

pp. 35-53
1984

4 Re

Response to Drought Among Farmers and Herders in Southern Kajiado District, Kenya

David J. Campbell¹

From 1972 to 1976 rainfall in Kajiado District of Kenya was below normal. The capacity of the farming and herding systems to cope with the consequent reduction in production is discussed within a context of changing land-use patterns and altered resource availability. It is concluded that land-use planning to allocate the available land and water resources and to promote off-farm employment is required to reduce the vulnerability of the population to future drought conditions.

KEY WORDS: Kenya; drought; farming; pastoralism; rural development.

INTRODUCTION

In the past decade the study of the effects of drought conditions has been a major focus of research concerning the interaction between socio-economic and environmental systems in the semi-arid areas of Africa (Bugnicourt, 1974; Campbell, 1977; Dalby *et al.*, 1977; Glantz, 1976; Oguntoyinbo and Richards, 1978; Wisner, 1977; Wisner and Mbithi, 1973). Among the important conclusions of recent research is that the impact of drought is related as much to social, economic, and political factors as to climatological ones (Copans, 1975; Lofchie, 1975; Watts, 1983). The increasing demands being made by national economies on rural areas in the form of taxation, demand for labor, the production of cash crops, and so forth is altering

¹Assistant Professor of Geography and African Studies, Michigan State University, East Lansing, Michigan 48824.

patterns of resource use and thus the capacity of farming and herding systems to manage the risks associated with the ecological variability of semi-arid lands is reduced. Explanation of the impact of drought is therefore being sought within a historical framework emphasizing changes in the interactions among social, economic, political, and environmental factors.²

This article examines the impact of the drought of the early 1970s in Kenya's semi-arid lands through a case study of the Loitokitok area of Kajiado District. Fundamental to the analysis is a study of changes in the pattern of resource use among farming, herding, and wildlife-related activities, changes that have their origin in the alienation of large tracts of farmland and rangeland by settlers during the colonial period and in the promotion of wildlife-related tourist activities.

Kenya's semi-arid lands are the home of a number of herding societies and the domain of large wildlife populations (Ominde, 1971). As a consequence of land alienation during the early years of the colonial era the area available to herders and farmers was reduced (van Zwanenberg and King, 1975). Large tracts of rangeland in the Rift Valley were transferred to settlers, a process that deprived herders of some of their best grazing lands and disrupted the linkages between herders to the north and south of the Rift Valley. Land use in semi-arid areas changed also as the alienation of farmland in the humid highlands forced numbers of farmers to migrate to the wetter margins of the rangelands in search of productive land (Campbell, 1981). This process of spontaneous migration accelerated after independence and additional expansion of cultivation in semi-arid lands resulted from the creation of government-sponsored irrigation and settlement schemes (Mbithi and Barnes, 1975).

Changing patterns of resource use by wildlife and herders have also resulted from government policy toward semi arid lands (Government of Kenya, 1979). Since the 1930s emphasis has been placed on developing a more commercial attitude among the herding peoples, culminating in

²It is important that, as Waddell (1977) has stated in a critique of early research on responses to natural hazards (Burton *et al.*, 1978, White, 1974), study of people's reactions to hazards such as drought be made in an historical context so that consideration can be given to the "possibility that human action might accentuate the gravity of hazards or that political and economic structures associated with a favored capitalist strategy of development . . . might amplify the effects of hazards" (Waddell, 1977: 75). Important contributions to this approach include the work on the Sahel drought by Copans (1975), Comité Information Sahel (1975), Meillassoux (1974), a recent study of food shortage in Kenya by Wisner (1981), and contributors to Part III of Hewitt (1983).

current efforts to limit the movements of herds and to improve the infrastructure available to herders through the provision of dipping facilities, better water supplies, and more efficient marketing services (Jahnke, 1978; Von Kaufman, 1976). The existence of large wildlife populations is a principal resource of Kenya's tourist industry and since 1945 large tracts have been set aside as national parks and reserves. Approximately 85% of these wildlife areas are located in the semi-arid parts of the country (Casebeer, 1975).

The diversification of the economy of the semi-arid lands is radically altering patterns of resource use. Herding, farming, and wildlife activities are all constrained in their location by the distribution of moisture. Areas affording year-round water are scarce, limited to hillsides, the courses of perennial streams, and the edges of swamps. In the past, livestock and wildlife shared the resources of these locations, but as farmers have put some under cultivation and others have been enclosed within national parks their availability to herders has been reduced.

The full impact of these changes has only recently begun to be recognized as rapid population growth among both farmers and herders has increased the demand for land. Current estimates place the national growth rate at 4% (Mott and Mott, 1980), and as crops better suited to semi-arid lands are developed the potential for conflict will become greater. Farmers and herders are already adapting to accommodate new resource constraints. Farmers are confronting problems associated with unreliable rainfall and soils of low fertility, while herders are adjusting grazing patterns to their modified access to pasture and water. Some are curtailing their movements and adopting a more sedentary way of life, while others continue to follow their traditional nomadic ways.

It was in this context of ongoing adjustment to altered social, economic, and environmental conditions that the people of Kenya's semi-arid lands confronted the drought of 1972-1976. Because increasing scarcity of resources was resulting from ongoing processes, the responses of the population during the drought might indicate the ways in which the herding and farming economies will adapt to future scarcity, unrelated to drought. Knowledge of such acceptable, self-generated responses might provide a basis for planning that can build on local aspirations and values to reach a resolution of anticipated conflict over land use before it occurs. In the absence of such planning, the potential for social conflict and environmental degradation caused by uncoordinated land use is high.

This article examines the effects of the period of low rainfall from 1972-1976 on the people of one part of Kenya's semi-arid lands, the Loitokitok area in Kajiado District (Fig. 1). This is an area in which major changes in land use have taken place in the recent past as increasing

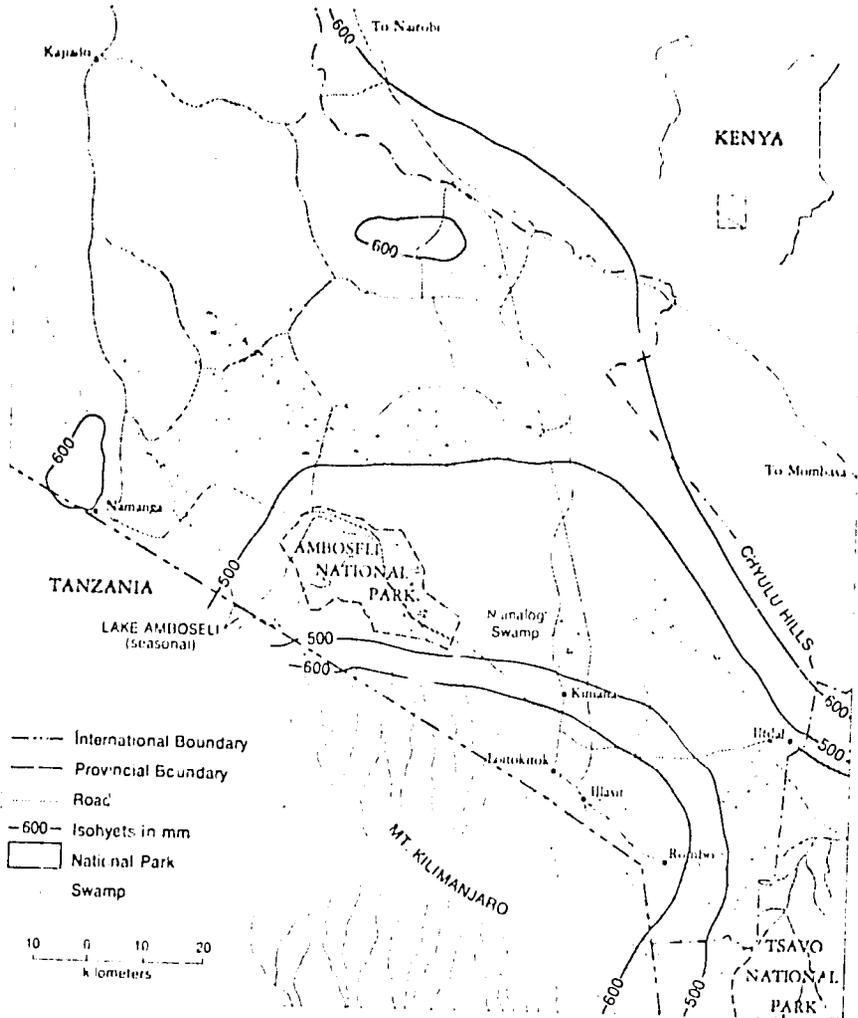


Fig. 1. Southern Kajiado District, Kenya.

cultivation and the designation of national parks and reserves have made an impact on the traditional pastoral system of the area. The relationships among changing patterns of land use, resource availability, and the ability of the people to cope with drought are the focus of this study.

SURVEY METHODS

The data for this study was collected from a questionnaire survey conducted in February and March of 1977 and supplemented at field

seminars held in March and April of 1978 at which the initial survey results were discussed (Campbell and Mbugua, 1978).

In the questionnaire survey, systematic sampling procedures were used to select respondents along transects across the ecological gradient from the wetter slopes of Mt. Kilimanjaro into the adjacent rangelands.³ The vast majority of respondents in the more humid, higher areas were farmers. Most were recent immigrants to the region and depended on crop production for their livelihood. In the dry rangelands herders predominated and a number of mixed livestock-crop enterprises were surveyed at the interface between the herding and the cropping zones. A total of 391 people were interviewed, of whom 166 (42%) were Maasai herders, 90 (32%) herder-farmers, and 135 (34%) non-Maasai farmers. The results of the survey are presented according to these economic categories, which have distinct spatial distributions in the area.

The information obtained from the questionnaire survey was assessed and supplemented at a series of seven field seminars held at different locations in the farming, herding, and mixed herding/farming zones of the survey area.⁴ Each of the seminar meetings was attended by 40-60 people, some of whom had been interviewed in the course of the survey. The participants in the seminars included a broad cross-section of the population but there was no way of assessing their representativeness.

The seminars served a number of purposes. First they provided a forum for presenting the results of the survey and an initial interpretation of them. The participants were able to comment on the interpretation and thus help to reduce errors introduced by researchers from outside the area. Second, the meetings allowed specific local problems to be discussed, their cause to be determined, and a range of remedies to be proposed. This exercise was most productive and demonstrated a keen awareness on the part of the population of the problems confronting them and of solutions based on local resources, values, and aspirations. A third objective was to report the results of the research to the people of the survey area. A

³The preparation of the questionnaire survey drew on the extensive work on peoples' responses to natural hazards (Burton *et al.*, 1978; White, 1974) and in particular on that dealing with responses to drought in East Africa (Hankins, 1974; Heijnen and Kates, 1974; Wisner and Mbithi, 1973).

⁴The seminars were organized by the Adult Literacy Team (ALT) based at the Roman Catholic Mission at Loitokitok. This team, involved in teaching literacy in the area using the techniques of Paulo Freire (Freire, 1973), organized the discussion of selected findings of the survey using these techniques. I am particularly indebted to the members of the ALT: Fr. Piet Payens, Peter Kisopia, Kenny Matampash, Daniel Mayani, and Tony Mepukori, to E. S. Mbugua and Mark Kisopia at the Institute for Development Studies, University of Nairobi, and to the survey enumerators for their assistance in implementing the research.

complaint heard frequently was that previous studies in the area had apparently yielded no results or tangible benefits to the people. Resentment of the research process was not uncommon and in one area the leaders refused permission to conduct the survey because previous research was perceived as of no use to the community. The field seminars thus provided an opportunity for feedback to the people in the survey area.

CHANGING LAND-USE PATTERNS IN THE LOITOKITOK AREA PRIOR TO 1972

In order to legitimize the annexation for European settlement of vast areas of excellent rangeland in the Rift Valley by the colonial government, a treaty was signed in 1911 that set aside a portion of southern Kenya as the Maasai Reserve, in which the dispossessed herders were to have exclusive rights of occupancy. The area of the reserve covered what are now the administrative districts of Narok and Kajiado (Great Britain, 1934).

At the time of the treaty southern Kajiado formed part of the lands of Ilkissongo Maasai. The area provided excellent year-round grazing and water for their herds. Dry season resources could be found on the slopes of Mt. Kilimanjaro, around the swamps in the lowlands, and bordering the streams that flow off the mountain. During the rains the semi-arid rangelands afforded widespread forage and water. Thus, during the dry season and droughts the herds were concentrated on the hillsides while during the rains they dispersed into the plains. The seasonal pattern of concentration and dispersal was, and continues to be, followed by the wildlife of the area (Western, 1975). In the past 30 years the access of the Maasai herders to these resources has been curtailed as cultivation of the mountain slopes, river valleys, and swamp margins has increased and as large areas have been designated as national parks and reserves.

Cultivation and wildlife conservation activities commenced in the area prior to World War II, but they only began to impinge on the pastoral resources after the war. In 1945 the National Parks Ordinance was passed, allowing for the demarcation of specific areas as national parks and reserves (Casebeer, 1975). National parks were set aside exclusively for the use of wildlife, while land-use policy within the reserves was the responsibility of the relevant county councils. In 1948 Tsavo West National Park, on the eastern boundary of Loitokitok Division, was created and the Chyulu Hills and Amboseli areas were designated as reserves. Although the Maasai continued to have access to the reserves, they were denied access to the water

and grazing resources of the Tsavo National Park.⁵ Pressure for the reserves of the area to be designated as parks resulted in Amboseli Reserve becoming a national park in 1974 and the future status of the Chyulu Hills is currently under discussion.

Although cultivation has a long history in the area (Bernsten, 1976), it was not until after World War II that the cultivated area increased rapidly as government officials, usually non-Maasai, and some local Maasai cleared small farms and invited relatives to join them. Land shortages elsewhere provided the impetus for many people to migrate to the wetter margins of the semi-arid areas, including the Maasai rangelands, such as the Ngong Hills and the slopes of Mt. Kilimanjaro. Although the Maasai expressed concern over the extension of the area under cultivation and despite the attempts by Section Committees and the Local Native Council to control immigration, the number of non-Maasai farmers increased because many were related to Maasai by marriage and were thus permitted to settle in the area (Government of Kenya, 1947). However, in 1950 the Maasai Council Land Usage By-Laws (Government of Kenya, 1951) were passed enabling the local council to control farming successfully by defining limits to cultivation. However, in 1952, in response to the nationalist uprising, a state of emergency was declared and the majority of the non-Maasai farmers were repatriated to their home districts, resulting in a decrease in cultivation in the area.

Cultivation did not expand again until after Independence, when people were able to move freely and land adjudication enabled individuals to own title to land and to farm under conditions of relatively secure tenure. The process of land adjudication was such that some land was demarcated as individual holdings and the remainder as group ranches.⁶ The first areas

⁵The Maasai were concerned because the boundaries of the park were drawn to enclose water sources used by their herds. In 1948, during a period of drought, the authorities did permit the herds to graze and water in the park but subsequently such access was denied.

⁶Land adjudication is the process whereby the government has given landowners legal title to specific land units that were formerly held communally under customary rights. The adjudication process is seen as a means of providing security of tenure and of increasing the landowners' responsibility for the use of the land. It is anticipated that degradation may be more successfully controlled under this system of land tenure than under the system of communal ownership. In Kajiado District some individuals obtained their own land as individual ranches, but the majority became members of group ranches, large tracts of land to which 150-1000 people have legal rights of ownership. The adjudication process began in 1963 and was largely completed by 1980. For a discussion of the impact of adjudication to ranches on Maasai society see Galaty (1980).

to be adjudicated in 1966 and 1967 were in the higher potential lands on the slopes of Mt. Kilimanjaro, where the majority of individual holdings are located. The original land owners were Maasai leaders, government officers, and others who realized the value of obtaining title to land, and many acquired large tracts. Initially, the Maasai cultivated small portions of their land, but once its monetary value became apparent subdivision into small farms for sale and rent to immigrant farmers took place. Over the past 15 years the lower slopes of Mt. Kilimanjaro have been taken over almost entirely by cultivation and farmers are increasingly buying or renting land in the better-watered localities in the plains, such as at Kimana and Rombo. As population increases this process of cultivation of more isolated areas with favorable soil and water conditions will accelerate. The extension of cultivation has severely depleted the range of dry season water and grazing resources available to herders, although in some areas this has been offset by the provision of water supplies in formerly dry localities, permitting year-round grazing (Western, 1975).

Land adjudication has also taken place in the plains, which have been divided into group ranches. Each ranch was to include both wet season and dry season resources and it was hoped that group ranch members would adjust herd size to the carrying capacity of their ranches. In practice, few ranches enclosed sufficient dry season resources and movement beyond ranch boundaries has continued (Davis, 1971; Halderman, 1972; Hedlund, 1971).

Wildlife management, cultivation, and land adjudication have contributed to a recent decline in the dry season grazing resources available to the pastoralists. This is clearly recognized by the Maasai (Table I), but its full impact was delayed by the adequate rainfall of the late 1960s and early 1970s, which led to good range conditions. With the drought in 1972-1976 it became clear that the remaining dry season grazing resources were not sufficient to meet the needs of the herds. The productivity of the rangelands decreased and the dire implications of having handed over much of their dry

Table I. Reasons Given for a Decline in Access to Dry Season Grazing Areas Since 1970 by 110 Maasai Pastoralists*

Cause of decline	Number	Percentage
Land used for cultivation	76	69
Land is part of national park	56	51
Land is part of holding ground	50	45
Land is part of individual or group ranch	13	12
Other responses	0	0

*Data from Campbell (1979b).

season grazing lands to farmers and of the enclosure of water sources in the national parks became apparent.

THE DROUGHT YEARS 1972-1976

Although the available climatic data suggests that the period 1972-1976 did not represent a particularly severe drought, the people of the area regard its effects as having been harsh: 91% of the pastoralist respondents stated that the drought was the worst they remembered, and though this may be partially explained by the fact that it was the most recent, it does indicate that its impact was great. It was the first drought experienced by the vast majority of the non-Maasai farmers interviewed since they had begun farming in the area, and the lack of rainfall drastically reduced their harvests.

For the Maasai farmers and herders the greatest problem brought by the drought was its impact upon their herds, while for non-Maasai farmers inadequate water supplies, lack of food, and a scarcity of land constituted the greatest difficulties. Throughout the area the period of the drought was one of general social unrest and malaise and the incidence of theft and arguments increased. In view of the major differences between the herding and farming system and of their capacity to cope with drought conditions, the effect of the drought upon each will be discussed.

The Impact of Drought on Maasai Pastoralists

The principal effect of the drought on Maasai herders was the loss of livestock, which resulted in a reduction in the food supply of the population. Animal numbers declined due to death caused by disease and starvation and as herders sold stock to raise cash to buy food. The value of the livestock that died or were sold during the drought in the Loitokitok area has been estimated at nearly Kshs 17,500,000 (U.S. \$2 million), of which sales accounted for approximately one-third (Campbell, 1979b).

One measure of the severity of the problem is clearly the monetary loss due to death of animals. The losses may also be examined in terms of the ability of the residual herd to provide sufficient food to meet the family's subsistence needs. A traditional strategy of pastoralists is to build up the numbers of livestock in good years in anticipation of the losses that will occur during a drought. Herders attempt to enter a period of drought with sufficient animals to enable them to provide for their subsistence needs, despite animal deaths and sales or loans of animals to others.

At the time of the survey the average herders had insufficient livestock to produce their subsistence needs even under good range conditions. The greatest deficit was in the number of sheep and goats, which are an important source of meat and are often sold for cash to buy food during periods when the milk production of the cows decreases. Given the return of favorable conditions that occurred soon after the survey was completed, the Maasai should have had enough animals to rebuild their herds and rapidly been able to fulfill their subsistence needs (Dahl and Hjort, 1976). This was indeed the case (Meadows and White, 1979), but at the time of the survey, at the end of the drought, many families were unable to meet their total subsistence needs from their herd. The capacity of a family to provide its subsistence depends on the size of the family, on that of the herd, and also on management strategies and access to resources. In the survey area, those who entered the period of drought with the larger herds experienced proportionately fewer losses than those who had fewer animals, and their larger residual herds afforded greater opportunities for recovery. At the onset of the drought the poorest 20% of herders owned insufficient cattle to meet their subsistence needs, and by the end 60% were unable to do so. Despite the fact that the Maasai are frequently accused of overstocking, the evidence from the drought demonstrates that the majority were not overstocked relative to their long-term subsistence needs. In a subsistence-oriented production system, large families require large herds and among the herders surveyed it was more common for overstocking relative to subsistence needs to occur among smaller than among larger families.

There have been frequent calls for policies to reduce the stocking rate in Maasailand in order to prevent environmental degradation. On occasion, in the absence of drought and disease, livestock numbers will increase and tax the carrying capacity of the land. This reflects a rational response on the part of herders to insure themselves against the effects of future calamities. Strategies designed to prevent overgrazing must be developed in a context of overall economic growth, providing alternatives to livestock as the source of savings, rather than in promoting the illusionary panacea of destocking.

The Impact of Drought on Maasai Farmers

The majority of the 90 Maasai farmer respondents practice a mixed economy, herding animals and growing mainly subsistence crops. While cultivation is not new to the Maasai of the area, the designation of "farmer" is. Most farmers grow crops such as maize, beans and potato and continue to rely heavily on livestock. This contrasts with the non-Maasai farmers of the area who keep very few animals and for whom crop pro-

duction is the basis of their economy. For most of the Maasai farmers the period 1972-1976 was the first in which they had to cultivate under drought conditions. The most frequently stated problems during that period concerned the loss of animals, drought and water supply, land shortage, soil erosion, and lack of food. Though they view themselves as farmers their most severe problems concerned their animals.

Livestock continue to provide the bulk of the Maasai farmers' subsistence needs, though their herds are in general smaller than those of the pastoralists. Prior to the drought the average herd was of sufficient size to meet the subsistence needs of the average family but the losses during the drought reduced the herds below the subsistence level. A comparison of farmers with different herd sizes demonstrates that only the largest herds contained enough animals to feed the people dependent on them at the time of the survey, though prior to the drought 70% of the herds had been of sufficient size. The losses incurred during the drought varied remarkably little according to herd size, though the smallest and largest herds suffered the greatest percentage of losses. Not all herd decline should be interpreted as a loss, however, as livestock sold represent liquidated assets rather than losses.

The second source of subsistence of Maasai farmers is crop production. While some crops are sold, most of the production is for home consumption. The Maasai have a very similar cropping pattern to that of non-Maasai farmers, though they pay less attention to growing sweet potatoes, a drought-resistant crop. Throughout the area crop production was below normal, the deficit being more severe for farmers in the drier, lower areas. It is estimated that crop production contributed only one-third of the subsistence needs of the Maasai farmers in the lower areas. In the absence of their herds the Maasai farmers, particularly those in the lower zones, would have been in severe difficulty. In the event, the combination of livestock and crop production appears to have been more successful in overcoming drought-related shortages than either activity practiced alone.

As will be shown later, while the Maasai farmers did call upon traditional strategies for reducing the effects of drought, they received famine relief proportionally less than other people, demonstrating an ability to provide for most of their subsistence needs. While the major specific effects of the drought were felt in livestock losses and in reduced harvests, the Maasai farmers, and all farmers, complained of a general feeling of unease and social disturbance during the period of drought.

The Impact of Drought on Non-Maasai Farmers

The majority of non-Maasai farmers in the Loitokitok area are Kikuyu and Kamba people who are recent arrivals in the area (Table II) from

Table II. Date of Commencement of Farming in the Loitokitok Area by Non-Maasai Farmers^a

Period	Kikuyu		Kamba		Other		Total	
	N	%	N	%	N	%	N	%
Pre-1962	2	3	1	3	2	9	5	4
1962-1966	7	9	2	6	4	18	13	10
1967-1971	31	39	8	25	7	32	46	35
1972-1976	39	49	21	66	9	41	69	52

^aData from Campbell (1979b).

many parts of Kenya but primarily from Central and Rift Valley provinces. About one-fifth of the farmers in the survey had come to the area from Tanzania.

The years of rapid immigration in the post-independence period, 1967-1972, were characterized by favorable rainfall conditions, and the farmers tended to plant crops such as maize, best suited to areas with relatively high rainfall. The decline in rainfall amounts after 1972 resulted, therefore, in a more severe reduction in harvests than might have been the case had crops more suited to the area's environmental conditions been planted. For most of the non-Maasai farmers 1972-1976 was the first period of drought they had experienced in the Loitokitok area, though many had done so in their home regions.

The non-Maasai farmers concentrate on growing maize and beans, but cultivate a variety of crops both for subsistence and for sale. Unlike the Maasai they keep very few animals. These farmers are found in two main zones in the area. The Kikuyu are predominantly in the buffer zone immediately below the Tanzanian border, while the Kamba are found mainly around Kimana where they cultivate under irrigation.

The most frequently mentioned problems affecting these farmers during the period of drought were water supply, land shortage, and lack of food. In the absence of significant numbers of livestock, crop production is the mainstay of the non-Maasai farming economy. The majority of farmers have small plots and are thus able to produce a surplus only in good years, while during the drought hunger was widespread.

The ability of farmers to produce crops depended on the location of their fields and the area under cultivation. Those farms located higher on the mountain slopes received more rainfall than those in lower-lying areas and others located along river valleys or around the swamp margins were also able to produce crops.

In general, however, the non-Maasai farmers faced a more difficult situation than either the Maasai farmers or pastoralists during the drought. The farmers in the low-lying drier areas encountered the most severe problems, illustrating the difficulties associated with expanding the area under crops into the less well-watered parts of the region.

THE RESPONSE TO DROUGHT

A number of studies of the response of African societies to drought have demonstrated that in areas prone to recurrent drought the population usually develops mechanisms for reducing its impact. Such strategies are usually integrated within the socioeconomic framework of the society but increase their importance once drought threatens the system. People

become more vulnerable when their society is undergoing a process of adjustment to altered social, political, economic, or environmental conditions because, particularly if good rainfall conditions prevail, they are more likely to concentrate on adaptation to meet immediate needs than on those required to alleviate a less imminent situation. This was certainly true of the recent arrivals in the survey area who had not had cause to develop strategies for coping with drought during the period of settlement in the region.

The Maasai Pastoralists' Response to Drought

Among the Maasai, traditional strategies for coping with drought are similar to those of other herders in Africa (Campbell, 1977; Dahl and Hjort, 1979), including (a) the movement of livestock, usually in the care of the younger men and *moran* (warriors), away from the *boma* (kraal) in search of pasture and water; (b) increased intrafamily assistance in terms of livestock loans and the calling upon of reciprocal grazing arrangements; (c) prayer; (d) selling stock to raise cash; and (e) increased use of alternative food supplies such as grains and wildlife meat. These strategies are not mutually exclusive and thus offer a wide range of alternatives to those affected by drought. An additional source of assistance in more recent droughts has been famine relief provided by government, missions, and international agencies. Information provided by respondents as to their activities during the drought demonstrates that not only did the Maasai pastoralists resort to traditional coping strategies but also that they are continually reviewing the situation, assessing the viability of these coping mechanisms, and adopting others where necessary.

Movement of People and Herds

The intensity and frequency of movements of livestock and people are related to the distribution of available resources. As a drought intensifies pasture deteriorates, water becomes increasingly scarce, and movement is necessary to obtain access to these resources. In the early stages of drought it is unusual for whole families to move; it is more common for the young men to move away with the herds in search of pasture and water. Only when the available resources become totally insufficient will whole families move. In the survey area some grazing and water resources remained available among the lower slopes of Mt. Kilimanjaro, and thus there was

relatively little need for local people to move widely. However, herders from other parts of Maasailand moved into the area to take advantage of the available resources. There was no major movement of Maasai pastoralists from the Loitokitok area toward Nairobi or other main towns.

Reciprocal Arrangements for Sharing Livestock

The Maasai keep a variety of livestock, cattle, sheep, and goats. These animals respond differently to the impact of drought and a diverse herd is one way of reducing the risk of a total loss of livestock. This objective is also achieved by splitting up the herd and moving some of the animals to a different area to be looked after by relatives or friends. Such dispersal of the herd results in its exploiting a wider resource base, thus, should one area be unable to support livestock those elsewhere may still survive.

This strategy is also a means by which those who have insufficient livestock may borrow animals to help meet their subsistence needs. In the survey area such reciprocity was common during the drought, more frequently involving relatives than friends.

An interesting aspect of the sharing of animals is that the process involves a higher percentage of individual ranch owners than members of group ranches in the Loitokitok area. In view of the general consensus among Maasai that individual ranchers tend to give up traditional behavior patterns and of the findings of Hedlund (1971: 27) that "there is an explicit reluctance among individual ranchers to take part in any cattle exchanges with friends and even close relatives," this degree of participation in reciprocal cattle sharing is surprising. Many individual ranchers were able to graze their animals on group ranches of which their sons are registered members, and thus their individual ranches may have been in better condition than group ranch areas due to lighter grazing pressure. As the drought intensified it is not unlikely that communal pressure was brought to bear to encourage individual ranchers to share their resources with relatives and friends.

The exchange or loan of animals is not the only form of assistance among family members during the periods of hardship. Gifts or loans of food and money are not infrequent and many other forms of assistance take place.

Sale of Livestock

In discussing the subsistence role of livestock their importance as a source of capital should also be emphasized (Baker, 1980; Goldschmidt,

Table III. Sales of Livestock by 58 Maasai Herders Reporting Actual Numbers Sold^a

	Cattle	Sheep	Goats
Mean	8.86	4.46	7.92
Standard deviation	9.86	3.34	3.18
Range	0-60	0-12	0-30
Average price/head (Ksh)	200	90	60

^aData from Campbell (1979b).

1981).⁷ Cash acquired from the sale of animals is used to buy food, clothing, and other items such as beverages (Meadows and White, 1979). In the study area sales of stock were considerable (Table III) and provided an average income of about 2500 Kshs during the year preceding the survey. Over the same period, reported expenditures on food, excluding beverages, averaged 1400 Kshs.

Assistance from Other Sources

As milk production from their livestock declined, other sources of food, particularly grains, became important. Herders obtained grain at the market, from relatives who grew crops, and from relief supplies provided by the government and the Roman Catholic mission and in most cases distributed according to need. The Maasai also consumed wildlife meat; 29% of respondents stated that it was better than nothing. Eland and antelopes are their favored quarry. In contrast, the farmers of the area do not consume wildlife.

Prayer

Over 90% of respondents had prayed for rain, while payments to the *laibon* (priest), in the form of sheep, goats, or money so that he might intercede to end the drought, were common; 85% of herders in the survey had made such contributions.

⁷Information on income and expenditure was obtained during the questionnaire survey by requesting respondents to recall their income and expenditure during the year prior to the survey. Given the possibilities for erroneous recall these figures should be read as being indicative rather than precise.

Maasai Farmers' Response to Drought

The majority of Maasai farmers retain close links with the pastoral community both through relatives and through membership in group ranches. The responses of the farmers to drought conditions reflect the importance of livestock in their economy and the continued links with the pastoral Maasai in that many of the strategies adopted by the pastoralists were also followed by farmers.

Movement of People and Herds

As explained previously, the Maasai move their livestock in response to the availability of water and grazing resources. This remains true of the farmers as well as the herders. At the time of the survey over 30% of the farmers' cattle and 20% of their sheep and goats were away from the farm being cared for either by relatives and friends or by members of the family who had moved with the livestock. It was reported by 23% that members of their family had moved away with the livestock in search of pasture, particularly to swampy areas such as Kimana, where pasture and water were available.

Reciprocity Among Relatives and Friends

The movement of livestock away from the farm reflects the continued willingness of Maasai to allow livestock from other, less-favored areas to graze on their land. This is particularly well developed among the pastoral Maasai. Sharing of foodstuffs is also important for farmers; 42% of Maasai farmers stated they had given food to relatives, 19% had received food from relatives, and 37% of pastoralists said they had received food from relatives. It appears likely, therefore, that the relatively advantageous position enjoyed by the Maasai farmers due to their mixed resources enabled them to provide a great deal of assistance to their less fortunate relatives during the drought.

Assistance from Other Sources

The principal off-farm sources of food during the drought were purchases at the market, gifts from relatives, and famine relief. In order to raise cash to buy food at the market, the Maasai farmers engaged in a number of activities. Of the average cash income, 36% came from petty

trading, 31% from the sale of livestock, and only 10% from the sale of crops. The type of activity differs from one family member to another; the head of household is most likely to trade, particularly in livestock, the sons to work in town, and the wives to sell food. It is noteworthy that fewer Maasai farmers (41%) than non-Maasai farmers (53%) and Maasai pastoralists (67%) received famine relief, an indication that their mixed economy enabled them to cope relatively well during the period of drought. The Maasai farmers continue to maintain strong links with the pastoral economy and to respond to drought in traditional ways. However, their mixed economy appears to allow them more versatility in time of drought as they are dependent on neither livestock nor crops for their entire subsistence needs.

The Response to Drought Among Non-Maasai Farmers

The majority of non-Maasai farmers are recent immigrants to the Loitokitok area and the period 1972-1976 was the first in which they had experienced inadequate rainfall. Prior to 1972 the farmers had concentrated on settling into the area and developing their farms to produce sufficient crops to meet their subsistence and cash requirements. Little attention had been paid to developing mechanisms for coping with the effects of drought, such as those found to be integral components of the way of life of farming people elsewhere in Africa who are prone to similar problems (Lallemande, 1975; Oguntoyinbo and Richards, 1978; Campbell and Trechter, 1982; Watts, 1983).

The crops planted by the farmers did not yield sufficient harvests to meet subsistence needs during the drought, and though many people had stored some food it was insufficient to offset the deficit in the harvest. Discussions with farmers as to precautions they could take to reduce the impact of future droughts demonstrated that while they know what precautions might have been useful, they had not taken them prior to the drought. However, after the experience of the drought period, more drought-resisting strategies are likely to be implemented.

In order to overcome the shortages the non-Maasai farmers had to depend on purchases at the market, the use of stored food, and famine relief. The purchase of food was the largest cash expenditure of most farmers, the average amount of 1700 Ksh accounting for nearly half of their reported cash expenditure. The principal source of income to pay for this food for the Kikuyu was off-farm business activities, such as shopkeeping, and remittances from wage earners in town, though crop sales accounted for about one-fourth of the average income. Crop sales were also an important source of income for the Kamba respondents who, unlike other

groups, also earned cash through wage labor, which accounted for nearly 20% of their total income averaging 1153 Kshs.

Assistance from Relatives

Assistance from relatives is not as well developed among the non-Maasai as among the Maasai and few non-Maasai farmers reported having given or received help from relatives. This is probably due to their having few relatives in the immediate vicinity. A few did state that a member of the family, usually a son, had moved away to stay with relatives. Most of these had left the Loitokitok area and returned to the area from which the family originally came.

Assistance from Sources Other than Relatives

Assistance from sources other than relatives was restricted mainly to famine relief provided by the government and by the Roman Catholic Mission. It was distributed according to need by the leaders of the community. The greatest need was felt by the pastoralists and the non-Maasai farmers who lacked the variety of resources available to the mixed farmers. The necessity for famine relief was such that it was second to the market place in importance as a source of food.

Off-Farm Activities

In their studies of migrants to other semi-arid areas of Kenya, Mbithi and Barnes (1975) and Wisner and Mbithi (1973) noted the importance of off-farm income as a supplement to crop production. This is also the case in the Loitokitok area; the range of off-farm activities practiced by non-Maasai farmers is shown in Table IV. Not all farmers had off-farm income, however, and the table reflects the responses of the 45% of the sample that declared such incomes. It demonstrates a variety of activities, based principally on local resources, that are engaged in to diversify the farmers' sources of income, though sales of food crops was the most frequent response.

The non-Maasai farmers had to rely heavily on their own agricultural resources during the drought. Intrafamily ties were weak as most had only recently moved to Loitokitok from other parts of the country and famine relief was of great importance in offsetting deficits in crop production.

Table IV. Source of Off-Farm Income of 61 Non-Maasai Farmers"

	Number	Percentage (%)
Selling food or crops	26	43
Working in town	25	41
<i>Biashara</i> (trade)	13	21
Selling charcoal or firewood	11	18
<i>Duka</i> (shop)	8	13
Selling beer	6	10
Laboring on another farm	6	10
Other	7	11

"Data from Campbell (1979b).

PRECAUTIONS AGAINST FUTURE DROUGHT

Drought is recognized as a recurrent problem by the majority of the people of the area although many farmers in the survey stated that they did not expect drought in the future. Some Maasai farmers may regard their mixed farming system as providing sufficient protection against drought, while non-Maasai farmers, recently arrived in the area, may regard the recent phenomenon as a unique event. Among those respondents who stated that they did expect drought in the future, almost all recognized precautions they would take against its effects (Table V). The precautions emphasize economic activities and many represent divergence from existing ones, and thus may alter their way of life to adapt to changing circumstances.

The responses of Maasai herders demonstrate a concern with the building up of reserves through keeping more animals, growing and storing

Table V. Precautions against Future Drought"

Precaution	Percentage of respondents (%)		
	Maasai herders	Maasai farmers	Non-Maasai farmers
Increase herd size	65	62	0
Grow more crops	57	30	46
Save cash	51	65	84
Store food	44	18	23
Reduce herd size	21	0	0
Reduce family size	14	0	0
Fence land	8	0	0
Work off-farm	1	4	9
Other	5	12	7
Nothing	0	0	2

"Data from Campbell (1979b).

crops, and saving cash. In view of the comparative success in meeting subsistence needs of those who entered the drought with larger herds, it is not surprising that increasing herd size is the most frequently cited precaution against future drought. However, new mechanisms are being adopted, particularly among younger Maasai (Table VI). The younger respondents tend to believe that reduced livestock numbers, increased cash savings, and cultivation will reduce the negative effects of drought. Should these views be maintained and become more widely accepted, a reduced emphasis on herding relative to cultivation may lead to the emergence of a mixed pastoral economy in Maasailand.

This process has begun. A number of Maasai already consider themselves farmers, though they continue to herd livestock. Their experience during the drought lends credence to the notion that mixed economy is more resilient than either the livestock-dominated or crop-dominated ones. All three groups give prominence to the idea of expanding the area under crops. Some seek to extend the cultivated area farther into the drier, lower lands; while this would provide additional farm land it would also accentuate the issue of conflicting demand for resources from the farming and herding sectors of the economy. Others, recognizing the emerging shortage of arable land, are using their land more intensively by reducing the amount of land left fallow. Such a response to an increasing population-land ratio might be anticipated (Boserup, 1965) but it entails the risk of exacerbating the soil erosion problem, already recognized by one-third of respondents as being severe, because few other conservative inputs to the farming system such as manuring and terracing are being made. In other areas of Africa where farming and herding occur in close proximity the use of manure as a fertilizer is common (Boulet, 1971; Dupire, 1972; Ludwig, 1968), but in the study area the non-Maasai farmers own few livestock and they do not permit the Maasai animals to graze on

Table VI. Precautions Against Future Drought by Age of Respondent, Maasai Herders"

Precaution	Age	
	30 and under (N = 42)	Over 30 (N = 117)
Increase herd size	14	87
Decrease herd size	18	27
Grow crops	26	66
Save cash	23	55
Store food	17	52

"Data from Campbell (1979b). Computed $\chi^2 = 13.245$, $df = 4$; critical χ^2 (0.05) = 9.488; critical χ^2 (0.01) = 13.277.

their fields, even after the harvest. Among the Maasai themselves there may be an opportunity for a more compatible rather than competitive land use system to emerge as Maasai farmers are less likely than non-Maasai farmers to deny access to their crop land to their own animals or those of herders.

While such compatible land use may allow for greater diversification of the Maasai economy it entails risks to the herding economy as a whole. Hjort (1981) warned of the development of "agropastoralism," a system in which the primary source of subsistence is farming and any surplus is invested in livestock, which may lead to the herds of farmers expanding "into areas formerly monopolized by nomadic pastoralists, creating a double impoverishment for nomadic pastoralists who experience competition for limited pastures and can no longer obtain food within the region" (1981: 140).

The increase in agricultural activity may affect not only the ecological resource base of herders but also the viability of the herding society by altering fundamental relationships among the society, the environment, and the herd as a social product of that society: "Pastoralists can become agriculturalists; however it is not simply a matter of shifting economic forms and retaining the same societies but a matter of fundamental alteration, not just of the means of production but of ideology as well" (Rigby, 1981: 162-163).

A further cause of concern regarding the viability of the herding system in the area is the future of the group ranches. The possibility that the grazing land currently held under group ranches may be insufficient for the needs of a growing population was recognized at the field seminars. As the population increases and as *moran* become junior elders and seek membership in the ranches, demands that each member be allocated individual tracts are expected. This situation would inevitably be to the advantage of the wealthy and could result in the marginalization of many. As Hjort explained, greater emphasis on the individual could lead to a decline in group support, a worsening position for the poor and an increase in agricultural activity both by the rich wishing to diversify their activities and by the poor who "engage in small scale cultivation—the only option for those who have no opportunities to leave their families or no market for their labor" (1981: 141).

Thus this strategy for reducing vulnerability, which many Maasai appear to favor may provide short-term benefits to a few who succeed in diversifying through cultivation but it implies important long-term consequences for the society as a whole.

The saving of cash is also seen as a useful precaution by Maasai farmers and is that most frequently mentioned by non-Maasai farmers. People recognize a number of difficulties with this strategy including the

low ability of people to save money and the lack of a bank at which they might save. Most farmers gain cash income directly after the harvest but purchasers pay low prices and what is earned is spent on immediate needs such as school fees and clothing. Discussion at field seminars indicated that farmers might receive better prices for their produce if they organized themselves into seller cooperatives so that they could negotiate a higher price for their crops. Many suggested that planting cash crops, such as coffee, would be a way of raising their incomes. The need for a bank to be established at Loitokitok was accepted by most people at the seminars but they realized that government action would be needed to accomplish this.

The availability of a bank might also encourage those who keep livestock as a means of saving to sell the animals when they are healthy and valuable rather than at times of need, such as in a drought, when the animals are in poor condition and fetch a low price. During the drought peoples' savings, livestock, were devalued against the commodity they wished to buy, grain, because the quality of livestock had declined, giving a poor selling price while the scarcity of grain drove its price up. Cash saved from the sale of healthy livestock would maintain its value relative to grain better than livestock.

Many farmers also expressed an interest in storing food crops. The amount available for storage is, however, limited as many farmers have to sell any surplus to raise cash and thus this may not be a viable strategy for them. For those who do have sufficient surplus to store, difficulties arise in the storage process due to losses from vermin and insect damage. The people of the area recognize a need for the construction of a suitable storage facility in the area to which they could contribute surpluses for use in time of drought.

A feature of the precautions listed by Maasai and other farmers in the area is that most concern activities that the people can implement themselves with little assistance from outside sources, such as the government. It became apparent at the follow-up field seminars that people did recognize there was much they could do themselves to alleviate drought-related problems, but they also realized their own limitations. For example, while they can increase herd size or plant different crops without external help, they could not open a bank without such assistance.

DISCUSSION

This study of the responses of the people of southern Kajiado District to the drought of 1972-1976 has demonstrated that, like other people who live in areas subject to natural hazards, they had developed a range of

strategies for reducing its effects. More importantly, however, it is clear that the effectiveness of these strategies was related not only to the intensity of the drought but also to their viability within a changing broader social, economic, and political environment. From a meteorological standpoint the rainfall deficiencies from 1972-1976 were not particularly severe, yet changes in socioeconomic conditions, clearly reflected in the land-use pattern, had resulted in the population being more vulnerable to reduced rainfall. The conclusions of other researchers that the impact of natural hazards is as much a function of political, economic, and social conditions as it is of environmental ones are borne out by this study (see footnote 2).

Among the most important factors affecting the people of the area has been the recent immigration of farmers, which has significantly altered land-use patterns and has resulted in the newly arrived farmers being ill-prepared for a drought and the herders being deprived of important drought-retreat pastures by the spread of cultivation into these areas. The changing balance between cultivation and pasture has important implications regarding the future of the area.

Ruthenberg (1977) has questioned the strategy of encouraging movement of farmers from the densely populated high potential lands of Kenya to the humid margins of the rangelands because cultivation in these drier lands entails higher risk due to the unpredictability of rainfall. As an alternative he proposed that more intensive use be made of the areas traditionally under cultivation in the western and central regions of the country. However, the issue of intensification of land use in these areas threatens focus on the politically charged question of land distribution in the highlands (Sorrensen, 1967; Wasserman, 1976) and in consequence the current efforts to promote the development of the arid and semi-arid lands are likely to be actively pursued (Government of Kenya, 1979).

The demand for cultivable land will increase in the study area not only as immigration of farmers continues but also if both farmers and herders expand the area being used for crops as a strategy for reducing the effects of drought. This strategy was cited by many respondents who indicated that they would cultivate in the lowlands, around the edges of swamps, and along river valleys. Under these conditions prime pastureland will be lost to agriculture and the resources available to herders will be diminished.

The herders of the area are acutely aware of the variety of resources available in the area (Western and Dunne, 1979) and their land-use system is dependent on access to different ecological zones at different times of the year. Continued removal of the more humid areas from their resource base threatens to disrupt the ecological basis of their production system. Further, as Hjort (1981) and Rigby (1981) have suggested, the expansion of the farming economy implies fundamental changes in land ownership and in

social relations that may undermine the ideological and social bases of herding.

The lack of complementarity between farming and herding in the area is in contrast to many other regions of Africa where they often interact in a less competitive and more supportive manner. McCown *et al.* (1979) have identified a number of categories of interaction. They recognize "ecological linkage" whereby, for example, herds may graze on crop residues following the harvest and "exchange linkage," in the form of trade of products of herd and farm, as being complementary, "competition linkage" may result where agriculture is expanding at the expense of grazing land.

In the study area some exchange linkage does occur, mainly at the market where milk, hides, and small stock are sold by the herders and grain is sold by farmers. Ecological linkage has not developed as an accepted form of interaction, although many farmers did complain that livestock grazed and trampled low crops, and, as has been demonstrated, competition linkage is present and appears likely to increase. Crucial to an understanding of this situation is the recognition that the short period of time most farmers have lived there may not have permitted linkages to develop. One must also be aware of the attitude among the Maasai that they need to protect their rights to the areas set aside for their use under the agreements made with the British colonial authorities. Many Maasai fear that the independent government is dominated by politicians who are sympathetic to the needs of farmers than to those of herders and are therefore less likely to respect the treaties made during the colonial period. While potential for greater interaction between the two economies may therefore exist there are strong constraints on their being realized.

The experience of the recent drought indicates that the farmers and herders of the area were severely affected. As population growth occurs among both groups and as immigration continues, the number of people in the area increases. The resources available are limited and in the event of a future drought a larger population, largely dependent on subsistence production, will be vulnerable. The evidence from the peoples' responses to the drought is that they are prepared to change selected aspects of their way of life and are actively seeking actions that may reduce their risk. If advantage can be taken of this readiness to change, development of Maasailand may be possible. The knowledge the people have of local environmental and economic conditions is reflected in the variety of improvements suggested at the field seminars. The majority of these could be implemented with local resources; others would require financial and technical assistance from government or other agencies.

In preparing development plans for the area under the current emphasis on semi-arid land development, it would be unfortunate if

planners should fail to recognize the value of "local science" and not use it to prepare plans with the local community.⁸ As Wisner and Mbithi (1973: 14) pointed out, "a relatively low cost and high benefit approach for the government in dealing with drought problems is to build upon the local patterns of adjustment to drought which have grown up in the different ecological zones of the country, fostering those which seem to be effective, discouraging some which seem wasteful, introducing new ones."

The involvement of the local people in the planning process has not been encouraged, and while planners continue to emphasize incremental improvements in subsistence activities the aspirations of the people will remain unfulfilled, their expertise in managing resources in a difficult environment will be wasted, and they will continue to be at risk to the effects of drought.

There is a great need in the area to explore ways of stimulating nonsubsistence aspects of the economy. The Ministry of Wildlife and Tourism has shown considerable innovation in bringing the benefits of the tourist potential of the area to the residents.⁹ Less attention has been paid to means of stimulating the livestock economy. There are indications that herders are becoming increasingly involved in the wider economy by selling more livestock and consuming greater amounts of purchased food (Meadows and White, 1979). Low livestock prices, irregular stock sales, and unreliable supplies of grains are identified as important constraints to the greater commercialization of the livestock economy, while in the longer term there will be a need for off-farm employment opportunities to absorb the growing population in productive activities. The possibility of developing a livestock-based industry, which would provide employment and keep the value added in processing within Maasailand, might be investigated (Campbell, 1979a 1981).

⁸Considerable attention is currently being paid in Kenya to district-level planning. This is a reflection of the adoption of a more decentralized approach. Recent contributions to the debate on decentralized planning have emphasized the importance of incorporating local resources, values, and aspirations in planning decisions (Friedmann and Weaver, 1979; Stohr and Fraser Taylor, 1981), but as yet little serious practical effort is being made in this direction in Kenya. However, as this study has demonstrated, people are clearly willing to contribute ideas towards activities designed to improve conditions.

⁹The competitive nature of resource use in the area has resulted in conflict between herders and farmers and between both these groups and the wildlife-related activities of the region. Those concerned with wildlife management recognize that unless wildlife-related activities can contribute to the livelihood of adjacent landowners, pressures to restrict wildlife will increase. The concept of involving local herders and farmers in tourism through investment in tourist facilities or through compensating them monetarily for the resources used by wildlife has been accepted and is being implemented (Thresher, 1976). It is anticipated that if wildlife-activities can yield income to the people of Kajiado District, such diversification of the economy will be accepted by the people.

There is therefore a need to prepare a development strategy with the people of the area that aims to reduce the pressure on the land resources while improving the peoples' ability to meet their needs. Such a plan should assess contemporary trends in land use in terms of their continued viability, examine possibilities for off-farm employment, and propose changes compatible with local aspiration as well as national goals. In the absence of careful planning, contemporary trends will continue, the costs to the national economy of recurrent famine relief will increase, and the potential contribution of the rangelands to Kenya's economic development will not be realized.

ACKNOWLEDGMENTS

The research reported in this article was conducted while the author was a Visiting Research Fellow at the Institute for Development Studies, University of Nairobi. This position was made available through a post-doctoral fellowship awarded by the Rockefeller Foundation. The support of the Institute and of the Foundation is gratefully acknowledged. The author is indebted to George Axinn, Larry Sommers, and to anonymous reviewers for their insightful comments on an earlier draft of this paper. The author remains solely responsible for the content.

- Baker, R. (1980). "Sociological factors" in the commercialisation of cattle in Africa. Development Studies Discussion Paper No. 61. University of East Africa, Norwich.
- Bernsten, J. L. (1976). The Maasai and their neighbors: Variables and interaction. *African Economic History* 2: 1-11.
- Boserup, E. (1965). *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure*. Aldine, Chicago.
- Boulet, J. (1971). *Magoumaz: Etude d'un Terron de Montagne en Pays Maja*. Office de la Recherche Scientifique et Technique Outre-mer, Paris.
- Bugnicourt, J. (1974) *Un Peuple Prive de son Environnement*. Programme "Formation Pour l'Environnement," Institut Africain de Developpement Economique et de Planification-United Nations Environment Programme-Swedish International Development Agency, Dakar.
- Burton, E., Kates, R. W., and White G. F. (1978). *The Environment as Hazard*. Oxford University Press, New York.
- Campbell, D. J. (1977) Strategies for coping with drought in the Sahel: A study of recent population movements in the Department of Maradi, Niger. Unpublished doctoral dissertation, Clark University, Worcester.
- Campbell, D. J. (1979a). Development or decline: Resources, land use and population growth in Kajiado District. Working Paper No. 352. Institute for Development Studies, University of Nairobi, Nairobi.
- Campbell, D. J. (1979b). Response to drought in Kenya Maasailand: pastoralists and farmers of the Loitokitok area, Kajiado District. Discussion Paper No. 267. Institute for Development Studies, University of Nairobi, Nairobi.

- Campbell, D. J. (1981). Land use competition at the margins of the rangelands: An issue in development strategies for semi-arid areas. In Norcliffe, G., and Pinfold, T. (eds.), *Planning African Development*. Croom Helm, London.
- Campbell, D. J., and Mbugua, E. S. (1978) Survey of land use problems in Kajiado District: A review of methodology. Working Paper No. 334. Institute for Development Studies, University of Nairobi, Nairobi.
- Campbell, D. J., and Trechter, D. D. (1982). Strategies for coping with food consumption shortage in the Mandara Mountains region of North Cameroon. *Social Science and Medicine*, 16: 2117-2127.
- Casebeer, R. L. (1975). Summaries of statistics and regulations pertaining to wildlife, parks and reserves in Kenya. Project Working Document No. 8. United Nations Development Programme-Food and Agriculture Organisation Wildlife Management Project, Nairobi.
- Comite Information Sahel (1975). *Qui se Nourrit de la Famine en Afrique?* Maspero, Paris.
- Copans, J. (ed.) (1975). *Sécheresses et Famines du Sahel* (2 vols.). Maspero, Paris.
- Dahl, G., and Hjort, A. (1976). *Having Herds: Pastoral Herd Growth and Household Economy*. Stockholm Studies in Social Anthropology, University of Stockholm, Stockholm.
- Dahl, G., and Hjort, A. (1979) Pastoral change and the role of drought. *SAREC Report R2*. Swedish Agency for Research Cooperation with Developing Countries, Stockholm.
- Dalby, D., Harrison-Church, R. J., and Bezza, F. (eds.) (1977). *Drought in Africa 2*, African Environment Special Report No. 6. International African Institute, London.
- Davis, R. K. (1971). Some issues in the evolution, organization and operation of group ranches in Kenya. *East African Journal of Rural Development* 4 (1): 22-33.
- Dupire, M. (1972). Les facteurs humains de l'économie pastorale. *Etudes Nigériennes* No. 6. Centre Nigérien de Recherche Sciences-Humaines, Niamey, Niger.
- Freiere, P. (1973). *Education for Critical Consciousness*. Seabury Press, New York.
- Friedmann, J., and Weaver, C. (1979). *Territory and Function: The Evolution of Regional Planning*. Arnold, London.
- Galaty, J. (1980). The Maasai group-ranch: Politics and development in an African pastoral society. In Salzman, P. C. (ed.), *When Nomads Settle: Processes of Sedentarization as Adaptation and Response*. Praeger, New York.
- Glantz, M. H. (ed.) (1976). *The Politics of Natural Disaster: The Case of the Sahel Drought*. Praeger, New York.
- Goldschmidt, W. (1981). An anthropological approach to economic development: In Galaty, J. G., Aronson, D., Salzman, P. C., and Chouinard, A. (eds.), *The Future of Pastoral Peoples*. International Development Research Center, Ottawa.
- Government of Kenya (1947). Kajiado District, Annual Report, 1947 (mimeo).
- Government of Kenya (1951). Kajiado District, Annual Report, 1951 (mimeo).
- Government of Kenya (1979). *Arid and Semi-Arid Lands Development in Kenya. The Framework for Implementation, Programme Planning and Evaluation*. Government Printer, Nairobi.
- Great Britain (1934). *Report of the Kenya Land Commission, September 1933*. His Majesty's Stationery Office, London.
- Halderman, J. M. (1972). Analysis of continued nomadism on the Kaputeie Maasai group ranches: Social and ecological factors. Discussion Paper No. 152. Institute for Development Studies, University of Nairobi, Nairobi.
- Hankins, T. D. (1974). Response to drought in Sukumaland, Tanzania. In White, G. F. (ed.), *Natural Hazards: Local, National, Global*. Oxford University Press, New York.
- Hedlund, H. G. B. (1971). The impact of group ranches on a pastoral society. Staff Paper No. 100. Institute for Development Studies, University of Nairobi, Nairobi.
- Heijnen, J., and Kates, R. W. (1974). Northeast Tanzania: Comparative observations along a moisture gradient. In White, G. F. (ed.), *Natural Hazards: Local, National, Global*. Oxford University Press, New York.
- Hewitt, K. (ed.) (1983). *Interpretations of Calamity from the Viewpoint of Human Ecology*. Allen & Unwin Inc., Boston.
- Hjort, A. (1981). Herds, trade and grain: Pastoralism in a regional perspective. In Galaty, J. G., Aronson, D., Salzman, P. C., and Chouinard, A. (eds.), *The Future of Pastoral Peoples*. International Development Research Center, Ottawa.

- Jahnke, H. E. (1978). An historical review of range development in Kenya. *Course Notes*, International Livestock Center for Africa, Nairobi.
- Lallemande, S. (1975). La sécheresse dans un village Mossi de Haute Volta. In Copans, J. (ed.), *Sécheresses et Famines du Sahel* (Vol. II). Maspéro, Paris.
- Lofchie, M. F. (1975). Political and economic origins of African hunger. *Journal of Modern African Studies* 13 (4): 551-567.
- Ludwig, H. D. (1968). Permanent farming on Ukara. The impact of land shortage on husbandry practices. In Ruthenberg, H. (ed.), *Smallholder Farming and Smallholder Development in Tanzania*. Weltforum Verlag, Munich.
- Mbithi, P., and Barnes, C. (1975). *The Spontaneous Settlement Problem in Kenya*. East African Literature Bureau, Nairobi.
- McCown, R. L., Haaland, G., and de Haan, C. (1979). The interaction between cultivation and livestock production in semi-arid Africa. *Ecological Studies* 34: 297-332.
- Meadows, S. J., and White, J. (1979). Structure of the cattle herd and determinants of offtake rates in Kajiado District, Kenya 1962-1977. *Pastoral Network Paper 7d*. Overseas Development Institute, London.
- Meillassoux, C. (1974). Development or exploitation: Is the Sahel famine good for business? *Review of African Political Economy* 1: 27-33.
- Mott, F. L., and Mott, S. A. (1980). Kenya's record population growth: A dilemma of development. *Population Bulletin* 35(3).
- Oguntoyinbo, J. S., and Richards, P. (1978). Drought and the Nigerian farmer. *Journal of Arid Environments* 1: 165-194.
- Ominde, S. H. (1971). The semi-arid and arid lands of Kenya. In Ominde, S. H. (ed.), *Studies in East African Geography and Development*. Heinemann, London.
- Rigby, P. (1981). Theoretical implications of pastoral development strategies in East Africa. In Galaty, J. G., Aronson, D., Salzman, P. C., and Choumard, A., (eds.), *The Future of Pastoral Peoples*. International Development Research Center, Ottawa.
- Ruthenberg, H. (1977). Some crucial aspects of future agricultural development in Kenya (mimeo). Ministry of Agriculture, Nairobi.
- Sorrensen, M. P. K. (1967). *Land Reform in the Kikuyu Country*. Oxford University Press, Nairobi.
- Stohr, W. B., and Fraser Taylor, D. R. (eds.) (1981). *Development from Above or Below? The Dialectics of Regional Planning in Developing Countries*. Wiley, Chichester.
- Thresher, P. (1976). Wildlife viewing cost-benefit simulation model. Volume 1: The main text. *Project Working Document No. 14*, United Nations Development Programme/Food and Agriculture Organization Wildlife Management Project, Nairobi.
- van Zwanenberg, R. M. A., and Kemp, A. (1975). *An Economic History of Kenya and Uganda 1800-1970*. East African Literature Bureau, Nairobi.
- Von Kaufman, R. (1976). The development of the rangeland areas. In Heyer, J., Maitha, J. K., and Senga, W. M. (eds.), *Agricultural Development in Kenya: An Economic Assessment*. Oxford University Press, Nairobi.
- Waddell, E. (1977). The hazards of scientism: A review article. *Human Ecology* 5(1): 69-76.
- Wasserman, G. (1976). *Politics of Decolonization: Kenya Europeans and the Land Issue 1960-1968*. Cambridge University Press, Cambridge.
- Watts, M. (1983). On the poverty of theory: natural hazards research in context. In Hewitt, K. (ed.), *Interpretations of Calamity from the Viewpoint of Human Ecology*. Allen & Unwin Inc., Boston.
- Western, D. (1975). Water availability and its influence on the structure and dynamics of a savannah large mammal community. *East African Wildlife Journal* 13: 265-286.
- Western, D., and Dunne, T. (1979). Environmental aspects of settlement site decisions among pastoral Maasai. *Human Ecology* 7(1): 75-98.
- White, G. F. (ed.) (1974). *Natural Hazards: Local, National, Global*. Oxford University Press, New York.
- Wisner, B. (1977). The human ecology of drought in eastern Kenya. Unpublished doctoral dissertation, Clark University, Worcester.
- Wisner, B. (1981). Nutritional consequences of the articulation of capitalist and non-capitalist modes of production in Eastern Kenya. *Rural Africana* 8-9: 99-132.

Wisner, B., and Mbithi, P. M. (1973). Drought in Eastern Kenya, comparative observations of nutritional status and farmer activity at 17 sites. Discussion Paper No. 167, Institute for Development Studies, Nairobi.

Energy Analysis of the Coal Fuel Cycle in an Appalachian Coal County

A. P. Watson¹

Preliminary results from an energy analysis of the coal fuel cycle in an Appalachian coal county have provided a systematic assessment of hidden energy subsidies in extraction, transport, processing, and combustion. Current results indicate that the system operates at an annual energy deficit of approximately 350×10^6 kcal. A major loss is depletion of the coal resource base by use of inefficient mining techniques. Although of smaller magnitude, reductions in work force and community productivity from occupational accidents, disease, and road maintenance requirements for transport also appear to be significant. Further assessment is needed to verify assumptions and characterize additional data bases.

KEY WORDS: Appalachia; coal; energy analysis.

INTRODUCTION

Coal production throughout the Appalachian Basin has been expanding steadily since the Arab oil embargo of 1973. Approximately 60% of the nation's coal is mined in Appalachian states (The President's Commission on Coal, 1980). Current energy-use projections, based on estimated size of reserves and proximity to markets, indicate eastern bituminous coals will be in great demand for electricity production into the next century. Any potential development of a synfuels industry will also

¹Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831.