



Food and Agriculture Organization  
of the United Nations

# **RAINFALL VARIABILITY AND DROUGHT IN SUB-SAHARAN AFRICA**

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May, 1996

## **Rainfall Variability and Drought in Sub-Saharan Africa**

Rainfall variability at a time scale 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 low rainfall.

Agricultural drought occurs 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. Much more than the occasional widespread and severe climatological droughts which catch the attention of the media, it is this "invisible" agricultural drought which prevents farmers at the subsistence level from achieving regular and high yields. "Invisible" drought is brought about by environmental degradation as much as by climate.

### **African droughts**

The continent has a long history of rainfall fluctuations of varying lengths and intensities.

The worst droughts were those of the 1910s, which affected east and west Africa alike. They were generally followed by increasing rainfall amounts, but negative trends were observed again from 1950 onwards culminating, in West Africa, in 1984.

Since then, starting in 1988, the Sahel has recorded a series of good years (frequently accompanied by floods) which some interpret as the end of the Sahelian drought. The reality is that rainfall will continue fluctuating, and that good and bad years will continue occurring. Some general regional patterns can be recognised, which can be expressed in terms of variability (inter-annual and intra-seasonal rainfall), trends (upward or downward) and persistence, a typical inertia which affects many climatic variables at all time scales (good and bad years do not occur randomly, but tend to be grouped).

### **Good years and bad years**

Even allowing for differences between countries in individual years, the period 1960-93 has experienced widely different conditions from year to year. The years from 1960 to 1969 were among the wettest of the period, while the seventies and eighties mostly recorded lower rainfall. The downward trend from 1960 to 1970 affected the whole continent, but

resulted in negative impacts on food production only in the low rainfall areas.

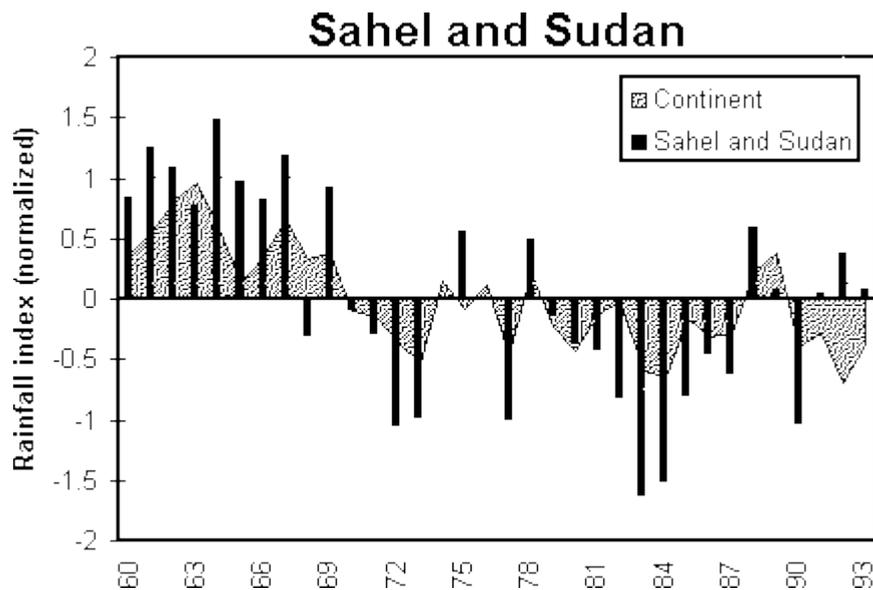
The years 1973, 1984 and 1992 were bad, while 1963, and to a lesser extent 1989, were remarkable years in that almost the whole continent experienced above average conditions. 1973 is interesting in that it constituted the first poor year after a run of good years. As such, it caught most countries unprepared. In contrast, the impact of 1984, which was more severe than 1973 in climatological terms, was relatively less serious as the economies of many countries (especially in the Sahel) had learnt by now how to cope with such extreme situations.

In 1973 (and less so in 1984) almost all African countries suffered, north and south alike. In contrast, the 1992 southern African drought was relatively limited in space since the Sahel had one of its good "after 1988" years (with average or above average conditions).

### **Regional patterns**

In order to allow a more synthetic discussion, the sub-Saharan countries can be classified into eight groups of similar behaviour based on rainfall patterns since 1960. The patterns observed in the different groups are not independent. Part of this behaviour is directly linked with the rain-bringing mechanisms in Africa and explains why continent-wide good and continent-wide bad years are infrequent. Each of the groups is characterised by persistence characteristics, trends and pseudo-cycles.

#### **1. Sahel and Sudan: Burkina Faso, Cape Verde, Chad, Gambia, Guinea-Bissau, Mali, Mauritania, Niger, Senegal and Sudan**



This group is one of the driest and most variable in Africa. Runs of dry years and runs of wet years are a typical feature of the climate of the countries in this group where extreme years (either good or bad) are more likely than average ones.

The group is characterised by a downward trend of rainfall until 1988, followed by series of about-average years. Worst drought years correspond to 1983 and 1984, but severe drought were also recorded in 1972, 1973 and 1977. In 1984, drought severely affected all countries from Mauritania to Ethiopia, including several bordering countries on the southern edge of the Sahel. In contrast, Mali and Niger were more seriously affected than other countries in 1973.

## **2. Southern-central Africa and Madagascar: Madagascar, Malawi, Mozambique, Namibia, Zambia and Zimbabwe**

The rainfall patterns in this second group are uncorrelated with Sahelian ones; total amounts are slightly higher, and the inter-annual variability is somewhat less. There is also no marked negative trend in rainfall, although the years after 1974, and particularly after 1985, have been characterised by marked pseudo-periodic fluctuations, with peaks in 1985 and 1989, and lows in 1987 and 1992.

Most of the area had not experienced serious drought after 1960, except in 1982, until it was hit by the 1991-92 drought (affecting the 1991-92 southern hemisphere summer cropping season). The drought most seriously affected the centre of the group, while Namibia and

Madagascar where relatively less affected. Note that several countries outside this group (Zaire, the Central African Republic, Rwanda and Burundi) also experienced reduced rainfall in 1991-92. However, they usually receive rainfall far in excess of their crops' requirements and suffered less than their southern neighbours.

The countries of the second group have so far displayed a remarkably stable persistence structure in that extremely wet and dry years and average years are about equally likely.

### **3. Central Gulf of Guinea countries and Tanzania: Benin, Côte d'Ivoire, Ghana, Tanzania, Togo**

The behaviour of rainfall in this group is not unlike what was observed in the Sahel, with a slight downward trend, and a tendency towards runs of dry years. The lowest rainfall index was recorded in 1977 (which also affected the Sahel), followed by 1992. In contrast, 1984 and 1972, which were drought years in the Sahel, were just slightly below normal in Group 3. The greatest differences, however, are observed during the sixties where group 3 experienced several well above normal rainfall years.

The group is usually not very drought prone, if only because the countries are not very homogeneous from a climatic point of view. Some areas have bi-modal rains (along the coast in the Gulf of Guinea countries, in the north-east for Tanzania), others have only one season (in the north of the Gulf of Guinea states, most of the country in Tanzania). In addition, Tanzania has high elevation climates and, considering the whole country, planting and harvesting takes place throughout the year.

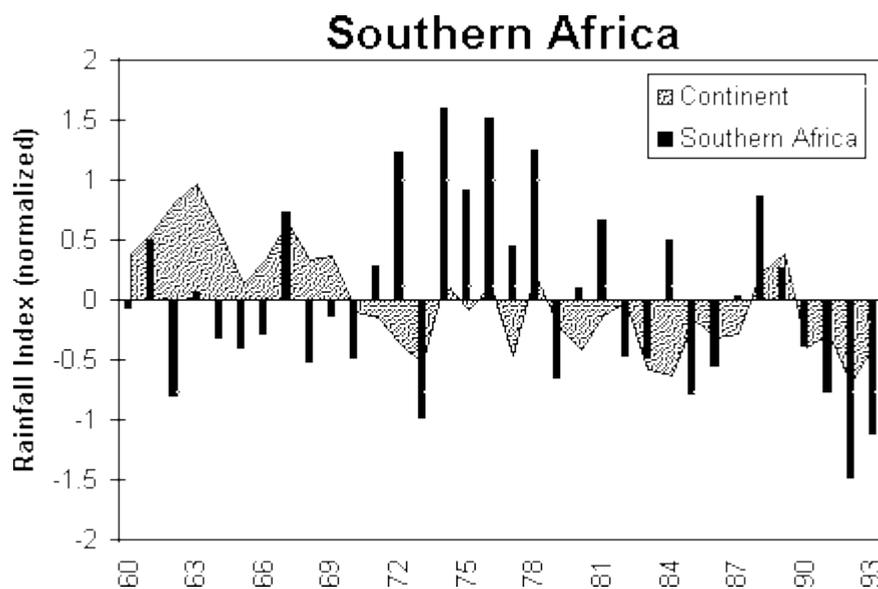
In the countries of this group, precisely because of the different rainfall regimes, drought usually affects relatively limited areas, e.g. southern Lake Victoria in Tanzania in 1974-75 and 1975-76.

The mechanism of the West African monsoon also accounts for the relative stability of the countries in the Gulf of Guinea: the monsoon rain belt moves north about February (first rains in the south) and reaches the "Sahelian" north in May, which thus corresponds with the short dry season in the south. When the rains move south again (September), the season ends in the north and the second season starts in the south, to last until November or December. The failure of the monsoon to move north thus leads to poor rains in the north, but unusually good rains in the south. The same type of compensatory mechanisms also plays a part on a continental scale.

#### 4. East and West Gulf of Guinea: Cameroon, Central African republic, Equatorial Guinea, Gabon, Guinea, Liberia, Nigeria, Sierra Leone

This is the wettest (Rainfall index: 1938 mm) and one of the least variable groups of countries in the continent. The northern half of several of the countries has Sahelian features, in particular the downward trend of rainfall. However, in contrast to the Sahel, the East and West Gulf of Guinea countries underwent less irregular rainfall (albeit below normal) than the Sahel during the 70s and 80s, and recent years were very close to normal. Given the high absolute amounts of rain, the countries in this group do not suffer so seriously as the arid countries from a comparable reduction in precipitation. In group IV, runs of good and runs of bad years tend to be longer than in the Sahel.

#### 5. Southern Africa: Botswana, Lesotho, South Africa, Swaziland



The Southern African group has a relatively low rainfall index and a variability that exceeds that of the Sahel. There are some common features between this group and Group 2, e.g. dry years in 1973, 1982, 1983 and 1992, but also notable differences, for instance in 1985 and 1993. The countries in this group were severely affected by the 1991-92 drought, which was the most severe after the 1981-85 droughts, the latter having been the worst since the 1920s.

#### 6. Horn of Africa and Kenya: Djibouti, Ethiopia, Kenya, Somalia

This area includes some of the driest places in the world. The time series which describes Group VI is almost uncorrelated with all the above mentioned groups, and slightly correlated with neighbouring group 8. The Group is characterised by low rainfall and a high variability (24%). The time series displays a typical pseudo-periodic behaviour with a cycle of 4 to 5 years. The region as a whole experienced good rainfall in 1989, but the last run of good years goes back to 1981-1983. Bad years tend to have less negative effect at the higher elevations which characterise central Ethiopia and parts of southern Kenya. 1973 and 1984 were poor years in parts of the region. Parts of the region have more than one cropping season, and drought does typically affect one of them more seriously than the other.

### **7. Central-west Africa: Angola, Congo, Zaire**

This second wettest group (rainfall index 1489 mm) has shown a very "smooth" behaviour between 1964 and 1984, with a slight positive 1960-93 rainfall trend due to a run of wet and very variable years from 1985 to 1990. This also accounts for the very high frequency of "dry" years following "dry" years in this part of the continent.

### **8. Great lakes countries: Burundi, Rwanda, Uganda**

In this group, rainfall indices are high and not very variable. As indicated, the rainfall patterns have some similarity to those in the Horn of Africa, with an almost-significant cycle of about 7 years. The region recorded some very wet years in the early 60s, and a run of low rainfall years starting in 1987.