# VARIATIONS IN THE STATISTICAL MEASURES OF MEAN RAINFALL

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**ABSTRACT**

Rainfall records are required for planning and development of water resources projects. Long term averages of rainfall are often needed. Decisions often have to be made with short term records, as long term rainfall records are not available for most parts of Nigeria. This study describes variations in some statistical measures as compared with their long term values. Records of 25 years will give estimates of mean rainfall within 4% of their long term values.

## 1. INTRODUCTION

Water resources development is a major item in the Nigerian Third National Development Plan 1975-1980 [1]. Long term averages of rainfall are required for proper planning and development of water resources projects. Such long records are not available for many parts of Nigeria and decisions have to be made with limited data.

This study describes the variations in some statistical measures of short rainfall records as compared with those of long term records. The analysis is based on 50 years (1912-1961) rainfall records of two rainfall stations in Nigeria- one station in the wet part of the country and the other in the dry part.

## 2. GEOGRAPHY OF THE RAINFALL STATIONS

The rainfall stations considered are Lagos in the wet part of the country and Kano in the dry northern part. The geographical descriptions of the two stations have been given by Perkins and stembridge [2] and Federal Ministry of Agriculture and Natural Resources [3].

(i) Lagos is the capital city of Nigeria and lies on latitude $6^0$ 27'N and longitude $3^0$ 24'E. It is located in the coastal plain that borders the Gulf of Guinea at an altitude of 3.05 meters above mean sea level. The climatic variations are governed by the moisture laden south-west winds blowing from the Sahara desert and known as the Harmattan. The mean number of rain days per annum based on 1951-1960 records is 134 days, and the mean annual temperature is $26.90^0$C. The vegetation is of the rain forest type characterized by giant trees such as Mohogany, African Walnut, Iroko and Obeche.

(ii) Kano is the ancient city of northern Nigeria lying on latitude $12^0$ 3'N and longitude $8^0$ 32'E. It is located on the northern high plains at an altitude of 472.5 meters above mean sea level. The climatic variations are governed by the south west winds and the Harmattan. The annual mean number of rain days is 65 days and the mean annual temperature is $26.3^0$C. The vegetation is of the Sudan Savanna type.

## 3. DATA

The basic data used in this study are the annual rainfall records of Lagos and Kano [4].The records cover a period of 50 years (1912-1961). Table 1 shows the annual rainfall in mm.

## 4. ANALYSIS AND DISCUSSION

The statistical measures computed from the basic data are the mean (x), the standard deviation(s) and the coefficient of variation (cv) [5]. Successive sample sizes of 10, 15, 20… 50 were taken from the 50-year series for each station. For example, first sample of size 10 included items from 1 to 10. The second sample of size 10 contained items from 2 to 11 and so on. In this way a series of 50 items yielded 41 samples of size 10. By this method the number of samples that could be formed with different sample sizes is given by:

$$n = N - z + 1$$

where

$n$ =Total umber of the samples

$N$=Total number of items in the series

$z$ = the size of the sample

Then, the umber of samples of sizes 10, 15, 20… 50 got from a series of 50 items were 41, 36, 31… 1. The statistical measures stated earlier were computed from each of

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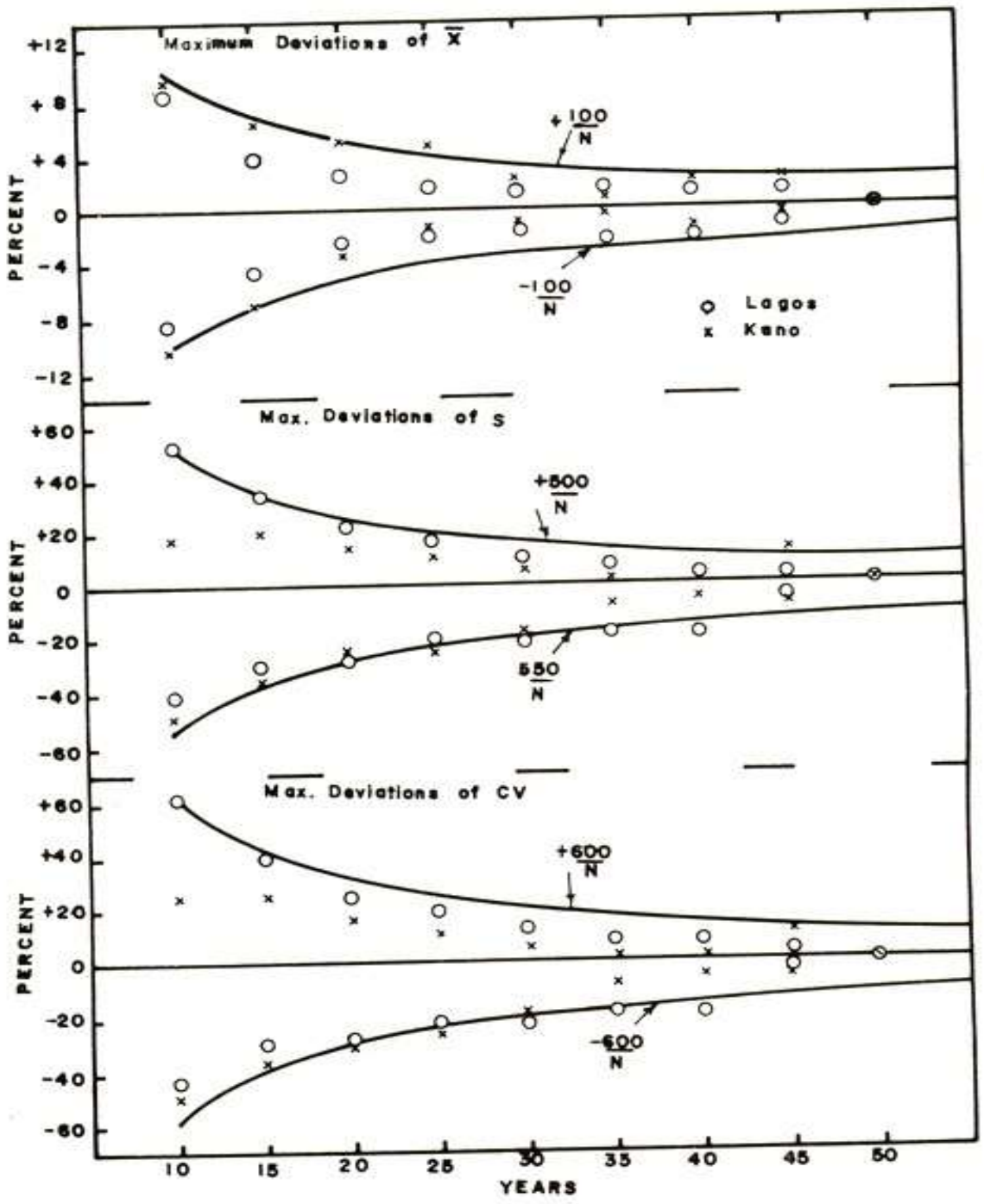


Fig.1. Maximum deviations of statistical measures of mean rainfall as percentages of long term values.

these samples. The 41 samples of size 10 yielded 41 values of the mean, the standard deviation and the coefficient of variation. Taking the statistical measures of the 50-year series as a base, the maximum deviations both positive and negative of the measures of the samples were computed and expressed as percentages. So, for the 10-year samples, 2 values for each station represent the maximum and minimum values of the 41 means expressed as percentages of the 50-year mean for the station. Fig. 1 shows the maximum deviations of the statistical measures as percentages of 50-year values. Envelope curves were drawn for each measure.

Table 2 gives the values of the statistical measures computed for the sample size of 50.

Formulae for the envelope curves shown in Fig. 1 are listed in Table 3.

Table 2: Statistical measures of mean rainfall computed from 50-year records (1912-1961).

| Station | X mm | S mm | cv |
|---|---|---|---|
| Lagos | 177.90 | 35.43 | .199 |
| Kano | 84.68 | 15.30 | .179 |

Table 3: Formulae of envelope curves.

| Maximum percentage deviation | X | S | Cv |
|---|---|---|---|
| Positive | $\frac{+100}{N}$ | $\frac{+500}{N}$ | $\frac{+600}{N}$ |
| Negative | $\frac{-100}{N}$ | $\frac{-550}{N}$ | $\frac{-600}{N}$ |

The maximum deviations for the mean rainfall computed from 10 years of rainfall record will be within + 10% and - 10% for the stations considered. It is observed that 25 years of rainfall records will give estimates of mean rainfall within 4% of their long term values. The standard deviation and coefficient of variation are measures of the variability of observations. It is observed that Lagos in the wet part of the country showed more variability than Kano in the dry part of the country.

## 5. CONCLUSION

The statistical measures considered in this study deviate from their long term values inversely with the period of record. Adequacy of data depends on the accuracy of estimates required. A small project in Nigeria may require estimates of mean rainfall within 10% of their long term values, in which case, 10 years of records will be adequate. For major projects longer term records may be necessary.

## REFERENCES

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[3] Perkins W.A. and J.H. STEMBRIDGE, 1957. Nigeria. Oxford University Press, London.

[4] Federal Ministry of Agriculture and Natural Resources, 1975. Rainfall Records for Lagos and Kano: Nigerian Meteorological Service, Lagos, Nigeria

[5] BENJAMIN, J.R. and C.A. CORNELL, 1970. Probability, Statistics and Decision for Civil Engineers, McGraw Hill Book Company, New York.

Table 1: Annual Rainfall in mm (1912-1961).

| YEAR | LAGOS | KANO | YEAR | LAGOS | KANO |
|---|---|---|---|---|---|
| 1912 | 102.23 | 73.00 | 1937 | 204.53 | 72.43 |
| 1913 | 151.63 | 47.63 | 1938 | 146.70 | 109.68 |
| 1914 | 172.48 | 67.40 | 1939 | 155.65 | 83.13 |
| 1915 | 225.35 | 80.58 | 1940 | 182.70 | 79.85 |
| 1916 | 151.23 | 97.30 | 1941 | 206.55 | 82.33 |
| 1917 | 288.73 | 85.55 | 1942 | 197.50 | 61.20 |
| 1918 | 134.55 | 101.85 | 1943 | 198.85 | 78.10 |
| 1919 | 120.98 | 81.03 | 1944 | 169.90 | 47.65 |
| 1920 | 132.75 | 107.78 | 1945 | 149.13 | 97.60 |
| 1921 | 208.05 | 85.33 | 1946 | 131.25 | 103.85 |
| 1922 | 212.50 | 89.73 | 1947 | 225.98 | 78.50 |
| 1923 | 178.88 | 79.25 | 1948 | 131.08 | 70.85 |
| 1924 | 124.80 | 83.35 | 1949 | 157.30 | 57.93 |
| 1925 | 191.00 | 88.55 | 1950 | 143.05 | 90.86 |
| 1926 | 189."93 | 68.93 | 1951 | 205.03 | 79.68 |
| 1927 | 131.50 | 75.68 | 1952 | 185.83 | 101.85 |
| 1928 | 197.63 | 87.35 | 1953 | 193.05 | 70.30 |
| 1929 | 214.28 | 82.08 | 1954 | 176.43 | 108.68 |
| 1930 | 178.80 | 97.98 | 1955 | 198.60 | 105.70 |
| 1931 | 208.88 | 116.33 | 1956 | 153.90 | 74.55 |
| 1932 | 120.23 | 98.98 | 1957 | 235.85 | 99.23 |
| 1933 | 189.63 | 83.48 | 1958 | 207.98 | 81.40 |
| 1934 | 194.50 | 78.30 | 1957 | 195.73 | 100.48 |
| 1935 | 196.78 | 92.30 | 1960 | 176.15 | 74.48 |
| 1936 | 155.70 | 96.40 | 1961 | 187.96 | 76.70 |