification is the product of a number of factors both natural and man-made which include limited rainfall, indigenous method of cultivation, excessive sourcing for fuel wood and indigenous grazing techniques all these have combined to deprive the environment of its natural vegetation thus accelerating the incidence of soil erosion.

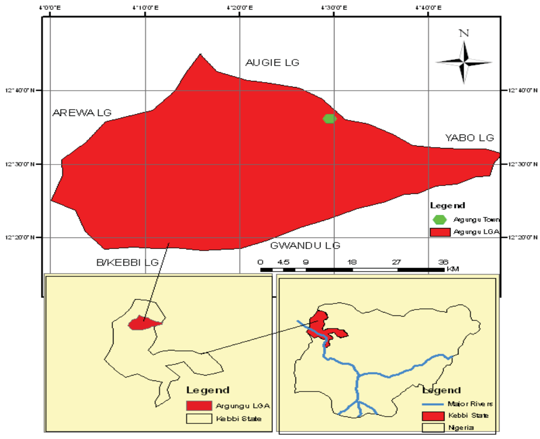

Figure 1: Location Map of the Study Area

3. Results and Discussion

The table below represent summarized monthly and annual rainfall data for the 1995-2012 for Argungu station. Maximum, average and minimum figures for monthly and annual rainfall for the area were also computed.

Table 1: Maximum, average and minimum rainfall at Argungu station 1995-2012

YEAR	MONTH												ANNUAL
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1995	0	0	0	71	0	129	136	137	49	0	0	0	522
1996	0	0	0	0	70	97	64	95	6	0	0	0	332
1997	0	0	0	4	139	106	160	153	43	4	0	0	609
1998	0	0	0	10	35	114	136	193	167	15	0	0	670
1999	0	0	0	1	68	34	131	258	249	58	0	0	799
2000	0	0	0	0	12	163	371	249	119	30	0	0	944
2001	0	0	0	10	43	102	314	266	95	4	0	0	834
2002	0	0	0	8	16	71	223	229	175	153	0	0	875
2003	0	0	0	2	38	78	234	261	152	14	0	0	779
2004	0	0	0	9	83	28	132	273	55	18	0	0	598
2005	0	0	0	0	26	84	174	148	102	19	0	0	553
2006	0	0	0	0	69	102	171	283	121	44	0	0	790
2007	0	0	0	0	108	52	385	227	127	0	0	0	899
2008	0	0	0	7	103	99	108	188	204	17	0	0	726
2009	0	0	0	0	15	80	77	218	152	51	0	0	593
2010	0	0	0	15	70	155	191	468	96	71	0	0	1066
2011	0	3	0	0	40	144	98	158	146	15	0	0	604
2012	0	8	0	0	44	40	152	188	106	135	0	0	673
MAX	**0**	**8**	**0**	**71**	**139**	**163**	**385**	**468**	**249**	**153**	**0**	**0**	**1066**
AVG	**0**	**1**	**0**	**10.94737**	**58.84211**	**96.89474**	**191.6842**	**234.7368**	**127**	**42.15789**	**0**	**0**	**733.2632**
MIN	**0**	**0**	**0**	**0**	**0**	**28**	**64**	**95**	**6**	**0**	**0**	**0**	**332**

Source: Kebbi Agriculture and Rural Development Authority Zone 1

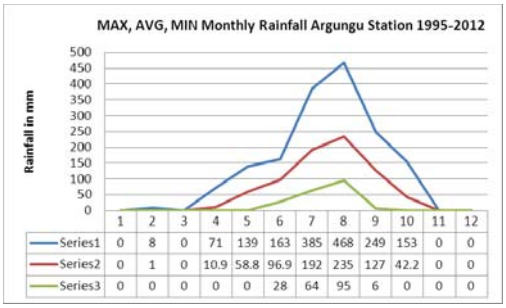

Fig 2: Graph showing maximum, average and minimum Rainfall

The graph above shows the maximum average and monthly trends in rainfall of the study area. Cumulatively, the month of August has the highest maximum of 468mm with average of 235mm and minimum of 95mm respectively over the last eighteen years (1995-2005).

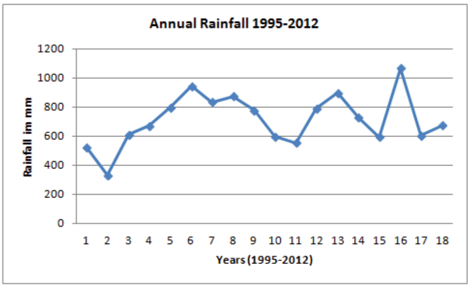

Figure 3: Graph showing annual rainfall 1995-2012

The graph of rainfall analyzed indicated the variability in rainfall trend for eighteen year period 1995-2012 which is characterized by fluctuations. The mean annual rainfall of the area being 800mm shows that at least for ten years, the area has witnessed low rainfall amount with the lowest (332mm) experienced in 1996 which is a drought year. However, the year 2010 received the highest rainfall amount of 1066mm.

Furthermore, at least for ten years within the period, agricultural production experienced low yield because most of the crops grown in the area (millet, sorghum, beans rice and groundnut) requires an average of 500mm-800mm (FAO, 1991)) of rainfall.

SUMMARY	Count	Sum	Average	Variance
1995	12	522	43.5	3512.818
1996	12	332	27.66667	1661.879
1997	12	609	50.75	4594.568
1998	12	670	55.83333	5524.697
1999	12	799	66.58333	9242.811
2000	12	944	78.66667	15195.88
2001	12	834	69.5	12071.18
2002	12	875	72.91667	8887.538
2003	12	779	64.91667	9376.265
2004	12	598	49.83333	6659.606
2005	12	553	46.08333	4108.447
2006	12	790	65.83333	8096.697
2007	12	899	74.91667	14809.17
2008	12	726	60.5	5949.909
2009	12	593	49.41667	5134.447
2010	12	1066	88.83333	18565.06
2011	12	604	50.33333	4368.424
2012	12	673	56.08333	4887.72

Table 2: Showing total sum, average and variance of Rainfall 1995-2012Argungu Station.

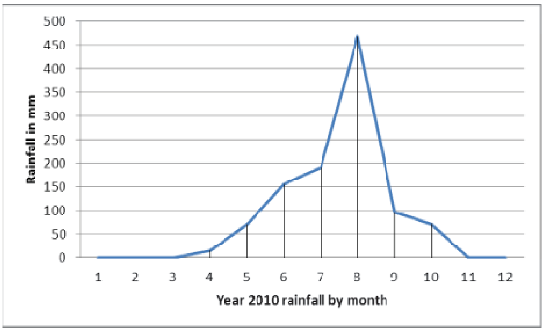

Figure 4: Graph showing monthly distribution of highest rainfall amount year 2010 (1066mm)

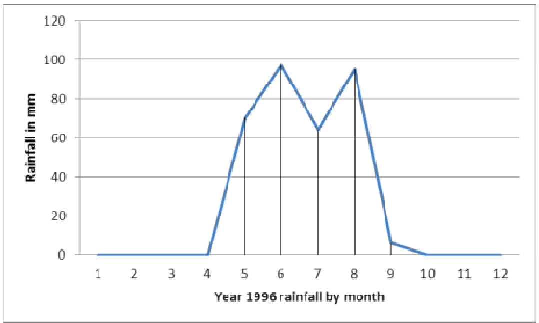

Figure 5: Graph showing monthly distribution of lowest rainfall amount year 1996 (332mm)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1202523.981	11	109320.4	54.26792086	1.6534E-54	1.835818655
Within Groups	410949.1111	204	2014.456			
Total	1613473.093	215				

Table 3 above indicate that there is a statistically significant difference in annual rainfall amount in Argungu between 1995-2012 since between groups variation is greater than within group variation

4. Conclusion and Recommendations

4.1 Conclusion

The study findings revealed that there is a great variability in rainfall amount in Argungu area. This was furher confirmed by the result of analysis carried out for the period 1995-2012. Fluctuations in rainfall affect crop production in the study area over greater part of the period under study.

Finally, rainfall variability in the area is an indication of climate change being experienced globally for which the study area is not an exception.

4.2 Recommendations

The significance of information on rainfall variability of Argungu area is vital for planning more especially against extreme situations such as drought and flooding in the light of foregoing this study recommendations are as follow:

1. Since annual rainfall is characterized by fluctuations, irrigation agriculture should be emphasized and supported by government to compliment rain-fed agriculture to boost crop production in the area.
2. Establishment of more weather stations in educational institutions around Argungu in order to have more access to more data on rainfall as the data available presently is grossly inadequate.
3. Replacement of present obsolete equipments with sophisticated ones in line with global best practices for more accurate data recording and reliability.

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