ELEPHANTS, HUMAN ECOLOGY AND ENVIRONMENTAL DEGRADATION IN NORTH-EASTERN GHANA AND NORTHERN TOGO

[1]MK Sam, [2]RFW Barnes, and [3]K Okoumassou

[1] Wildlife Department, PO Box M239, Accra, Ghana
[2] Dept of Biology 0116, University of California at San Diego, La Jolla, CA 92093-0116, USA
[3] Direction de la Faune et de la Chasse, BP 355, Lomé, Togo
* Address for correspondence

RESUME

Une étude sur le statut des é1éphants *(Loxodonta africana) a* été conduite au nord - est du Ghana et au nord du Togo en Avril - Juin 1996. L'objectif était de déterminer le statut des é1éphants et d'évaluer le problème des dégâts de cultures (Okoumassou *et al.,* cc volume). Ce rapport a discuté la distribution des é1éphants dans cette région et a décrit le conflit entre la population et les é1éphants et leurs rapports avec les bouleversements politiques au Togo, la croissance de la population humaine, la dégradation des sols, et les changements liés à la chute de la pluviométrie. Une série d'études est recommandéc pour mettre en place un plan d'utilisation de Ia terre.

INTRODUCTION

A survey of the status of elephants *(Loxodonta africana)* in north-eastern Ghana and northern Togo was conducted in April-June 1996. The objective was to determine the status of elephants and evaluate the crop-raiding problem. (Okoumassou *et al.*, this volume) discussed the distribution of elephants for the region. This paper describes the conflict between people and elephants and its relationship to political upheavals in Togo, the growth in the human population, soil degradation, and changes in rainfall. A series of studies is recommended which will form the foundation for a land use plan.

STUDY AREA AND METHODS

The study area (Figure 1) comprised the north-eastern part of Ghana (Upper East Region of Ghana and Garnbaga District) and the northern part of Togo (Région des Savanes and the *prefecture* of Kandé). See Okoumassou *et al.* (this volume) for details of the study area and a description of methods.

RESULTS

Trend in elephant numbers

An aerial census in 1991 estimated 130 elephants in the area between Fosse-aux-Lions National Park and the Forêt de Doung before the Park was invaded by local communities residing around the Park (Stalmans and Anderson, 1992). No censuses have ever been conducted on the Ghanaian side. Jamieson (1972) recognised the tracks of 12 different elephants and concluded that there were perhaps 25 elephants, with a possible maximum of 50. Sam (1994) used footprint measurements to identify groups, and descriptions of other groups, to estimate between 100 and 150 animals.

Mole NP is the Wildlife Department station that is responsible for elephant matters in northern Ghana. The elephant control files show few complaints from the Upper East Region during the late 1980s compared to the 1990s. Furthermore, when elephant control units were sent to the Region, they stayed longer during the 1990s.

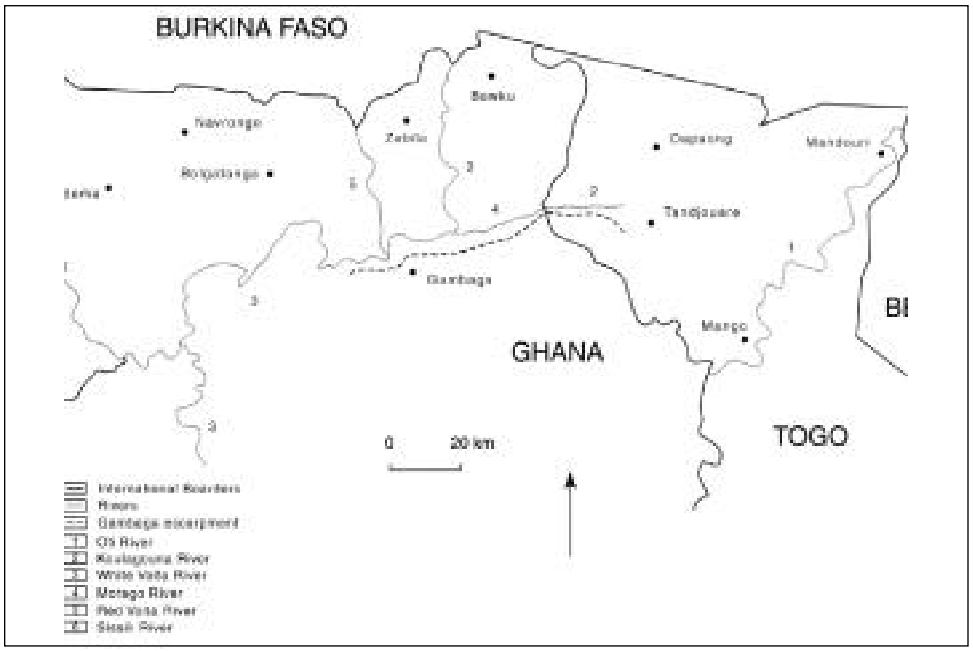

Figure 1. Map of north-eastern Ghana and northern Togo.

Elephants have always moved between Burkina Faso, Ghana, and Togo (Okoumassou *et al.,* this volume). Villagers living near the border reported that elephants moved from Togo to Ghana when the Togolese protected areas were taken over by local people during the political disturbances of 1990 to 1992 (Okoumassou *et al.*, this volume). Of the 18 Ghanaian villages that said they had suffered crop-raiding in the last decade, ten said in 1996 that elephant crop-raiding had become more frequent during the preceding ten years, and several specified "during the last four or five years". Only one said it had decreased. Thus, although there is no hard data to prove the point, it seems likely that elephant numbers have increased on the Ghanaian side of the bonier during the 1990s.

Relations between people and elephants

Sixty-six villages were visited, 42 in Ghana and 24 in Togo. Thirty-seven (or 56%) reported that elephants have damaged crops within the last ten years. Most farmers reported that elephants damaged crops around harvest-time, and noted that elephants usually take all food crops. Sometimes elephants open granaries, and occasionally break into compounds or houses to obtain stored grain.

A few elders said it would be a pity if their children never saw elephants. But 84% of the villages (n = 49) claimed that elephants played no part in their lives or culture, other than as malevolent creatures that destroy their food supplies. Villagers often expressed their hostility towards elephants. On the other hand, 64% (n = 39) said that elephant dung or parts of elephants, such as the skin, are used as medicines in their villages. Elephantiasis, measles and skin rashes were most frequently mentioned ailments. They believe that dung has medicinal powers because the elephant eats a wide range of plant species. Since plants often contain pharmacologically active compounds, they believe that many medicines are therefore concentrated in the dung. Elephant dung is often sold in markets for this reason. The richer members of some ethnic groups used to make bracelets and amulets from ivory, but that practice seems to be dying out. The people of Pana (in Togo) differed from the others, as their clan reveres elephants because elephants are believed to be their ancestors.

Human population densities

The human population density of Ghana's Upper East Region increased from 61 to 87 per km^2 between 1970 and 1984 (Anon, 1984). If human populations have continued to grow at the same rate, then numbers will have been about 118 per km^2 by 1996. The human population densities of the five prefectures in the Région

des Savanes ranged from 25 per km^2 around Mango to 201 per km^2 around Dapaong.

Soil fertility

Nine out of ten villages in Ghana and 21 out of 23 in Togo answered questions about soil fertility, ie. a combined percentage of 91%, reported that fertility had declined. Most explained the declining soil fertility by the shortage of land, which forces them to cultivate the same plots year after year instead of leaving them fallow. PNUD/ FAO (1991) and DCA (1992) made the same point. Changes in cattle management mean that manure is no longer deposited on farmland, and fertilisers are too expensive.

In three villages no decline in soil fertility had been noticed (Weisi in Ghana; Penserie and Donga in Togo). Weisi lies in a sparsely populated area because it was a bad onchocerciasis zone. There is plenty of land and the people can still leave fields fallow. The people of Panserie were removed from their present location in 1980 when the area was declared a game reserve. The land lay fallow until their return 12 years later. Donga lies in the less populated part of north-eastern coiner of Région des Savanes.

The Regional Agriculture office was unable to provide information on soil fertility trends in north-eastern Ghana. In Togo, however, PNUD/FAO (1991) found that 23% of the soils surveyed in Région des Savanes were very degraded, 49% were medium degraded, and only 28% were not degraded. In particular, the area north of Dapaong, where the human density is high and land in short supply, was very degraded. The soils of the region are shallow and erosion has made large areas useless for cultivation (PNUD/FAO, 1991).

According to PNUD/FAO (1991), 65 to 80 people per km^2 is the density which the land can support in Togo (NB: it is not clear how this figure was calculated). Each person requires 0.5ha under cultivation plus 4ha of fallow (PNUD/FAO, 1991). These densities have long been surpassed in the Tône and Tandjouaré *prefectures* and also in Ghana's Upper East Region.

Game populations

Many elders commented on the transformation of the natural vegetation brought about by expanding villages. Forty-four out of 46 villages (ie. 96%) reported that wildlife populations had declined due to hunting and habitat loss. Among the antelopes Jamieson (1972) saw on the Ghanaian side were roan *(Hippotragus equinus),* kob *(Kobus kob),* oribi *(Ourebia ourebi),* bushbuck *(Tragelaphus scriptus),* and red-flanked duiker *(Cephalophus rufilatus),* but 24 years later in the same area only oribi were seen. The elephant is the only large mammal species which has not declined on the Ghanaian side. This is largely because elephants are known to be protected by the government, and few hunters have powerful enough rifles to kill elephants.

Rainfall

Eight out of nine villages in Ghana and 22 out of 23 in Togo (ie. a combined percentage of 94%) reported that rainfall has decreased, and they also complained that the rains were less predictable. Many said that the wet season is shorter now, because the rains start later and end earlier. Consequently they must plant their crops in May or June rather than in April as in the past. One chief said that streams and shallow wells had dried up because the water table was falling.

In Upper East Region we obtained rainfall records for Navrongo (1932 to 1995) and Gambaga (1925 to 1959, and 1967 to 1976). In Région des Savanes only those for Mango (1969 to 1995) could be obtained. The Navrongo time-series (Figure 2) is the longest, covering 64 years. The running mean shows an apparent decline in rainfall between the early 1930s and the early 1990s (Figure 2). A linear regression of the records lying between the first and last peaks indicates a significant decline of 3.1mm per annum ($r = -0.318$, $n = 56$, $P < 0.05$).

There are a number of peaks and troughs in the Navrongo time-series. The running mean shows abundant rain in the early 1930s and for most of the 1950s. Then there were smaller peaks in the early 1970s and late 1980s. However, a Fourier Series analysis (Wilkinson, 1990) of both the raw data and the smoothed series does not indicate any rainfall cycles (Sam *et al.*, 1996). Therefore these are irregular fluctuations rather than cycles. The recent rainfall decline mentioned by villagers in 1996 is because the first half of the 1990s saw a downswing in the most recent fluctuation.

Thus we can break the Navrongo time-series into three components. The first is the long-term decline. The second is the irregular fluctuations which cause peaks and troughs. The third is the random year-to-year variation.

The relationship between net annual above ground productivity (NAAP, measured in gm per m^2) and rainfall for sites with rainfall between 12

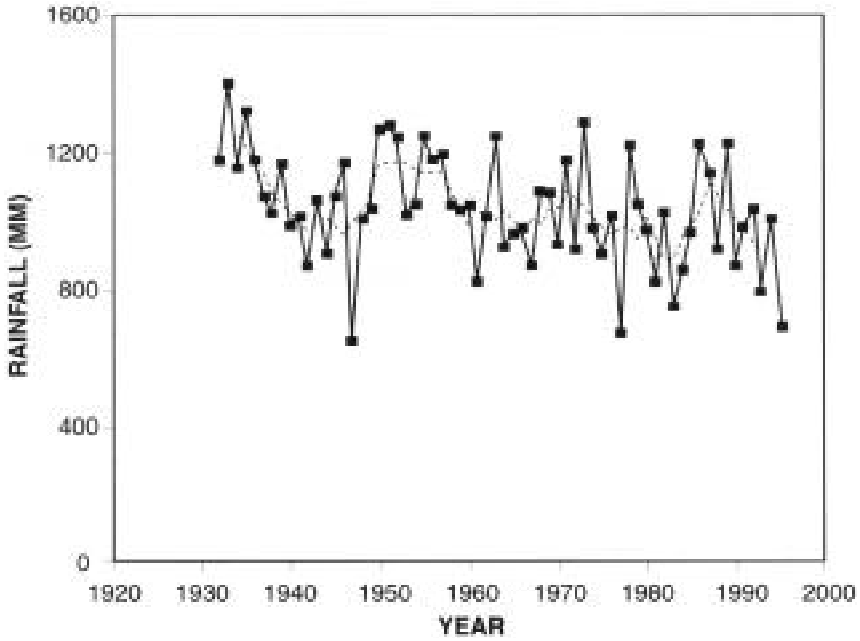

Figure 2. Rainfall records for Navrongo for 1932 to 1995 The broken line is the five -year running mean; it shows the trend in the average rainfall.

(R, in mm) is given by Rosenzweig (1968):

$\log_{10}NAAP = 1.66\log_{10}R - 1.66$

and 1,318mm per annum. This equation reveals a non-linear relationship. For example, a decline in rainfall from 1,000mm to 900mm (ie. a 10% reduction) produces a 16% decline in plant productivity. The average plant productivity of the five most recent years is 25% less than that of the five preceding years.

Temperatures

Data on mean maximum and minimum temperatures were available for Mango (1969 to 1995) and Navrongo (1961 to 1995). For each series we compared the first and last five-year periods. Table 1 shows a warming trend on both sides of the border. The study area is warmer now than in the early 1960s or 1970s.

DISCUSSION

Environmental degradation

Rainfall

Elsewhere in West Africa there is evidence for a later start and earlier end to the wet season (Adejuwon et al., 1990). A false start to the rains causes poor germination as farmers plant their seeds too early; an early finish means that late crops do not mature fully (Adejuwon *et al.*, 1990). However, the Navrongo and Mango data did not corroborate the farmers' assertion that the wet season was starting later. But both showed that in the last five years less rain fell in September, the end of the wet season.

The Navrongo time series confirmed the farmers' complaints of a long-term decline in rainfall, as well as the short-term decrease in the last few years. Rainfall has also decreased in southern Ghana in recent decades (Barnes *et al.*, 1997), and West Africa in general has seen a decrease, especially since 1970 (Hulme, 1992; Nicholson, 1993).

Table 1. Changes in mean temperatures for two meteorological stations.

(a) Navrongo	
Variable	Difference between 1961 - 1965 and 1991 - 1995
Monthly mean maximum	Higher in 11 months of the year
Monthly mean minimum	Higher in all months of the year
(b) Mango	
Variable	Difference between 1969 - 1973 and 1991 - 1995
Monthly mean maximum	Higher in 7 months of the year
Monthly mean minimum	Higher in 11 months of the year

Figure 2 shows fluctuations which are irregular in both period (that is, the time from one peak to the next) and amplitude. These are not cycles which are regular in period and amplitude, but rather irregular fluctuations. Such fluctuations can sometimes be generated by random variations in rainfall (Burroughs, 1992). The rainfall trend for the West African Sahel depicted by Bunting *et al.* (1976: Figure 3) for 1930 to 1970 is similar **to** that shown by the dotted line in Figure 2 for the same years. Bunting *et al.* (1976: page 62) concluded that the Sahelian fluctuations were "small in amplitude...and have no regular pattern" and "are to be expected from a random series".

Such fluctuations have important implications for the human condition and the management of natural resources in northern Ghana and Togo. Rainfall affects crop growth, pasture growth, and the productivity of wild plants consumed by domestic and wild animals, including elephants. Changes in rainfall produce disproportionate changes in plant growth. A long-term decline in rainfall combined with the downswing of the rainfall fluctuation during the first half of the 1990s (Figure 2), implies lower plant productivity, at least around Navrongo. Therefore, during the first half of the 1990s the land could support fewer people, fewer domestic animals, and fewer wild animals than say 50 years ago. If soil fertility has also decreased, then as a result of changes in both rainfall and soil, the land can support fewer people than before.

Although Rosenzweig's (1968) equation applies only to wild plant productivity, a similar relationship should apply to crop growth. This is illustrated by the sharp drops in crop yields in Région des Savanes during 1988 and 1990 (see Figure 5 in PNUD/FAO [1991]). Less rain fell at Mango in those two years (88% and 78% of the mean respectively), yet yields of yams, groundnuts, and beans fell by about half. These irregular fluctuations will therefore produce lean years and fat years. Our study coincided with a lean period.

Temperatures

Temperature changes may be associated with global warning (Houghton *et al.*, 1996), with the global ocean circulation and patterns of sea surface temperatures (Hulme, 1992), with desertification in the Sahel (Sinclair and Fryxell, 1985), with local landscape changes such as bush clearance, or a combination of these factors.

Ghana's human population has grown ten-fold during this century, while Togo's has grown five-fold since 1920 (Sam *e tal.*, 1996). Much of the natural vegetation in northern Ghana has been cleared for villages and farms (Boateng, 1970). The replacement of the natural vegetation by cultivated land, which is bare for a large part of the year, will increase the albedo (the amount of energy from the sun that is reflected back to the atmosphere). When solar energy falls upon natural vegetation it is absorbed and used in evaporation and transpiration which has a cooling effect. Thus temperatures are higher over cleared land (Ripley, 1976).

Albedo, evapotranspiration and heat balance (the amount of heat stored by and moving to or from the soil, the vegetation, and the atmosphere) are all interlinked and affect the climate. The effects of land use on albedo, temperature, and rainfall depend upon soil type, soil moisture, the amount of plant litter covering the soil, the density of trees and shrubs, latitude, and season (Ripley, 1976; Charney, Stone and Quirk, 1975; Sinclair and Fryxell, 1985). All that can be shown at present is that the landscape of Upper East Region and Région des Savanes is changing as a result of increasing human populations, and that the rainfall and temperature records indicate that the local climate is also changing. These climatic changes will affect both agriculture and

pastoralism. They will also affect elephants. For example, decreasing rainfall means less forage available to elephants, and a falling water table will cause streams and water holes to dry up earlier in the dry season, or to dry up completely. The earlier drying of water holes will affect the behaviour and movements of elephants. Since people usually concentrate around permanent water sources, there will be more frequent contact between elephants and people.

Temperature changes also affect the behaviour and movements of elephants because they are sensitive to heat, especially the young (Barnes, 1983). Temperature also affects plant growth and therefore the amount of food available to elephants.

It is assumed that the trends towards a warmer drier climate will continue. While that could be the case if the changes are due to human impacts, it is possible that the changes are due to natural variations in the regional climate. In that case the future could bring a period of wetter years.

Crop-raiding

The geography of the area complicates management of the crop-raiding problem. The Forest Reserves along the Red and White Voltas and the Morago river (Figure 1) provide refuge for elephants in Ghana. Settlement is forbidden and human activities are limited; there is good forest cover, having a higher percentage canopy cover than outside; and they are close to water. Their elongated shape creates a long boundary per unit area of forest. Elephants can emerge from the forest at any point along the boundary, making it impossible to deploy the elephant control unit effectively, and fencing the forests would be prohibitively expensive.

On the Togolese side, the corridor between Forêt de Doung and Fosse-aux-Lions NP is also long and narrow and lies adjacent to cultivation. A proposal to fence the corridor (Stalmans & Anderson, 1992) was abandoned in 1990 to 1992.

"Elephant problems" are often symptoms of changes occurring elsewhere in the ecosystem. Such changes cause elephants to move from one place to another or to change their behaviour. It is suggested here that crop raiding has increased in the Red Volta valley because of a combination of factors. The political upheavals in Togo drove elephants out of the Togolese parks and some went to the Red Volta valley (Okoumassou *et al.,* this volume). The growing human population needs farmland, and the shortage of land causes the same plots to be cultivated year after year (PNUD/FAO, 1991; DCA, 1992). As the productivity of the soil falls, more land is needed to feed each person, and there are more mouths to feed every year. Yet the supply of land is fixed and so there is less space for elephants. Inevitably this will lead to greater conflict with people.

Food aid is sometimes needed in the Upper East Region. Against a backdrop of poverty and declining natural resources the people in the Red Volta valley are even less able to bear the losses caused by elephants. Indeed, the presence of elephants imposes a cruel and intolerable burden upon them. Yet it is our sad conclusion that the local people have unwittingly helped to generate the problem by moving into areas formerly occupied by elephants, and taking more land as their villages grow.

RECOMMENDATIONS

Human ecology

The future of elephants in northern Ghana and northern Togo is inextricably entwined with the human condition and the state of the natural environment. A management approach based on ecosystems must be adopted to ensure a future for both people and elephants. Thus certain key questions of human ecology have to be addressed in order to secure the future of elephants:

i) What is the rate at which the natural vegetation is being cleared for settlement and agriculture?

ii) What is the rate of change of soil fertility? What is the rate of change of crop yields in relation to the number of years the land has been farmed? Yields vary with soil type, time the soil has been cultivated, and with rainfall, so research should be designed to account for all three variables. This question could be answered by a series of plots on farms, stratified by soil type, which have been under cultivation for different periods. The research activities would need to run for several years to account for year-to-year variations in rainfall.

iii) What is the rate at which the human population is growing in each district *or prefecture?*

The answers **to** these three questions will tell us how many people the land can support, ie. the human carrying capacity. The following aspects of the physical environment must be evaluated:

iv) Changes in the local and regional climate, by an analysis of records from many meteorological stations.

v) Changes in stream flow and watertable levels.

vi) Loss of topsoil through erosion.

The following aspects of the biotic environment must be evaluated:

vii) The trend in firewood resources.

viii) Grazing resources in relation to livestock.

ix) The rate of loss of game populations (ie. the resources of wild meat).

This study was a short study, and the conclusions conform to the standard paradigm of increasing human populations degrading semi-arid environments. That interpretation has been challenged recently (eg. Beinart, 1996; Brockington & Homewood, 1996) and the suggested studies above will confirm whether or not this interpretation of the processes taking place in the study area is correct. Furthermore, only one set of long-term rainfall records was obtained for the entire study area and many of the conclusions are based upon that set. Figure 3 shows that there are differences between the three sites.

One would expect Gambaga to differ from the other two because it is an upland site. Mango is less variable than Navrongo but still shows the same decline during the 1990s. Ideally, one should use the average trend from a network of rain gauges. At one time Ghana had a national network, but it broke down during the recession of the 1970s and early 1980s.

Elephant ecology and land use

Estimates of elephant numbers are essential, as well as information on seasonal distribution. Burkina Faso, Togo, and Ghana need to collaborate in a study of movements between the different parts of the study area.

Burning, grazing, and wood-cutting inside the Forest Reserves will make them less attractive than farmland to elephants, so a balance must be found between human disturbance inside the Reserves and the need to keep elephants within their boundaries.

These studies must form the basis for a land use plan which stipulates how much land is to be reserved for natural vegetation and wildlife, not forgetting the need to protect water catchments.

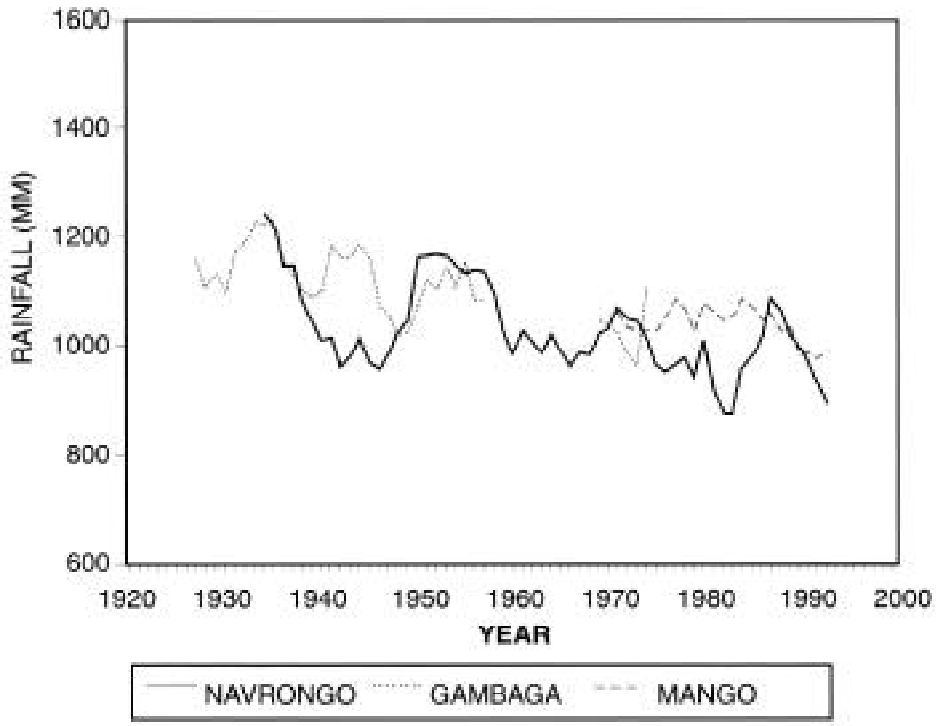

Figure 3. A comparison of the long-term trends of Navrongo. Gambaga, and Mango. The five-year running mean is shown for each site.

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