Seasonal rainfall forecasting in West Africa

Dr Derek Winstanley, now at the Ecological Systems Research Division, Environment Canada, Ottawa K1A OH3, emphasises that seasonal rainfall forecasting is vital if early warnings are to be obtained of food shortages.

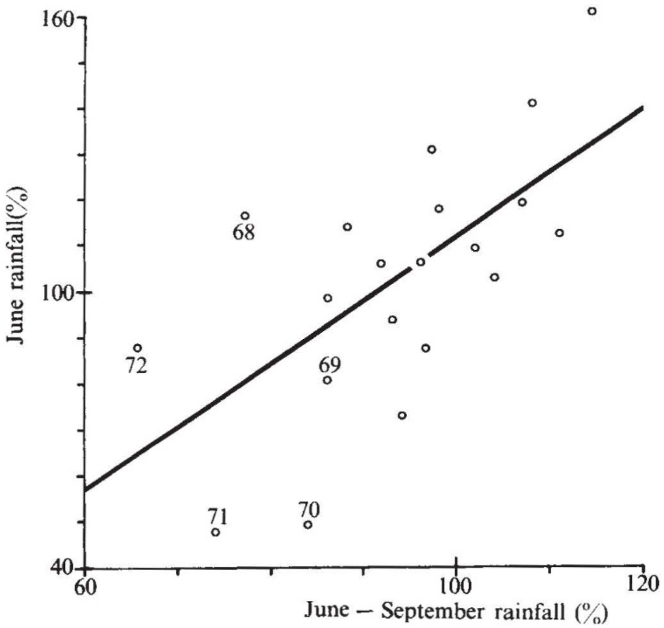

Fig. 1. Mean percentage of normal (1931–60) June rainfall at 59 stations between 10° and 20°N, from the Atlantic coast eastwards to Chad, plotted against the mean percentage of normal June–September rainfall for the 20 years 1953–72. The regression line has been derived by the least-squares method. Data sources are refs 5 and 6

FOOD production and the maintenance of the ecological balance in the semi-arid zone to the south of the Sahara depend on the rains which fall from June to September. For the past six years the rains have failed[1]. Last year 3.5 million head of cattle worth £180 million perished, there was a grain shortage of 1 million tons and some 6 million people were placed on the brink of starvation. In order to avert disaster on an unprecedented scale in 1974, an increase in the already massive amount of international aid is essential. Clearly, successful seasonal rainfall forecasting could lead to an early assessment of food shortages.

I have taken 59 stations between 10° and 20°N, from the Atlantic coast to Chad, and have calculated the mean percentage of normal (1931–60) rainfall for June and for the wet season June–September each year during the period 1953–72. The mean June rainfall for the 59 stations is 124 mm and the mean amount for June–September is 636 mm, 88% of the mean annual total.

Figure 1 shows a highly significant correlation ($r = +0.63$) between June rainfall and the seasonal total. When June rainfall is below normal the total seasonal rainfall is also below normal.

There is clearly a strong tendency for anomalous rainfall patterns to persist throughout the wet season. This suggests an equally strong persistence of the large scale atmospheric circulation systems which control rainfall. The year 1968 was rather anomalous in that June rainfall was 17% above normal but the seasonal total was 23% below normal. This was the first year of widespread rainfall deficiencies and it is possible that there was a rapid switchover of circulation types in about July of that year. Figure 1 shows that the subsequent dry years fit into the pattern.

The rainfall deficiency in this zone increases with latitude[1]: at 18°N there has been a cumulative rainfall deficiency of 250–300% of normal since 1968, whereas at 10°N there has been only a small decrease in rainfall. I have previously suggested that the cause of this decrease in rainfall is a decrease in the northward extent and intensity of the ascending branch of the Hadley cell, concomitant with a weakening of the global atmospheric circulation[1–3]. Taking the annual number of days of the westerly weather type over the British Isles as an indicator of the strength of the global atmospheric circulation[4], it is apparent that for the past few years the global circulation has been weaker than at any time for about a century. The drought to the south of the Sahara thus represents an extreme situation but I have suggested that such droughts may become more frequent in the next 60 years[3].

It is doubtful whether any nation can cope with a cumulative rainfall deficiency of 300% over 6 years. But the very fact that there are such large scale atmospheric controls on rainfall could provide a rational basis for integrated long term development. What must be determined are the maximum cumulative rainfall deficiencies that can be expected. It must then be decided what level of rainfall deficiencies can be tolerated, if the countries are to maintain some degree of self-support, either nationally or through some political or economic union. Development should then be encouraged in the more favourable areas, even though good rains may extend farther north in some years.

In 1973 world cereal stocks were reported to be at the lowest level for 20 years. Significantly, it was adverse weather in the Soviet Union in 1972 which led to the purchase of huge amounts of American grain; this, probably more than any other single factor, led to the depletion of world grain stocks and the escalation of world food prices. With depleted world cereal stocks it is not easy to guarantee supplies for major disaster relief programmes. Assuming that supplies are available on the international market, the high prices cripple the economies of the drought and flood-affected developing countries; in the case of India, the high cost of food imports has also necessitated the curtailment of the family planning programme.

The main development constraints in this zone are surely climatological, but the task of development seems to be beyond the individual capabilities of the governments. In any future development plans there are three points to be taken into consideration. First, large scale atmospheric circulations exert a unifying influence right across this zone, such that there will again be years when the rains fail over some 5 million square kilometres. Second, the atmospheric controls on rainfall are such that percentage deficiencies, and surpluses, will always increase with latitude. Third, climatic fluctuations in this zone are closely related to climatic fluctuations in other parts of the world, so that in some years there are likely to be synchronous food shortages in different regions which could affect world food stocks.

1 Winstanley, D., *Bird Study* (in the press).
2 Winstanley, D., *Nature*, **243**, 464–465 (1973).
3 Winstanley, D., *Nature*, **245**, 190–194 (1973).
4 Lamb, H. H., *Geophys. Mem. No. 116* (Meteorological Office, Bracknell, 1972).
5 *World Weather Records* (US Department of Commerce, Washington DC, 1967).
6 *Monthly Climatic Data for the World* (Environmental Data Service, NOAA, US Department of Commerce, Washington DC, 1961–72).