

Variations and Trends in Annual Rainfall Amounts and the Onset of the Rainy Season for Kano for 87 Yaers (1916-2002).

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Abstract: Rainfall data for 1916-2002 were used and onset dates were calculated based on a hybrid method by Ati, *et al*^[1]. The 10-year running mean was used to test for trends in the series. In order to further identify the long-term temporal variance structure in the rainfall and its series, they were subdivided into decadal periods (1920-1929, 1930-1939...1990-1999). Their means, standard deviations and coefficients of variation were compared. Annual rainfall totals in Kano was decreasing particularly since the 1960s but the last decade especially the late 1990s have been witnessing increasing annual rainfall totals. Most studies dealing with data terminating before the mid-1990s agree with the conclusion of decreasing annual totals from the 1960s^[6]. Later studies agree with the increasing annual rainfall from the mid-1990s. There is no clear pattern shown for the trend in onset dates. If the present upward trend in annual rainfall totals continues, a statistically significant shift in the onset dates may be expected to occur.

Key words:

INTRODUCTION

Climates varied in the past on different time scales. In recent times climate variability is suspected to be increasing and climate may be changing. This has generated a lot of interest and concern among agro meteorologists and climatologists. Changes in rainfall characteristics have been studied particularly in the seasonally arid tropics^[7,4].

Delimiting climate variability and trying to prove actual climate change are very complex endeavours. Much of the data taken has been designed to observe weather rather than climate change. In recent times, however several parameters of variability and possible change have been studied. These include changes in average sea level^[11,12] and changes in average carbon dioxide levels^[9]. In recent years temperature trends and changes in rainfall characteristics have also been studied, the latter particularly in seasonally arid tropics^[8,3,4,2].

Agriculture would be seriously affected by increased variability and trends in the seasonal characteristics of rainfall in an environment where one of the major limiting factors of agricultural production is the amount of water available through rainfall. This research is an analysis of variations and trends in both rainfall and its onset series for Kano.

MATERIALS AND METHODS

Rainfall data from 1916 to 2002 form Kano was used for this study. Onset dates were calculated for the length of data using the hybrid method by *Ati et al.*,^[1]. The hybrid method is a combination of the criteria of Kowal, and Sivakumar^[10]. Onset is defined as the decade in which rainfall is greater than 25mm and where subsequent decades of precipitation is greater than 0.5 potential evapotranspiration and where there is no dry spell of more than 7 days within the nest 30 days of the date on which the above criteria is satisfied. If such a dry spell exists, the onset date would be the date of the first rains after the dry spell.

All the data were tested for normality using the skewness and kurtosis in the SPSS computer package with a significance level of 95%. The data was tested for trends using Man-Kendal's rank statistical parameter (τ) and the Spearman's rank correlation (r_s). To further specify the nature of the various characteristics each data period was divided into decades and the statistics for each decade calculated. The trend line was plotted for each parameter and the 10-Year running mean calculated and plotted. Comparisons between non-overlapping sub-periods were carried out using the student's t-test.

RESULTS AND DISCUSSION

Annual Rainfall Totals: The general statistics of annual rainfall totals for Kano is no table 1. The annual rainfall totals were normal at 95% confidence level. Kendall's statistic and Spearman's Correlation did not indicate any statistically significant trend at 95% confidence level. In fig. 1 the trend line did not indicate any significant trend in the annual rainfall totals for Kano. The 10-year running mean indicates a decreasing rainfall amounts from the mid-1960s up to the late 1990s then sharp increase is noticed. Decadal statistics of the annual rainfall totals for Kano are presented no table 2. From the table, there is decreasing decadal mean from 1963-1972 with significant increase in the last decade. Student's t-test results no table 4.3 for the non-overlapping sub-periods 1923-1932, 1933-1942 through 1993-2002 shows a significant difference between the means of the sub-periods 1953-1962 and 1963-1972, and 1983-1992 and 1993-2002.

Onset Dates of the Rainy Season: The general statistics of onset dates for Kano are no table 4. The onset series was normal at 95% confidence level. Kendall's statistic and Spearman's Correlation did not indicate any statistically significant trend at 95% confidence level. From fig. 2 the trend line and the 10-year running mean did not indicate any significant trend in the onset series for Kano. Decadal statistics of the onset for Kano are presented no table 5. From the table, there is no clear pattern shown for the onset for Kano. Student's t-test results no table 6 for the non-overlapping sub-periods 1923-1932, 1933-1942 through 1993-2002 does not show any significant difference between the means of the sub-periods.

Discussion: Trends in annual rainfall totals for Kano did not show any significant trend using the Mann-Kendal and Spearman's correlations. This might be due to the duration of the data. The long duration of the data would have 'swallowed up' short term variations that occurred within the period. This assumption is

Table 1: General statistics of annual rainfall for Kano.

Mean	SD	CV	Min	Max	Range	T	r_s	Z_1	Z_2
865.20	250.31	28.93	434.00	1869.30	1435.30	τ	r_s	1.164	2.601
						-0.080	-0.085		

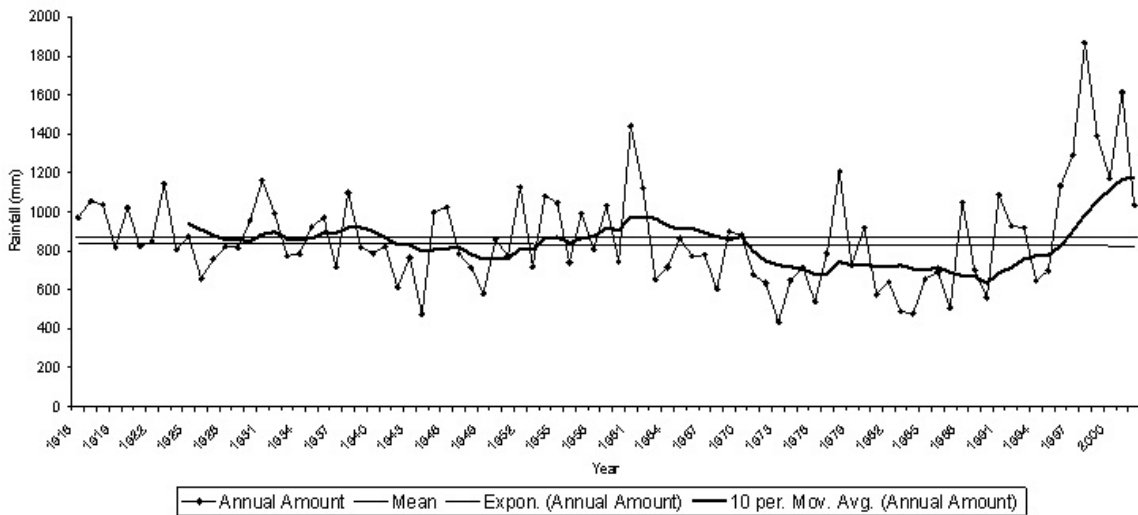


Fig. 1: Trends in annual rainfall amount for Kano.

Table 2: Decadal statistics of annual rainfall totals for Kano

Decade	Sum	Mean	SD	CV	Min	Max	Range	Z_1	Z_2
1923-1932	8984.14	898.41	163.93	18.25	658.00	1163.00	505.00	0.490	-0.568
1933-1942	8306.25	830.63	136.51	16.44	611.75	1097.25	485.50	0.552	0.688
1943-1952	8100.03	810.00	200.70	24.78	476.50	1128.00	651.50	-0.030	-0.455
1953-1962	9725.50	972.55	225.92	23.23	718.00	1440.50	722.50	0.754	0.612
1963-1972	7476.80	747.68	107.23	14.34	601.75	896.25	294.50	0.166	-1.522
1973-1982	7191.15	719.12	218.49	30.38	434.00	1208.30	774.30	1.230	2.080
1983-1992	7143.99	714.34	229.27	32.09	478.70	1087.40	608.70	0.703	-1.030
1993-2002	11771.00	1177.10	383.59	32.59	648.00	1869.30	1221.30	0.366	-0.276

Table 3: Results of student's t-test of annual rainfall for Kano

Sub-Periods	T-test
1923-1932 and 1933-1942	0.864
1933-1942 and 1943-1952	0.256
1943-1952 and 1953-1962	-1.621
1953-1962 and 1963-1972	2.733*
1963-1972 and 1973-1982	0.372
1973-1982 and 1983-1992	0.056
1983-1992 and 1993-2002	-5.250*

supported by the trend shown by the 10-year running mean and the decadal statistics. This show decreasing trend starting from 1963-1972 up till the late 1990s when sharp increase was noticed in the annual rainfall totals. Earlier authors^[5,2] have stated that northern Nigeria is getting drier. Recent data, as indicated in this study, however, shows a reversal of this trend. Onset Dates of the rainy season did not show any

significant trend for Kano. This indicates that trends are more significantly noticed in rainfall amounts than in the onset of the rainy season.

Conclusion: The analysis shows that annual rainfall totals in Kano started decreasing in the 1960s but the last decade especially the late 1990s have been witnessing increasing annual rainfall totals. For the onset dates no clear regional pattern could be seen. If the present upward trend in annual rainfall totals continues, a statistically significant shift in the onset may be expected to occur.

Increasing trend in rainfall totals may pose significant danger to areas that are prone to flooding as reservoirs could easily overflow leading to loss of life and property.

Table 4: General statistics of Onset Dates for Kano.

Mean	SD	CV	Min	Max	Range	T	r_s	Z_1	Z_2		
167	8.36	10.99	126	207	81	τ	Z	r_s	z	-0.117	-0.506
						-0.030	0.696	-0.045	0.678		

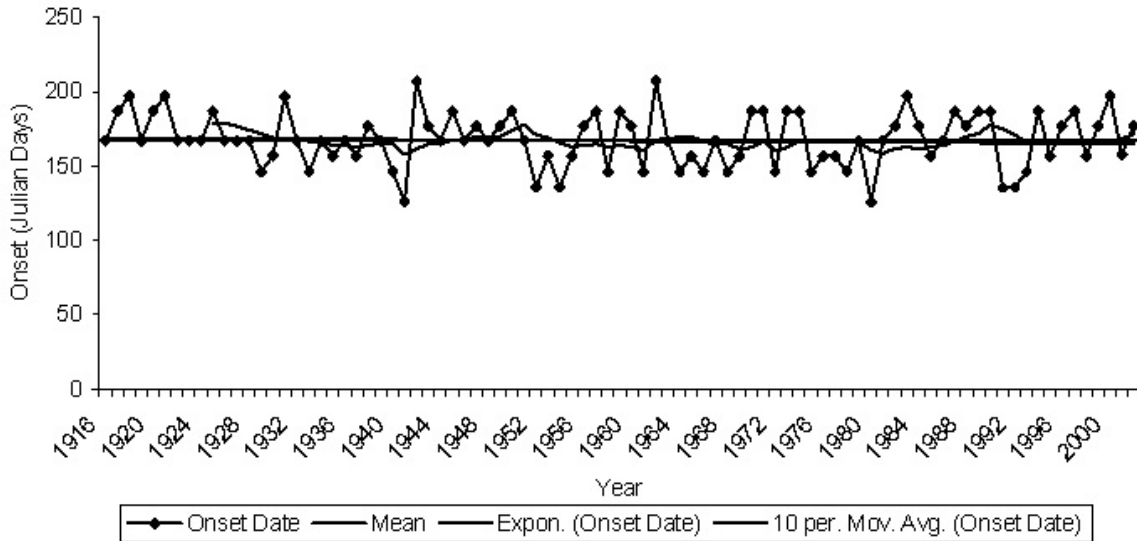


Fig. 2 Trends in onset dates for Kano.

Table 5: Decadal statistics of Onset Dates for Kano

Decade	Mean	SD	CV	Min	Max	Range	Z_1	Z_2
1923-1932	167	14.16	8.48	146	197	51	0.703	1.228
1933-1942	167	21.56	12.91	126	207	81	0.604	1.741
1943-1952	167	14.56	8.72	136	187	51	-1.516	3.535
1953-1962	167	22.70	13.59	136	207	71	0.261	-0.923
1963-1972	157	16.17	10.30	146	187	41	0.813	-0.650
1973-1982	167	19.39	11.61	126	187	61	-0.328	-0.286
1983-1992	167	21.55	12.90	136	197	61	-0.774	-0.641
1993-2002	177	16.57	9.36	146	197	51	-0.132	-1.185

Table 6: Results of student's t-test of Onset Dates for Kano

Sub-Periods	T-test
1923-1932 and 1933-1942	0.753
1933-1942 and 1943-1952	-0.872
1943-1952 and 1953-1962	0.330
1953-1962 and 1963-1972	0.780
1963-1972 and 1973-1982	-0.120
1973-1982 and 1983-1992	-0.952
1983-1992 and 1993-2002	-0.153

REFERENCES

- Ati, O.F., C.J. Stigter and E.O. Oladipo, 2002. "A comparison of methods to determine the onset of the growing season in northern Nigeria." *International Journal of Climatology*, 22: 731-742.
- Ati, F.O., 2003. "Tends and changes in the rainfall and its onset series for Kano" *Proceedings of the Regional Conference on Global Climate Change and Food Sustainability in Africa held at the Conference Hall, Nigerian Meteorological Agency (NIMET), Oshodi - Lagos. 11-14.*
- Hulme, M., 1987. "Secular Changes in wet season structure in Central Sudan". *J. Arid Environments*, 13: 31-46.
- Oladipo, E.O., 1992. "Drought in Northern Nigeria: an indication of abrupt climatic change?" Paper presented at the 1992 Meteorological Society of New Zealand Conference on Weather and Climate Risks. Lincoln University, Lincoln, pp.19.
- Oladipo, E.O., 1993. "Is the climate of Northern Nigeria becoming more arid?" Paper presented at the 36th Annual Conference of the Nigerian Geographical Association, 18-22. Federal University of Technology, Minna, pp. 13.
- Oladipo, E.O. and J.D. Kyari, 1993. "Fluctuations in the onset, termination and length of the growing season in Northern Nigeria" *Theor. Appl. Climatol.* 47: 241-250.
- Repapis, C.C. and C.M. Philanders, 1988. " A note on the air temperature trends of the last 100 years as evidenced in the Eastern Mediterranean time series." *Theo.Applied Climate*, 39: 93-97.
- Sahsamanoglou, H.S. and T.J. Makrogianis, 1992. "Temperature trends over the Mediterranean Region, 1950-1988" *Theor. Appl. Climatol.* 45: 183-192.
- Schneider, S.H. and R.S. Chem. warming and coastline flooding: Physical Factors and Climate Impact" *Ann. Rev. Energy*, 5: 107-140.
- Sivakumar, M.V.K., 1988. "Predicting rainy season potential from the onset of rains in southern sahelian and sudanian climatic zones of West Africa" *Agricultural and Forest Meteorology*, 42: 295-305.
- Titus, J.G., 1986. "The Basis for expecting a rise in sea level" in: *Green House Effect, Sea level Rise, and Salinity in the Dalawa Estuary.* EPA Publication.
- Warrick, R. and J. Oerlemans, 1990. "Sea level rise." In: Houghton, J.T., Jenkins, G.J., Ephraums, J.J. (eds) *Climate Change: The IPCC Scientific Assessment.* 257-281.