RAINFALL TREND IN THE SUDANO-SAHELIAN ZONE OF NIGERIA

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Abstract

The climate of sudano-sahelian belt is characterized by alternate wet and dry season in response to the changes in pressure patterns. This gives rise to two distinct prevailing air masses over the country at different times of the year. The rainy season in this region is associated with late onset and earlier cessation, the onset and cessation are characterized with destructive storm. It was also revealed from the findings that there is higher mean rainfall than the long-term mean in the earlier decade of 1958 – 1967, while the decades from the early 1970s to the mid-90s show declining rainfall total. An attempt is also made to use trend analysis to see the rainfall variations over four stations (Kebbi, Yobe, Sokoto and Katsina) in the zone. Rainfall data for 50 years in the zone were tested using 5-year and 10-year running mean. The whole period was divided into decades and the decadal means compared with long-term mean. Results indicate a decrease in annual rainfall in the zone from the mid 1970s up to the mid 1990s. Recent trends, however, show increase in annual rainfall from the mid 1990s. The importance of this for agricultural and water resources planning and development cannot be over emphasized.

Keywords: Climate, rainfall, trend, running mean, sudano-sahelian zone.

INTRODUCTION

The emission of green house gases into the atmosphere has lead to changes in atmospheric composition and global climate change. The effect of global climate change on the environment varies from one ecological zone to another. In some areas, it has resulted in higher atmospheric temperature and rainfall, while in some other areas the reverse is the case. Yet in some areas, the effect is insignificant.

Worldwide, people have tried to study the nature of the effect of global climate change on their environment. The Sudano-Sahelian ecological zones of Nigeria are zones of marginal rainfall and yet contribute immensely to the agricultural production of Nigeria's grain crop and livestock. The sahelian drought of the 1970s and the 1980s ravaged the sahelian zone and left farmers impoverished. It is therefore, important to investigate the current trend in weather conditions in the sudano-sahelian zone of Nigeria. Although alternating wet and dry years have always been observed in tropical rainfall data (Oguntoyinbo, 1978; Adefolalu, 1972), the declining precipitation effectiveness due to anomalous rainfall patterns since the 1972-73 drought suggests that a dangerous trend in mean conditions is taking place (Adefolalu, 1986a, b).

It is therefore of interest to understand the mean precipitation patterns in order to find out the major trends which can then be used to infer the causes and effects of recent precipitation ineffectiveness, which was previously diagnosed by Flohn et al. (1974) and supported by the findings of Kidson (1977).In a recent study on precipitation trends in Nigeria, Adefolalu (1986a) has shown that time-trends in rainfall between 1911 and 1983 can be associated with the long-term multiplier effect of land surface (ecological) changes – a reflection of the feed-back process induced by human activities.

In this paper, discussion will deal with whether the sudano sahelian zone of Nigeria is experiencing through the analysis of the rainfall trend.

THE STUDY AREA

The Sudan-Sahel Savannah zone is located in Northern Nigeria between latitude 10^oN and 14^oN and longitude 4^oE and 14^oE and lies immediately to the south of Sahara desert.

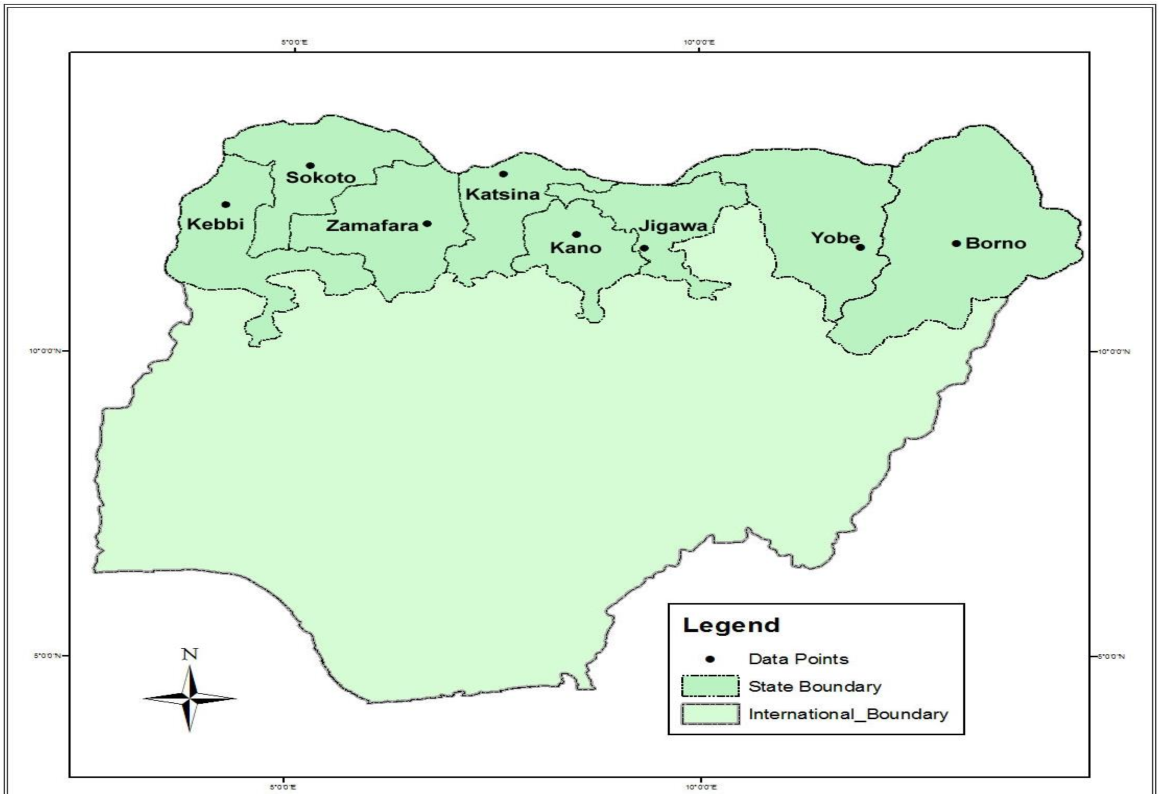

FIG. 1 MAP OF NIGERIA SHOWING THE SUDANO SAHELIAN ZONE

source: Department of geography futminna

The climate of the zone is savannah type with alternating wet and dry seasons. The rainfall in this region is less than 1000mm per annum in only about five months in the year, especially between May and October. Rainfall in this zone is highly variable and the onset of the rain is erratic. The rainfall intensity is very high between the months of July and August. There is intra-zonal difference in the amount of rainfall received by the Sudan –Sahel savannah. The southern part receives more rain and is less variable compared to the northern section.

The gross features of rainfall patterns in this region, as in other parts of the country are usually in association with what is often called the Inter tropical Discontinuity (ITD). The movement of the

ITD northwards across the country between January and August, and its retreat from the southern fringe of the Sahara desert, after August, cause much of Nigeria to experience seasonal rainfall. The ITD itself is the boundary at the ground between the dry Tropical Continental (cT) air of northern origin and the moist Tropical Maritime (mT) air of southern origin. Within the mT air mass is enclosed a number of rainfall producing systems, such as the disturbance lines (especially the easterly waves), squall lines and the two tropospheric jet streams. It is the magnitude of these systems that influences the amount and seasonal distribution of rainfall over the region.

MATERIALS AND METHODS

The data used for this study is rainfall data spanning a period of 50years from 4 synoptic stations in the sudano-sahelian zone of Nigeria (see table 1). The data were collected from the Nigeria Meteorological Agency (NIMET), Oshodi, Lagos.

The series of data for the selected stations was tested for normality using the standardized coefficient of skewness (Z_1) and Kurtosis (Z_2) as defined by Brazel and Balling. Z_1 is calculated as Where xi are the yearly rainfall totals; and for the onset series, yearly onset dates (in Julian days), x is the long term mean and N is the number of years in the sample (see table 2). The normalizing limit is 95% of the error margin. If the absolute values of Z_1 and Z_2 are greater than 1.96, a significant deviation from the normal curve is indicated at 95% confidence level. 5-year and 10-year running means were calculated for annual rainfall for the selected stations. To further specify the nature of annual rainfall trend for the stations each data period was divided into decades and the mean for each decade calculated. The decadal means were compared with the long-term mean.

Table 1 List of Rainfall Stations and Periods of Available Data

Station	Station No.	Latitude	Longitude	Period	No. of Years
Kebbi	1107.4	11,11	07,38	1958-2007	50
Yobe	1201.2	12,01	07,12	1958-2007	50
Sokoto	1305	13,01	05,15	1958-2007	50
Katsina	1307.04	13,01	07,41	1958-2007	50

Table 2 Coefficient of Skewness and Kurtosis for the selected stations

	Kebbi	Yobe	Sokoto	Katsina
Skewness	0.48889.4	0.359626	-0.38992	0.097691
Kurtosis	0.96991	0.08783	-0.06647	-0.49321
All the stations were found to be normal at 95% confidence interval				

RESULTS AND DISCUSSIONS

Kebbi: From figure 2, 10-year and 5-year running means show annual rainfall below the long-term mean. The rainfall was fluctuating all round the year. The trend line showed an overall decrease in the rainfall. The decadal statistics of the annual rainfall totals for Kebbi are presented in table 3 and figure 3. The decadal means were on the decrease with the decade 1998-2007 the minimum. In overall the trend line showed a general decrease in the decadal mean of the 50 years under consideration.

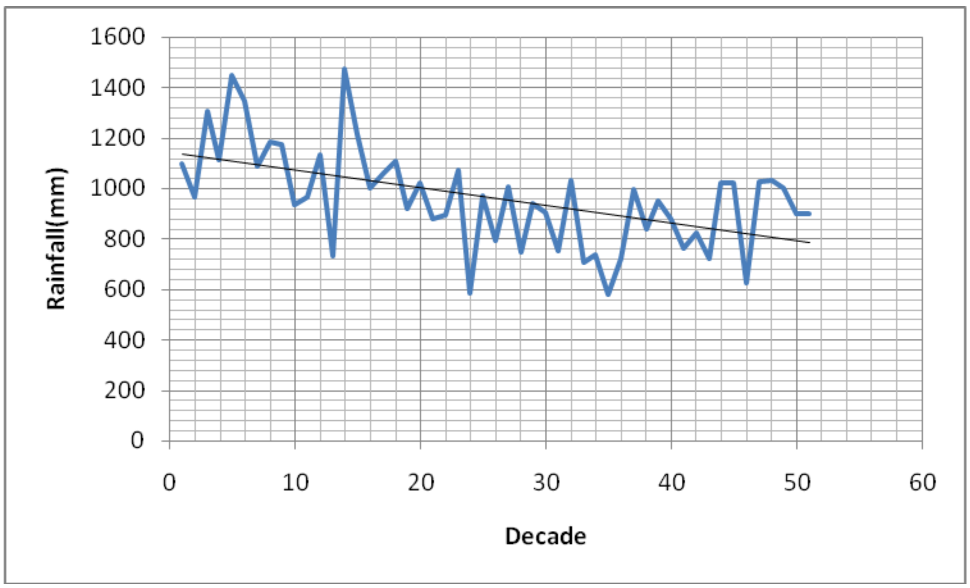

Fig. 2 Trends in Annual Rainfall Amount for Kebbi

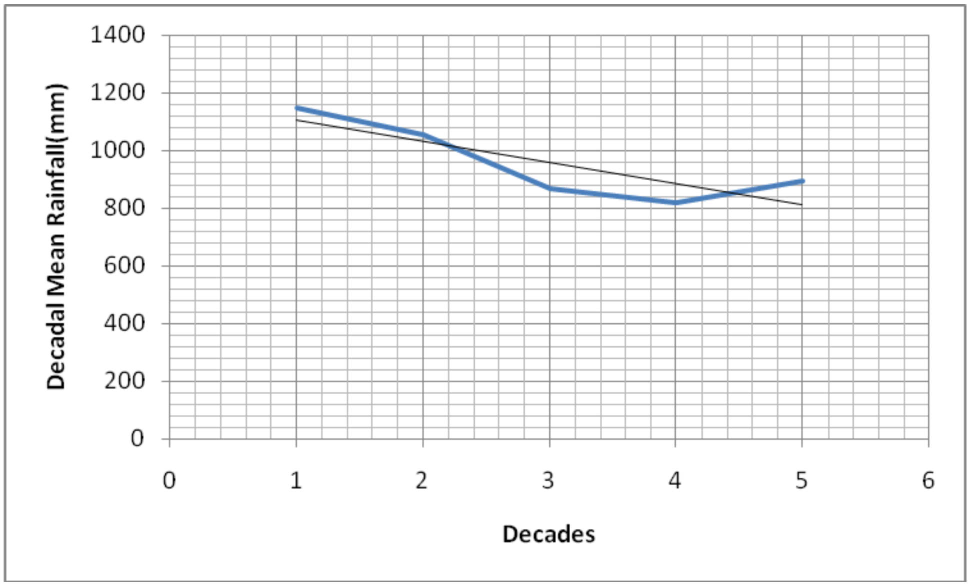

Fig. 3 The Trend of the Decadal Means for Kebbi

Yobe: From figure 4, 10-year and 5-year running mean show annual rainfall above the long-term mean. From the late 1960s to the early 1990s the rainfall was above the long-term mean. The rainfall was on the increase generally when the trend is considered. Decadal statistics of the annual rainfall totals for Yobe are presented in table 3 and figure 5. The decadal means were above the long-term in the decade 1989-1997 and in the last decade (1998-2007).

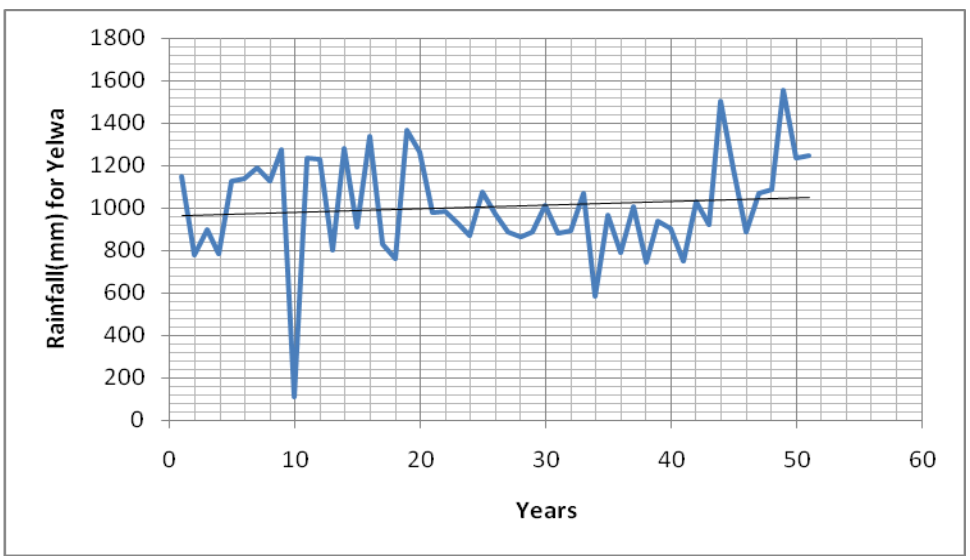

Fig. 4 Trend in Annual Rainfall Amount for Yobe

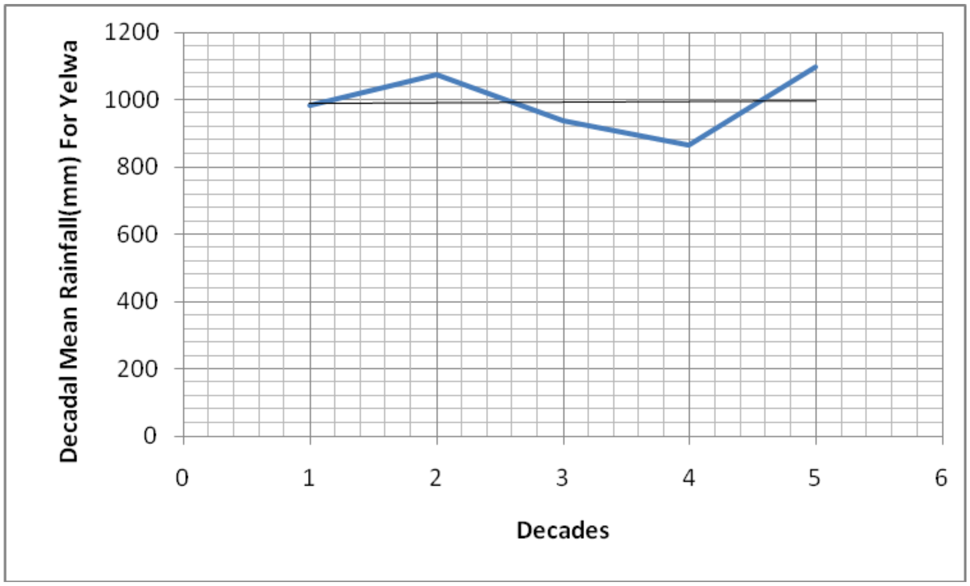

Fig. 5 The Trend of the Decadal Means for Yobe

Sokoto: The annual rainfall totals for Sokoto are normal at 95% confidence level. 10-year and 5-year running means show annual rainfall above the long-term mean from the beginning of the data up to the mid of the first decade. From the later part of the first decade to the early part of the last decade was below the long-term mean.fig 6 and 7.

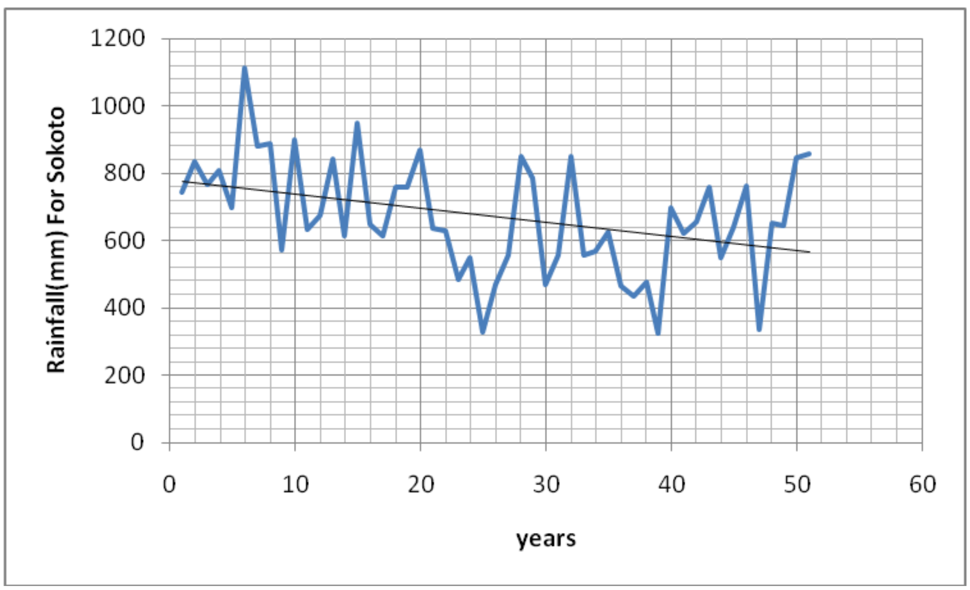

Fig. 6 Trend in annual rainfall amount for Sokoto

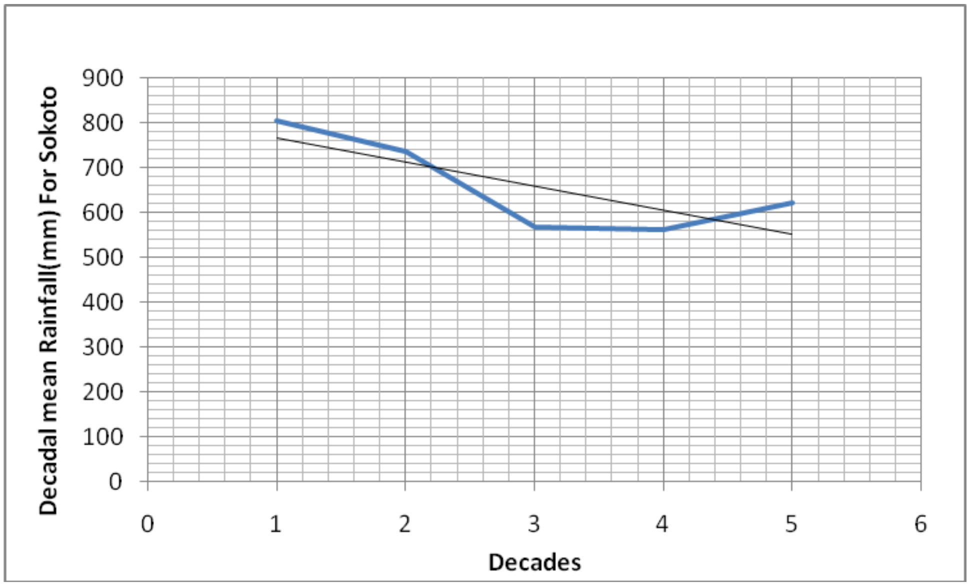

Fig. 7 The Trend of the Decadal Means for Sokoto

Katsina: The annual rainfall totals for Katsina are normal at 95% confidence level. 10-year and 5-year running-means show annual rainfall above the long-term mean from the beginning of the dacade up to the mid 1980s and from the late 1980s up to the mid 1990s and from the late 1990s up to the end of the period. Decadal statistics of the annual rainfall totals for Katsina are presented in Table 3 and figure 8 and 9.The decadal mean were above the long-term for decades 1958-1967 while the means were below the long-term mean for 1989-1997 through 1998-2007. Though the last decade was below the long-term mean, there is evidence of increasing rainfall in the last decade.

In general, the earlier decade of 1958-1967 shows higher mean rainfall than the long-term mean. The decades from the early 1970s to the mid 1990s shows declining rainfall totals. This observation is in agreement with earlier studies (Olaniran, 1989). However, for all the stations there is evidence of increasing rainfall totals in the last decade 1998-2007. This implies a positive trend in annual rainfall totals towards the end of the study period. This trend is likely to continue into subsequent decades.

Table 3 Decadal Statistics for Kebbi, Yobe, Sokoto and Katsina

Station	Annual	1958-1967	1968-1977	1978-1987	1988-1997	1998-2007
Kebbi	962.33	1145.96	1053.47	866.73	820.36	895.62
Yobe	1007.16	984.54	1076.32	937.68	866.73	1098.33
Sokoto	670.48	802.86	735.87	567.67	562.52	621.96
Katsina	1035.6	1132.77	1331.25	941.53	894.08	828.34

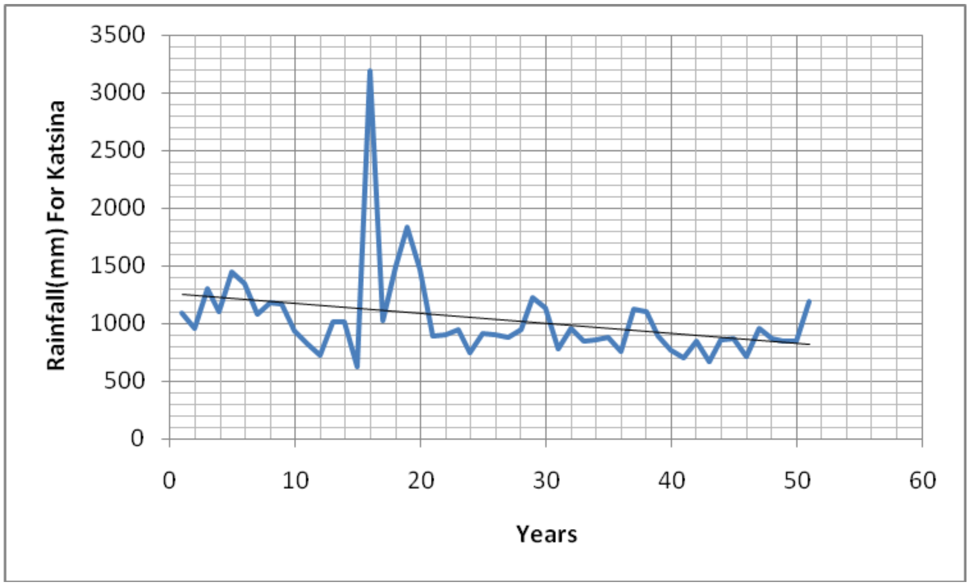

Fig. 8 Trend in Annual Rainfall Amount for Katsina

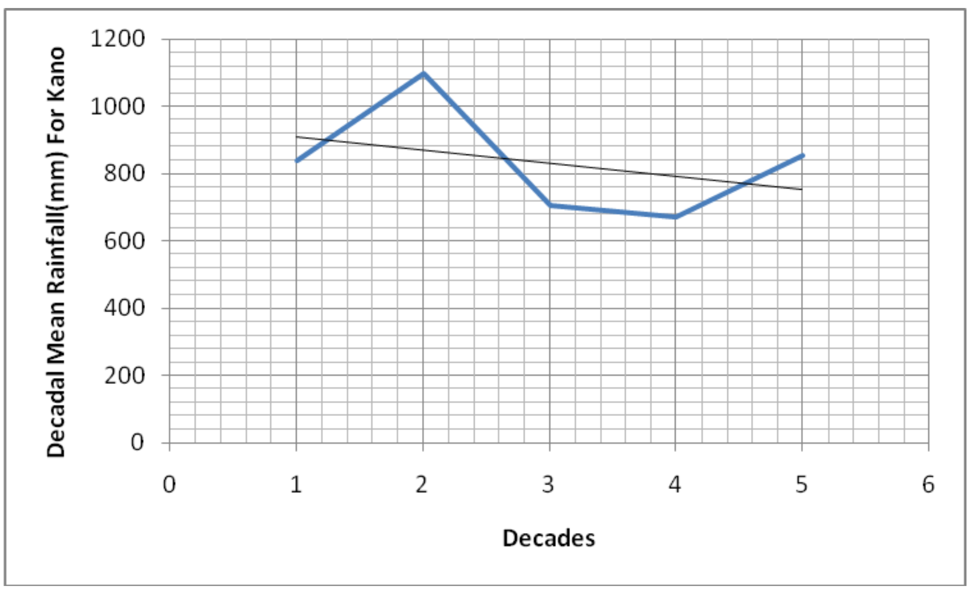

Fig. 9 The Trend of the Decadal Means for Katsina

CONCLUSION

It has been shown in this study that there is significant increase in annual rainfall amount in the last decade of the study. It means, therefore, that we are experiencing wetter conditions in the sudano-sahelian zone of Nigeria. This is at variance with earlier conclusions drawn on the rainfall trends in the zone. However, these previous studies were based on data covering up to the late 2000. Increasing annual rainfall totals portends both good and bad. Good because there is improvement in water supply to an otherwise marginal area. This is important for agricultural production and water resources management. Bad because, flooding dam collapse as a result of excessive rainfall on an impervious terrain could lead to damage to life and property.

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