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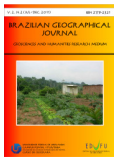

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An assessment of monthly rainfall profile for kano, Kano State (Nigeria)

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ABSTRACT

This study examined the trends in annual totals and pattern in monthly distribution in Kano latitude 12°03' N Longitude 08°32'N. Daily records of rainfall over a period of 60 years were used. The annual and the monthly rainfall data were subjected to normally test using Fisher's standard co-efficient of Skewness (Z_1) and Kurtosis (Z_2). The result shows that over 78% of the data conform to the Gaussian normal distribution at 95% significant confidence limit. A linear regression technique was used to determined trend in both monthly and annual distribution. To further determine the trend, ten years and five years running mean were used also. The results show that, with the exception of June all the rainy month under study conform to the annual rainfall trends which started to decline in the 1960's, but with an increase toward the end of the period under study. Monthly rainfall value shows an abrupt and frequent extreme variability between years with the exception of August. However, some times increase in monthly values reduces the frequency and

intensity of such occurrence. This extreme variability is often described as catastrophic to crops at all stages of development. However, May rainfall is on the decline. This will result to late onset, frequent dry spell or false start. Monthly rainfall value of June to October shows an increasing trend. This implies an increase in the rainfall intensity and this will accelerate the erosive nature of the tropical rainfall in the station. It will also result to rapid surface run off, excessive soil erosion and water logging. This will greatly affect crop yield. Understanding the regions rainfall characteristics especially monthly trend will assist the government to transforming agriculture in the region from the inherited subsistence farming to commercial farming. This will help in assisting Nigeria in realizing the millennium development diseases, malnutrition and illiteracy etc

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MOTS-CLES:
Les précipitations
Kano
le Nigeria

RESUME – UNE EVALUATION DU PROFIL DES PRECIPITATIONS MENSUELLES POUR L'ETAT DE KANO, KANO (NIGERIA). Cette étude a examiné les tendances dans les totaux annuels et le modèle de distribution mensuelle à Kano latitude 12003 - 08032'N N Longitude. Des registres journaliers de précipitations sur une période de 60 ans ont été utilisées.Le rapport annuel et les données mensuelles de pluie ont été soumis à des tests en utilisant normalement Fisher standard de coefficient d'asymétrie (Z1) et Kurtosis (Z2). Le résultat montre que plus de 78% des données sont conformes à la distribution gaussienne normale à la limite de confiance de 95% significative. Une technique de régression linéaire a été utilisée pour déterminer la tendance dans la distribution de deux mensuels et annuels. Afin de mieux déterminer la tendance, dix ans et cinq années consécutives signifie également été utilisées. Les résultats montrent que, à l'exception de Juin tous les mois des pluies à l'étude sont conformes aux tendances des précipitations annuelles qui ont commencé à décliner dans les années 1960, mais avec une augmentation vers la fin de la période sous étude. Valeur mensuelle des pluies montre une variabilité de brusques et fréquents entre les extrêmes année à l'exception du mois d'août. Toutefois, une certaine augmentation de fois dans les valeurs mensuelles réduit la fréquence et l'intensité de tels événements. Cette extrême variabilité est souvent décrite comme catastrophique pour les cultures à toutes les étapes du développement. Toutefois, les précipitations de mai est sur le déclin. Cela se traduira par l'arrivée tardive, fréquentes périodes de sécheresse ou de faux départ. Valeur mensuelle des pluies de Juin à Octobre montre une tendance croissante. Cela implique une augmentation de l'intensité des précipitations, ce qui permettra d'accélérer le caractère érosif des pluies tropicales dans la station. Elle entraînera également à la surface rapide de ruissellement, l'érosion des sols et l'exploitation forestière excessive d'eau. Cela affectera grandement le rendement des cultures.Comprendre les caractéristiques des pluies régions particulièrement tendance mensuelle aidera le gouvernement à l'agriculture transformant dans la région de l'agriculture de subsistance à une agriculture commerciale héritée. Cela aidera à aider le Nigeria dans la réalisation du millénaire pour le développement des maladies, la malnutrition et l'analphabétisme, etc.

PALAVRAS-CHAVES:
Chuvas
Kano
Nigeria

UMA AVALIAÇÃO DO PERFIL DE PRECIPITAÇÃO MENSAL PARA O KANO, ESTADO DE KANO (NIGÉRIA). Este estudo examinou as tendências nos totais anuais e no padrão de

distribuição mensal em Kano latitude 12003 - 08032'N N Longitude. Registros diários de precipitação ao longo de um período de 60 anos foram utilizados. Os relatórios anuais e os dados mensais de precipitação foram submetidos a teste normalmente usando o padrão de Fisher co-eficiente de assimetria (Z1) e Curtose (Z2). O resultado mostra que mais de 78% dos dados estão em conformidade com a distribuição gaussiana normal no limite de confiança de 95% significativo. A técnica de regressão linear foi utilizada para determinada tendência na distribuição tanto mensal e anual. Para determinar a tendência, 10 anos e cinco anos de execução médios foram usados também. Os resultados mostram que, com exceção do mês de Junho todo o mês de chuva em estudo estão em conformidade com as tendências anuais de precipitação, que começou a declinar na década de 1960, mas com um aumento até o final do período em estudo. Valor de precipitação mensal mostra uma variabilidade extrema abrupta e freqüente entre os anos com exceção de agosto. No entanto, algumas vezes aumentar em valores mensais reduz a freqüência ea intensidade de tal ocorrência. Esta extrema variabilidade é muitas vezes descrita como catastrófica para as culturas em todas as fases de desenvolvimento. No entanto, as chuvas de Maio está em declínio. Isso vai resultar em aparecimento tardio, período de seca frequentes ou falsa partida.Valor de precipitação mensal de junho a outubro mostra uma tendência crescente.Isto implica um aumento na intensidade da chuva e isso vai acelerar a natureza erosiva das chuvas tropicais na estação. Ele também irá resultar na superfície rápida fugir, a erosão do solo excessivos e alagamentos. Isso vai afetar muito o rendimento das culturas. Compreender as características chuvas regiões especialmente tendência mensal irá ajudar o governo a transformar a agricultura na região a partir da agricultura de subsistência herdada para a agricultura comercial.Isso vai ajudar na assistência a Nigéria na realização das doenças de desenvolvimento do milênio, desnutrição e analfabetismo etc.

1 Introduction

In general, rainfall is the climate variable of primary importance in shaping the spatial and temporal variations of agriculture in the tropics. The seasonal cycles of rainfall directly determine the tempo and rhythm of agriculture through its limitation on the length of the growing season. The start of the rain in the tropics is seldom abrupt, but is usually foreshadowed by a succession of isolated showers of uncertain intensity with intervening dry period of varying duration (Ojo, 1977, Ati *,* 2002).The break of the rainy season may be early in some years, greatly delayed in others (Bationo et al,1997). Annual totals show a wide variation from year to year, whereas in any given year the incidence may show remarkable irregularities since the rains fall almost entirely as heavy showers or thunderstorms and this will greatly affect the yield of crops as observed by Anuforum and Okpara (2003).

Northern Nigeria is characterized by the two distinct seasons. The wet- season (April-October) and, the dry season (November-March), (Anyadike,1993). The percentage of seasonal rainfall to annual total often exceeds 90 percent exhibiting the strong seasonality in the rainfall (Virmani, 1979). High proportion of rainfall occurs in large storms of high intensity. Thus 40 percent of rainfall in the tropics occur at intensities of at least 25mm/hr, a figure considered as threshold value at which rainfall become erosive (Hudson, 1971) cited by Virmani (1979).The rainfall intensity is very high in the month of July and August. As a result, though the environment is

generally dry, crops are frequently lost through too much rain. It also results in rapid surface run-off, soil erosions and water-logging (Pollock, 1968, Udo, 1970).Many researches undertaken in the Sudano-Sahelian region especially on trends bin annual rainfall amount shows a declining trend. For example Adefolalu, 1986b, Anyadike, 1992 and Oladipo,1989.However,recent researches in the region in general and Kano in particular, shows an increasing trend especially those that encompasses data of mid 1990s and early 2000s (Ati,2006). Annual rainfall is not as critical as its distribution within the planting season. Understanding rainfall distribution pattern within the rainy season will go along way in helping the farmers in taking decision on cropping and farming systems. This is why it is important to determine the profile of rainfall within the raining season. So as the rainfall increases the structure of the rainy might have been witnessing some variation. This paper attempts to investigate the pattern of monthly rainfall profile in Kano. It has been observed that the quantity and quality in some month is critical to certain stages of plant growth, (Adebayo and Adebayo, 1998, Ibrahim et al, 2006).

2 Study area

Kano lies on latitude 12°N Longitude 08°32'.The climate of the study area is of savanna type with alternating wet and dry season.It is characterized by a strong seasonality in rainfaa and relatively high temperature(Iguisi,2002).Rainfall is less than 1000mm per annum and occurs in only five month in the year between May to October. Rainfall is highly variable and onset of the rains is erratic (Ati,2002). The daily sunshine duration is -8 hours. Air temperatures are constantly high with high evaporative demands. The potential evapotranspiration is only exceeded by actual rainfall from June to September and not very often in June (Mortimore and Wilson, 1965, Oguntoyinbo, 1983, Sivakumar et al, 1991, Falola et al, 1993).

The vegetation of the study area is Sudan Savanna type, made up of short grasses 4-6 feet high and stunted trees. The predominant tree species are Acacia, the dump palm, the silk cotton and baobab. A prolonged period of bush burning, over grazing, cultivation and tree harvesting for cooking purposes has considerably degraded the vegetation cover to open grassland, bare surface and scattered scrubs. The grass communities sprout up shortly after the onset of the rainy season, blossom and become luxuriant almost completely covering the ground surface towards the later part of the rainy season. The grasses wither and turn rustic brown (Iguisi,2002).The study area belongs to the lower step platform of the north central plateau, often referred to as high plains of Hausa land. It is predominantly of pre to upper Cambrian basement complex origin. The area has relatively level topography with an average hiegt of 600m above sea level. The soil of the area belongs to ferruginous tropical soils. They are ion dominated often resulting in reddish color. It is developed under 1500-400mm annual rainfall and area marked wet-dry season. Their common feature is the downward movement of clay within the profile (eluviations) that tends to produce sandy surface (Directory of soil institution and experts in Africa, 2002)

3 Materials and the sources

Materials for the research include record of daily rainfall for 60 years from the stations spread. Materials were sourced from the Nigerian Meteorological Agency (NIMET) Office Oshodi Lagos.

4 Methods of data analysis

Normality Test:

Each series of data from the stations were subjected to normality test to examine whether the data is normally distributed using the standardized coefficient of Skewness (Z_i) and Kurtosis (Z_2) defined by Brazel and Balling (1986) as

Skew ness

$$Z_1 = \{[\sum_{i=1}^{N}(x_1 - \bar{x})^3 / N] / [\sum_{i=1}^{N}(x_i - x)^2 / N]^{3/2}\} / (6/N)^{1/2}$$

Kurtosis

$$Z_2 = \left[\frac{\sum_{i=1}^{N}(x_i - \bar{x})^4}{N} / \sum_{i=1}^{N}(xi - \bar{x})^2 N \right] / \sqrt{24/N - 3}$$

ii. Computation of Rainfall Characteristics:

Annual Rainfall: - Annual rainfall totals were calculated by summing up the daily rainfall data for each year in the station within the period under study. Annual total is calculated as:-

$$X = \sum_{i=1}^{N} xi$$

Where x = Annual rainfall totals xi = daily rainfall records.

Monthly Rainfall**:** - Monthly rainfall total will be calculated by summing up the daily rainfall data for each month (Rainy) in the station through the period under study. Calculated as:

$$x = \sum_{i=1}^{N} xi$$

Where x = monthly rainfall totals

xi = daily rainfall records.

Test of Trends

Linear regression techniques was used to test for trends in the rainfall series (Annual and monthly totals) in order to determined whether there is any monotonic increases or decreases in the average values between the beginning and the end of the series given as:

Five -year and ten-year running means were calculated to further specify the character of the rainfall totals (annual and monthly).

The mean annual total of the whole period under study in stations was calculated as!

$$\bar{x} = \frac{\sum x}{n}$$

Where $\bar{x}$ = mean annual total of the whole period under study.

$\sum x$ = the sum of total value of the station.

n = the number of years under study.

The computed means stand as long term means for the annuals totals (for the entire period). The period under study was sub-divided into decadal sub-period (1947-1956, 1957-1966, 1967-1976, 1977-1986, 1987-1996, 1997-2006). The mean of each decade of the annual total were calculated as;

$$\bar{x} = \frac{\sum x}{n}$$

Where $\bar{x}$ = the decadal mean (annual total).

$\sum x$ = sum of the total value of the station (decade).

n = number of years in the decade.

The decadal mean were compared with long term mean and their significance tested using crammer's test.

$$t_k = \left[n(N-2)/N - n(1+t^2{}_k)\right]^{1}/_{2}\, t_k$$

The rainfall (records) gave us the rainy month in the stations. So, having identified the rainy month, a long term mean of each rainy month in the station were calculated as:

$$\bar{x} = \frac{\sum x}{n}$$

Where $\bar{x}$ = monthly mean (longhorn mean) of a particular month for the whole period under study.

$\sum x$ = sum of total value of a particular month for the whole years under understudy.

n = number of years study.

Then the month value of the whole period was sub–divided into decadal sub-period. The sub- periods mean of the particular month was calculated as:

$$\bar{x} = \frac{\sum x}{n}$$

Where $\bar{x}$ = decadal mean of a particular month.

$\sum x$ = sum total value (decade) of that particular month.

n = number of years in the decade.

DATA ANALYSIS

Trend in annual rainfall in Kano for 60 years (1946-2005)

The annual rainfall value in Kano from 1946-2005 are normally distributed at 95% confidence limit. Regression line indicates an increasing trend. Five year running mean indicate values below the long term mean with a sudden increase in the first decade. Then the value increase above the long term mean until early 1970's. From then+ the value decline and remain below the long term mean until late 1990's.

The decadal mean of the annual rainfall in Kano from 1946 -2005 show the first two decade with high value above the long term mean reaching peak in the last decade. The third, fourth and fifth decade have low value below the long term mean.

Statistics of Annual Rainfall in Kano 1946-2005

Mean	849.3427
S/Dev	277.1448
CV	32.63051
Skew	1.176531
Kurt	2.102659

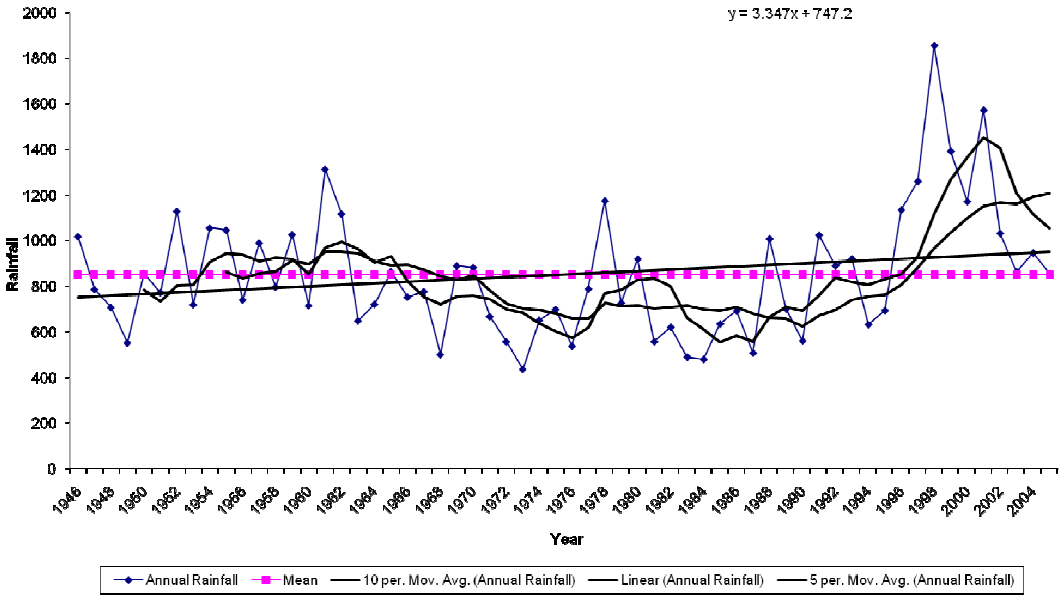

Fig. 72: Annual rianfall trend for Kano

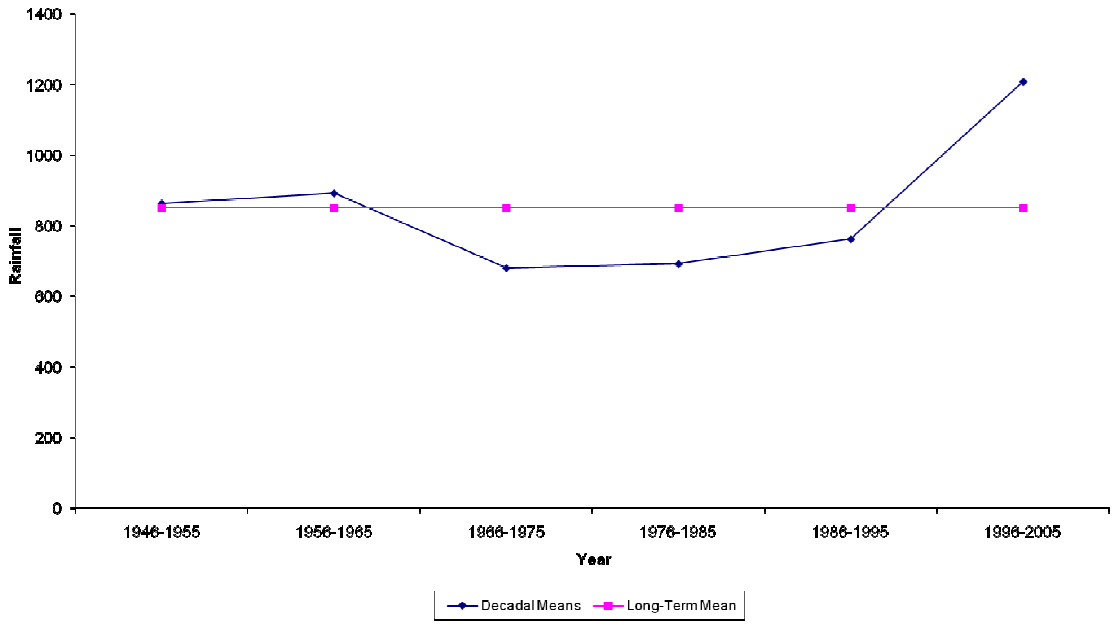

Fig. 73: Relationship between decadal means and long-term mean for annual rainfall in Kano

Trend in may rainfall value in Kano for 60 years (1946-2005)

The May rainfall value in Kano from 1946-2005 are normally distributed at 95% confidence limit. Regression line indicates a declined trend. Five year running mean indicate values below the long term mean from the beginning with a sudden increase in the first decade. The value decline below the long term mean in early 1970's with a sharp increase between1981-1985. The value increase above the long term mean in early 1990's and decline in mid 1990's with a sudden increase inbetween 1999-2003. The decadal mean of May monthly rainfall values in Kano from 1946-2005 show the first two decade with high value above the long term mean. While the remaining four decade indicates low value below the long-term mean.

Statistics of Monthly Rainfall Value in Kano 1946-2005

	May	June	July	August	September	October
Mean	52.72017	119.777	220.7787	298.9107	143.5915	13.03667
S/Dev	43.22959	60.84254	104.2262	112.5565	83.97827	17.53732
CV	81.99821	50.79651	47.20847	37.65558	58.48415	129.2867
Skew	1.488549	0.508684	1.789774	0.211544	1.116871	1.358733
Kurt	3.103711	-0.06158	4.863321	-0.3026	1.624337	1.109394

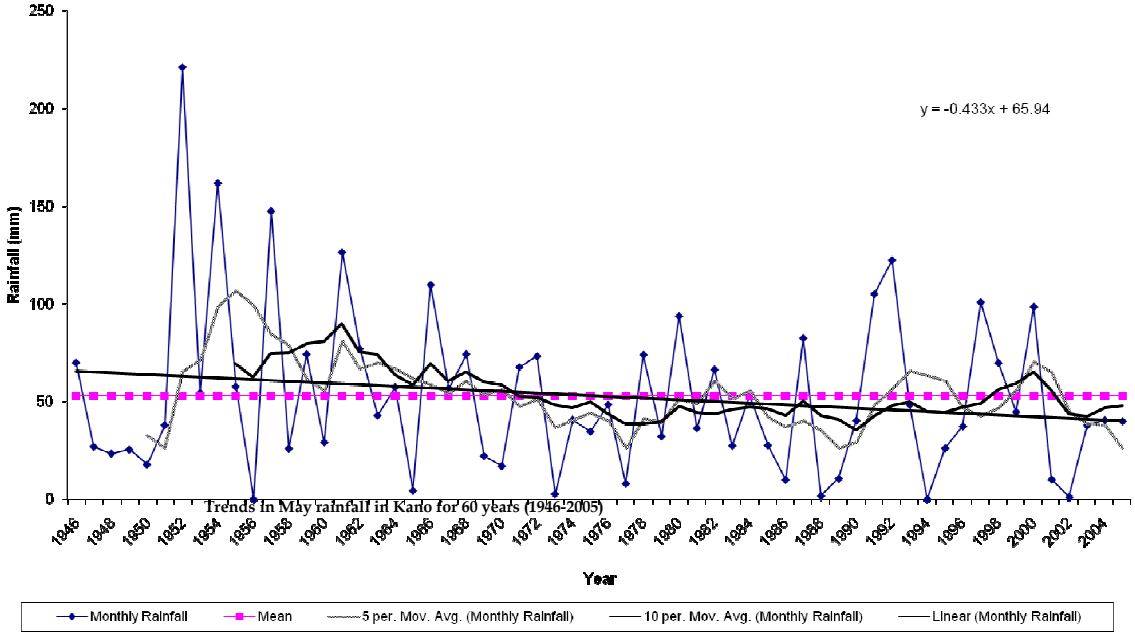

Fig. 74: Trends in May rainfall in Kano for 60 years (1946-2005)

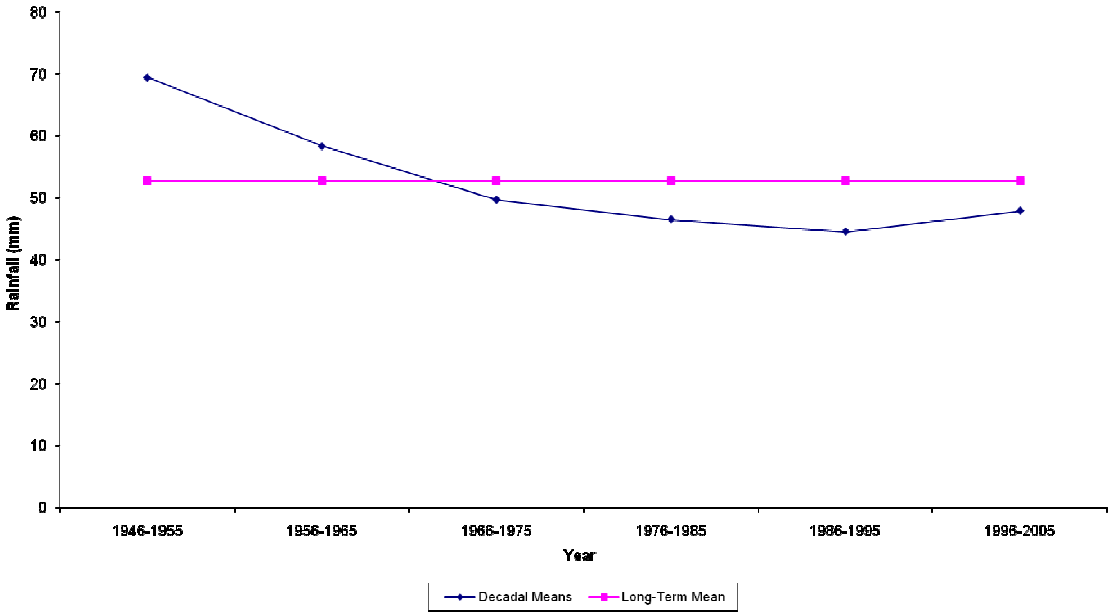

Fig. 75: Relationship between decadal means and long-term mean for May rainfall in Kano

Trend in june rainfall value in Kano for 60 years (1946-2005)

The June rainfall value in Kano from 1946-2005 are normally distributed at 95% confidence limit. Regression line did not indicate any significant trend, rather the line passes through the long term mean. Five year running mean indicate values below the long term mean in the first decade. The value decline below the long term mean again in early 1970's with a sudden increase between (1976-1982). The values remain below the long term mean until early years of the last decade.

The decadal mean of June rainfall value in Kano from 1946- 2005 shows values below the long term mean in the first third and fifth decade. The second and the last decades have values above the long term mean with moderate value along the long-term mean in the fourth decade.

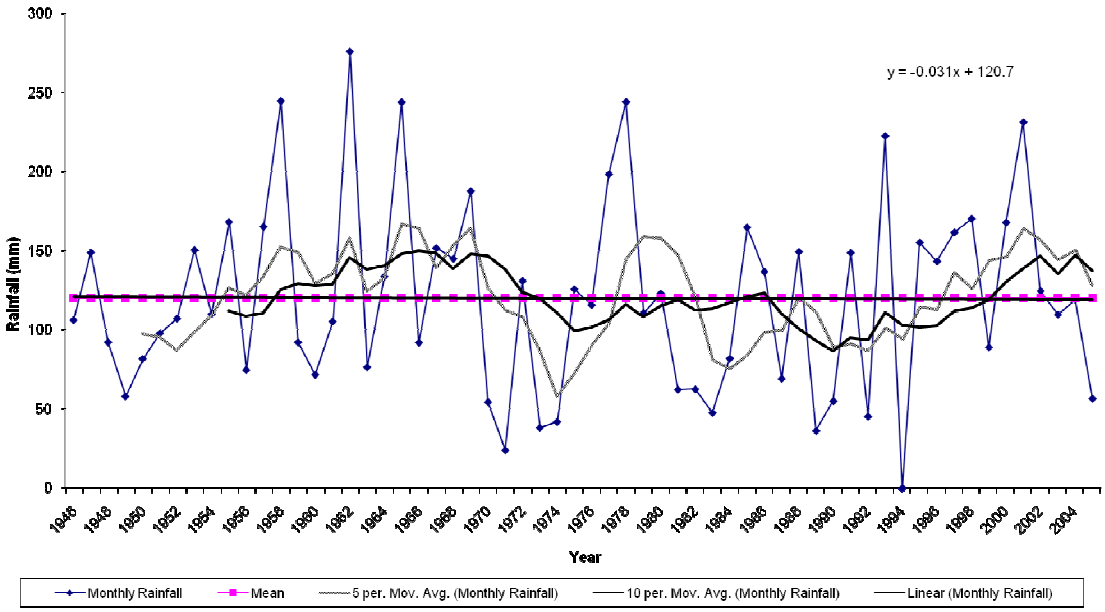

Fig. 76: Trends in June rainfall in Kano for 60 years (1946-2005)

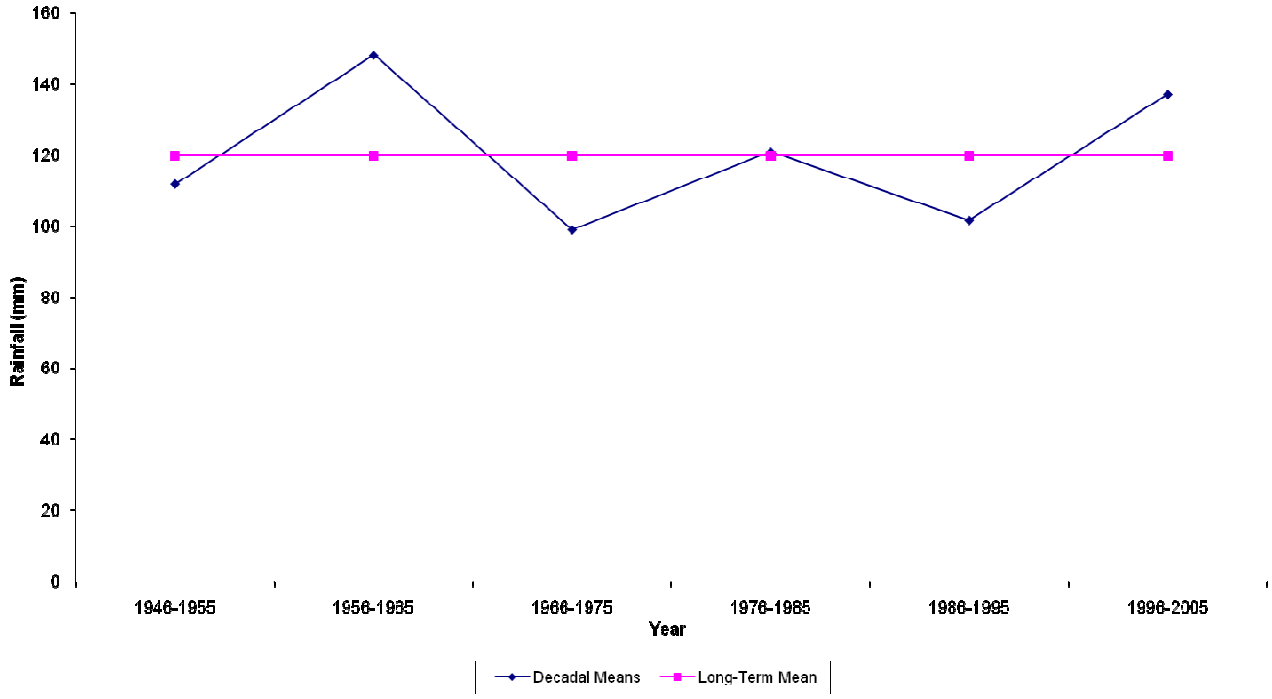

Fig. 77: Relationship between decadal means and long-term mean for June rainfall in Kano

Trend in July rainfall value in Kano for years (1946-2005)

The July rainfall value from 1946-2005 are normally distributed at 95% confidence limit. Regression line did not indicate any significant trend. Five year running mean indicate values below the long term mean from the beginning with a sudden increase in the first decade. The value remained above the long term remain until early 1960's. From then the values decline the remains below the long term mean until early years of the last decade.

The decadal mean of July rainfall value in Kano from 1946 – 2005 show moderate value along the long-term mean in the first, second and last decade. The third, fourth and fifth decade indicate value below the long-term mean.

Trend in august rainfall value in Kano for 60 years (1945 - 2005)

The August rainfall value in Kano from 1946 – 2005 are normally distributed at 95% confidence limit. Regression line indicates an increasing trend. Five years running mean indicates values above the long term mean in the first two decade. Then the value decline and remain below the long term mean until early 1990's.

The decadal mean of August rainfall value in Kano 1946 – 2005 shows the first two decade with high value above the long-term mean reaching peak in the last decade. While the remaining three decade has value below the long-term mean.

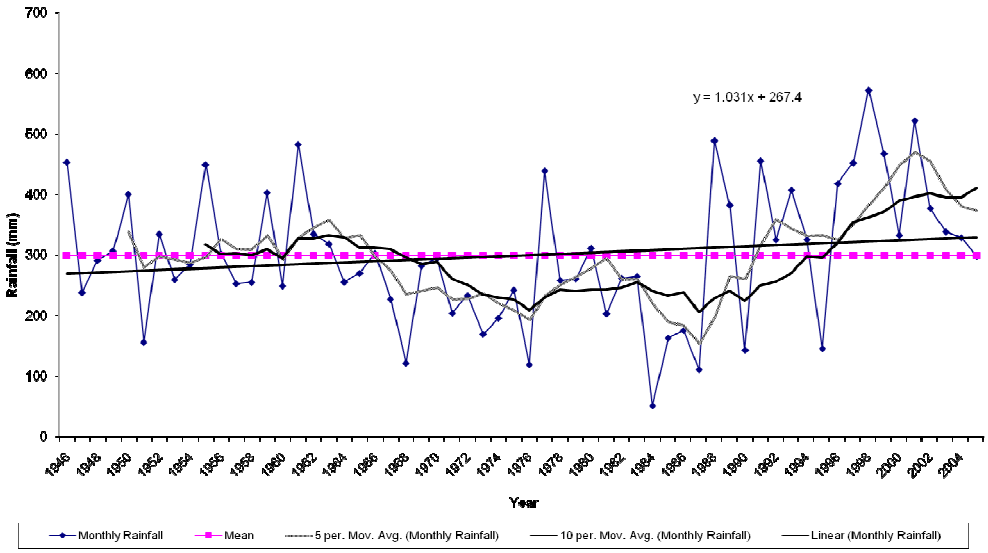

Fig. 80: Trends in August rainfall in Kano for 60 years (19462005)

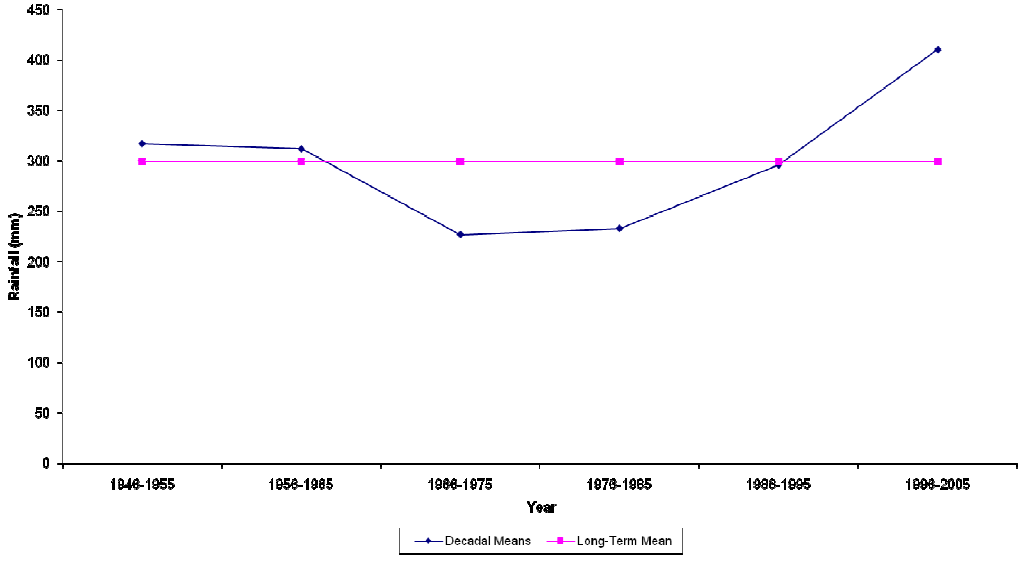

Fig. 81: Relationship between decadal means and long-term mean for August rainfall in Kano

Trend in September rainfall value in Kano for 60 years (1946 - 2005)

The September rainfall value in Kano from 1946 – 2005 are normally distributed at 95% confidence limit. Regression line indicates an increasing trend. Five year running mean indicate values below the long term mean in the first two decade with a sudden increase between 1955-1956 and 1961-1966. From then the value decline and

remain below the long term mean until toward the end of the fifth decade with a sharp increase between 1978-1979.

The decadal mean of September rainfall value in Kano from 1946 – 2005 shows low value below the long- term mean in the first five decade. The last decade indicates high value above the long- term mean.

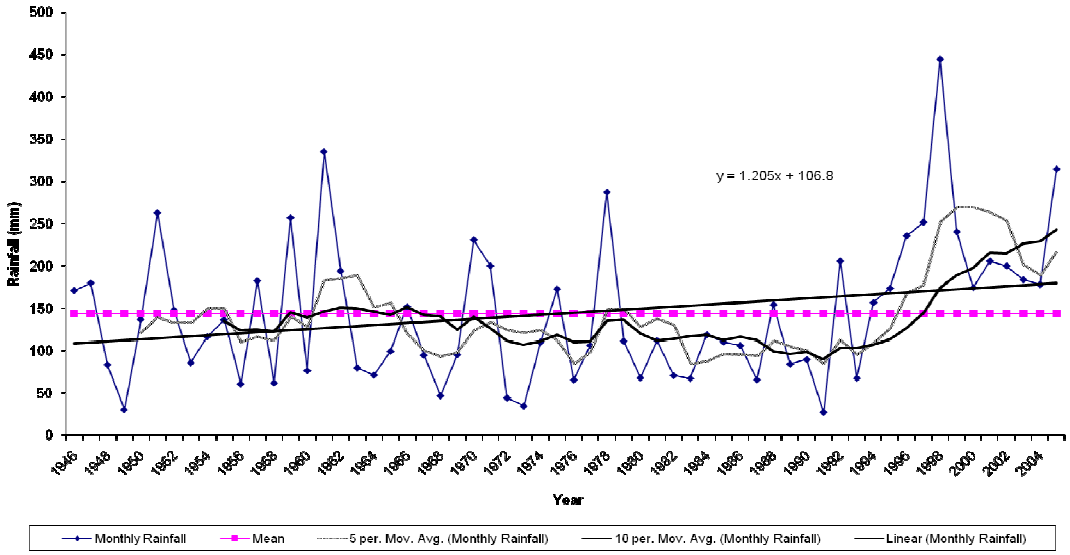

Fig. 82: Trends in September rainfall in Kano for 60 years (1946-2005)

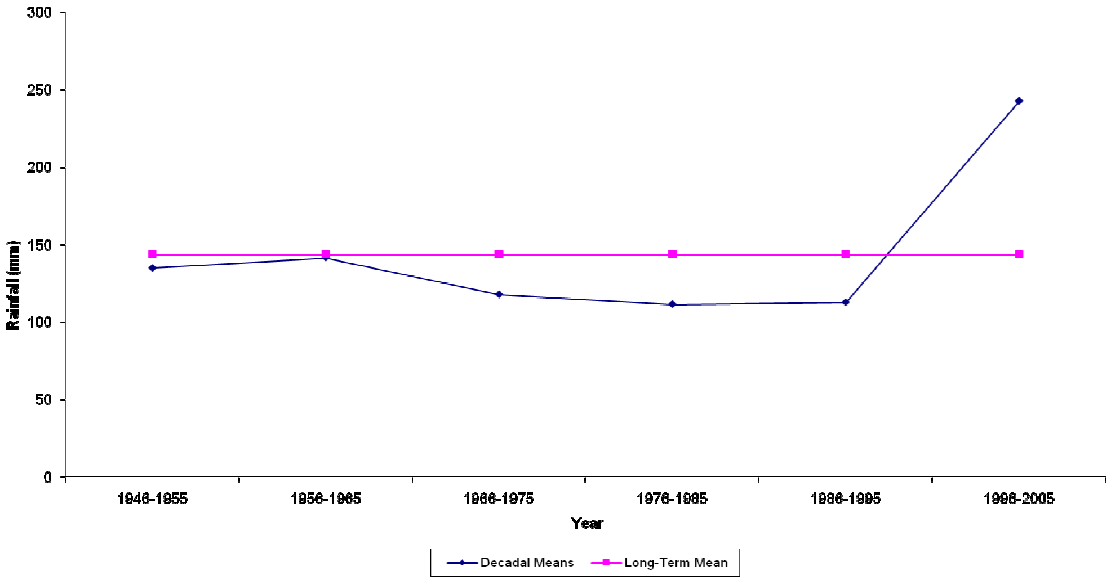

Fig. 83: Relationship between decadal means and long-term mean for September rainfall in Kano

Trend in October rainfall value in Kano for 60 years (1946 - 2005)

The October rainfall values in Kano from 1946 –2005 are normally are normally distributed at 95% confidence limit. Regression line indicates an increasing trend. Five year running mean indicate values below the long term mean from the beginning with a sudden increase in the first decade. The value decline below the long term mean in the second decade and remain below the long term mean until early years of the last decade with a sudden increase between 1969-1974 and 1976-1982.

The decadal mean of October rainfall value in Kano from 1946 – 2005 shows high value above the long- term mean in the first fourth and last decade. The second, third and fifth decade indicates low value below the long- term mean.

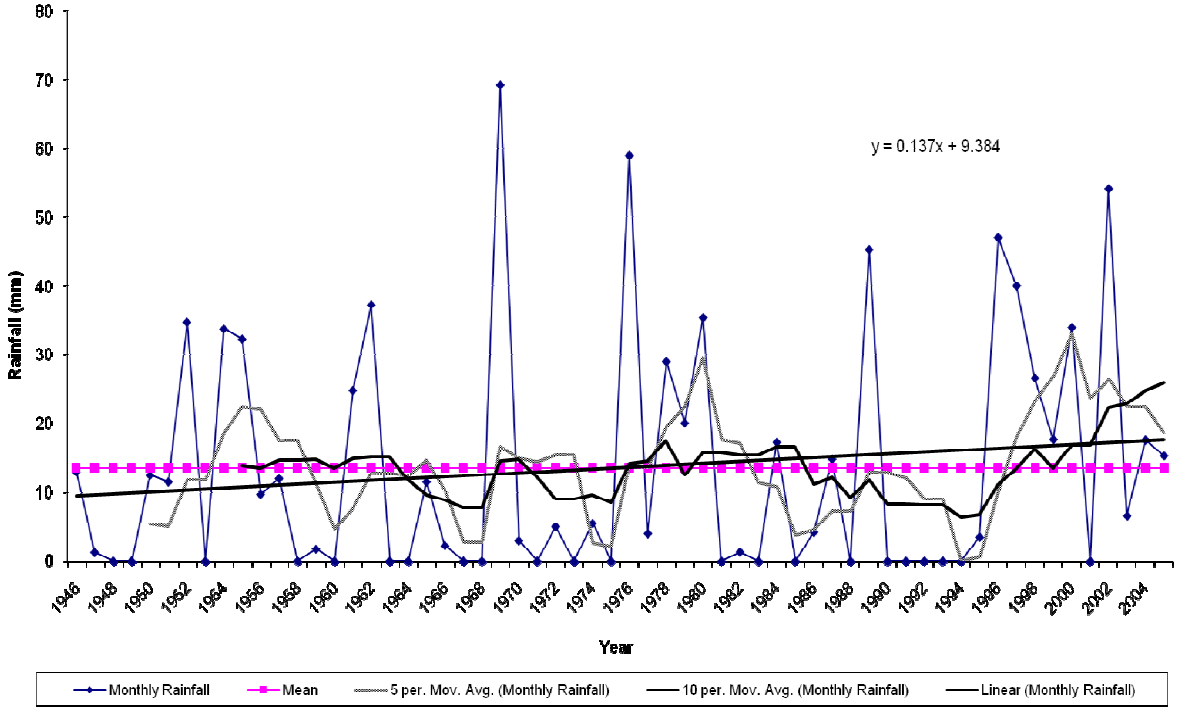

Fig. 84: Trends in October rainfall in Kano for 60 years (1946-2005)

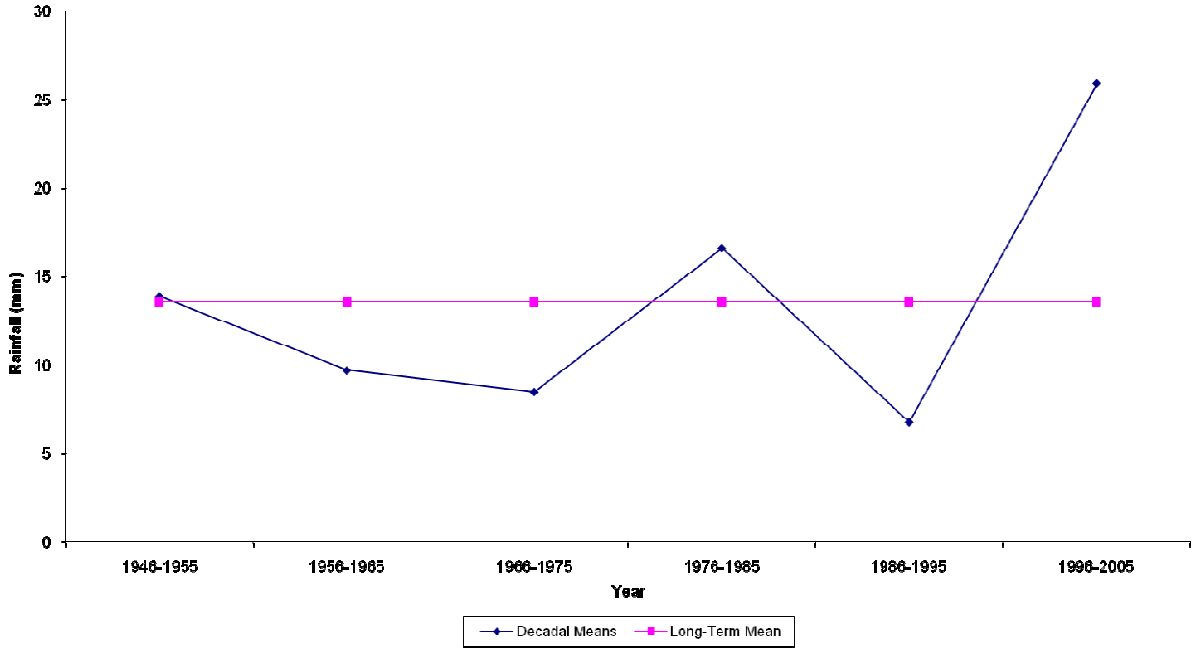

Fig. 85: Relationship between decadal means and long-term mean for October rainfall in Kano

6 Conclusion

Despite annual rainfall increase in the region, May rainfall in the station is on the decline. This may result to late onset, frequent dry spells or false start. This will lead to late sawing and will maximize the risk of immature harvesting which in turn may greatly affect crops yield (Ati, 2002).

With exception of May, monthly rainfall amount in the rainy month is on the increase. This implies an increase in the rainfall intensity. This will maximize the erosive nature of tropical rainfall in the region. It will also result to rapid surface run-off, excessive soil erosion and water logging. Indeed crop yields may be affected through too much rain (Polluk, 1968, Udo, 1970).

As the rainfall intensity within the rainy season increases, minerals component of the soil will illuviated annually in great quantity thereby limiting the soil fertility. It will also accelerate soil erosion that will lead to the development of gullies in many places thereby limiting the size of arable land annually.

Understanding the regions rainfall characteristics especially monthly trend will assist the government to transforming agriculture in the region from the inherited subsistence farming to commercial farming. This will help in assisting Nigeria in realizing the millennium development goals. Such as reducing poverty, communicable diseases, malnutrition and illiteracy etc

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