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ODA

Overseas Development Administration

Renewable Natural Resources Profile

Kenya



NRI

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OVERSEAS DEVELOPMENT

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ADMINISTRATION

Kenya

Renewable Natural Resources Profile

Natural Resources Institute

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ACRONYMS

ASAL	arid and semi-arid land
CARE	Co-operative for American Relief Everywhere
CIAT	International Centre for Tropical Agriculture
EIU	The Economist Intelligence Unit
EMI	Embu-Meru-Isiolo Programme
FAO	Food and Agriculture Organisation of the United Nations
IRDPs	integrated rural development projects
ITDG	Intermediate Technology Development Group
KARI	Kenya Agricultural Research Institute
MSY	maximum sustainable yield
NGO	non-governmental organisation
NRI	Natural Resources Institute
ODA	official development assistance
ODA	Overseas Development Administration
OECD	Organisation for Economic Co-operation and Development
RNR	renewable natural resources
TLU	tropical livestock unit
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development

INTRODUCTION

This profile of the renewable natural resources (RNR) sector of Kenya has been compiled by the Natural Resources Institute (NRI) for the Overseas Development Administration. It brings together material from a wide range of published and unpublished sources into a comprehensive account of the physical and socio-economic characteristics of Kenya's RNR sector and its future development potential. Views expressed are the responsibility of the authors alone and are not necessarily those of NRI.

The Profile is arranged so as to provide an easily accessible and assimilable source of information on the RNR sector of this country. The Key Facts and Summary of RNR Potential sections are intended both to summarise key information and issues, and highlight developmental opportunities, constraints and the potential for addressing these. These aspects are covered in greater depth in later sections which provide comprehensive physical, social-economic and technical data and information which are particularly relevant to the areas under consideration. Although an attempt has been made to present information in as logical a manner as possible, owing to the inherent complexity of this exercise, some omissions and inaccuracies will be inevitable. However, as this compendium is intended to be updated on a regular basis, any such problems may be accommodated in later editions.

The principal authors of this profile are David Barton (socio-economist) and Vernon Gibberd (agronomist). Data were also contributed by Barry Blake (fisheries biologist) and Mike Hulme (Climatic Research Unit, University of East Anglia).

KEY FACTS

RESOURCES

Total area	580 370 km ²
Land	569 140 km ²
Inland water	12 000 km ² approx
Coastline	536 km
Exclusive Economic Zone	118 000 km ²
Continental shelf to 200 m	14 000 km ²
Mean annual discharge of four major rivers ¹	8080 million m ³
Annual freshwater withdrawals (1970–92) ²	
Total	1.1 km ³
Per capita	51 m ³
Rainfall	Wide variation according to climatic zone: 150–2500 mm
Land use ³	
Arable	40 000 km ²
Permanent crops	5 200 km ²
Permanent pasture	213 000 km ²
Forest/woodland	168 000 km ²
Other	149 240 km ²
Forest and other land	
Gazetted forest	17 000 km ²
Ungazetted (excluding National Parks)	5 000 km ²
National Parks and Reserves	42 000 km ²

Source: FAO (1995); World Bank (1994); EIU (various dates)

Note: ¹The major rivers are the Tana and Athi, discharging into the sea, the Ewaso Ngiro, discharging into an inland delta, and the Nzoia, discharging into Lake Victoria. ²Data refer to any year from 1970 to 1992. ³Arable land—9% high quality, 9% medium quality, 9% marginal; marginal land for mixed farming—13%; rangeland and semi-desert—60%.

AGRICULTURE

Main crops ¹ (1994)	Area (ha)	Production (t)
Maize	1 450 000	2 970 000 ²
Wheat	155 000	2 230 000 ²
Tea	101 000 ²	209 000 ²
Coffee (green beans)	153 000 ²	74 000 ²
Sugar cane	45 000	3 470 000
Sisal	30 000	34 000
Rice (paddy)	10 000	50 000
Barley	27 000	37 000
Millet	90 000	60 000
Sorghum	120 000	130 000
Potatoes (white)	47 000	250 000
Sweet potatoes	66 000	650 000
Cassava	101 000	842 000
Pulses	700 000	200 000
Cotton (seed)	n/a	8 000 ²
Coconuts	n/a	43 000
Vegetables	n/a	655 000
Pineapples	n/a	270 000
Mangoes	n/a	24 000
Bananas and plantains	n/a	580 000
Cashew	n/a	15 000
Pyrethrum (dried flowers)	n/a	13 000

Source: FAO (1995)

Note: ¹ Smallholder sector crops—main food crops: maize, pulses, cassava, sweet potatoes, bananas, sorghum; main cash crops: coffee, tea, sugar cane, vegetables, fruit, pyrethrum. Commercial or large farm sector crops—tea, sugar, wheat, fruit and vegetables. ² Unofficial FAO estimates; all other data are estimates.

LIVESTOCK

1994 estimates	Number	No. slaughtered/production	
Cattle	11 000 000	1 621 000 head	215 000 t
Sheep	5 500 000	1 851 000 head	22 000 t
Goats	7 438 000	2 721 000 head	30 000 t
Pigs	107 000	83 000 head	5 000 t
Camels	815 000	—	—
Chickens	26 000 000	49 000 t	
Dairy (milk)			
Cow	3 866 000	1 905 000 t	
Sheep		1 000 t	
Goat		3 000 t	
Hides and wool			
Cattle hides		34 049 t	
Sheepskins		4 441 t	
Goatskins		9 524 t	
Wool (greasy)		1 900 t	
Wool (scoured)		935 t	

Source: FAO (1995)

FORESTRY

	Standing stock ('000 m ³)
National forests	137 400
Wood biomass on large farms	40 000
Woodlots	10 000
Plantations	27 400
Savannah bush	635 500
Savannah grassland	122 000
Rangeland	50 400

Source: UNDP/World Bank (1987)

FISHERIES

Total catch (1991)	198 637 t
Inland	191 218 t
Marine	7 419 t
Total aquaculture production (1991)	1 178 t
Value	US\$ 2 962 000
No. fishermen	6 250 marine (1991); 22 169 inland (1986)
No. inland vessels (1986)	5360
No. marine artisanal vessels (1985)	1828 (canoes)
No. trawlers (1989)	14
Average catch (1988-90)	142 317 t
Imports (1988-90)	368 t
Exports (1988-90)	13 891 t
Supply per capita (1988-90)	5.7 kg/year

Source: FAO (1991b); FAO (1993)

MINERALS

Soda ash	181 300 t
Fluorspar	80 600 t
Salt	72 500 t
Limestone products (excluding cement)	30 700 t
Other	40 200 t

Source: EIU (1993)

ECONOMY

GNP per capita (1992)	US\$ 310
GDP from agriculture (1992)	27%
Labour force in agriculture	81%
Main trading routes	Mombasa (port), road and rail to Uganda, Zaire and Rwanda; road to Arusha (Tanzania)

Source: World Bank (1994); UNDP (1994)

DEMOGRAPHY

Population (mid-1992)	25.7 million
Average annual population growth rate (1980-92)	3.6%
Urbanisation (1992)	25% (10% in 1970)

Source: World Bank (1994)

HEALTH AND EDUCATION

Under-5 mortality (1992)	74 per 1000 live births
Access to safe water (1990)	49%
Adult literacy rate (1990)	69%

Source: World Bank (1994); UNICEF (1994)

KEY ENVIRONMENTAL ISSUES

Major causes of environmental degradation are high population growth rates and inequalities over access to resources. The resulting poverty leads the poor to trade off long-term sustainable resource use for short-term consumption of stocks. The result is:

- **Soil degradation and erosion**, particularly in the arid and semi-arid lands as the cultivation frontier expands from the higher potential areas
- **Reduction in biodiversity**, outside protected areas and increasing conflicts between wildlife protection and traditional resource-use
- **Reduction in forest cover**, for estate and smallholder production and increasing fuelwood shortages
- **Overfishing and pollution** of Lake Victoria

KEY TRANSBOUNDARY ISSUES

- **Smuggling** of key consumer goods distorting local production, income from transit trade via Mombasa
- **Shared exploitation of Lake Victoria fisheries**
- Large numbers of **refugees** from **Somalia** and elsewhere
- **Security problems** on Somali border

SUMMARY OF RNR POTENTIAL

Zone/sub-zone	Environment	Land use
Humid West Zone		
Lake Hinterland	1100–2200 m altitude; 800–2000 mm rainfall. Deep, fertile red clays to shallow, infertile sandy loams.	Extensive rainfed cultivation near Lake Victoria; limited irrigation. Intensive farming on surrounding uplands. Some estate tea and sugar.
Western Highlands	2000–4000 m altitude; 1300–2500 mm rainfall. Soils volcanic, variable depth, generally humic topsoil.	Mostly forest reserve on steep slopes. (Population density 100 persons/km ² outside forest reserves.)
Upland Plateaux	1800–2300 m altitude; 900–1200 mm rainfall. Infertile red clays to highly fertile volcanic loams and clay loams.	Extensive cereal production at higher altitudes; maize and livestock at lower altitudes.
Central Highlands Zone		
	1500–3000+ m altitude; 600–2500 mm rainfall. Volcanic and granitic soils range from dark red friable clays to impermeable black clay to shallow and sandy.	Small-scale intensive rainfed cultivation. Food crops including potatoes; tea, coffee, and horticulture with supplementary irrigation
Coast Zone		
	<0–400 m altitude; 500–1500 mm rainfall. Soils complex from infertile sands to drained clays.	Small-scale low-intensity rainfed cultivation and tree crops. Some irrigated rice.
Semi-Arid Upland Zone		
Northern	1000–2000 m altitude; 400–800 mm rainfall. Soils variable derived from volcanic rocks and ash.	Extensive pastoralism and large-scale ranches.
Southern	1000–2000 m altitude; 400–1000 mm rainfall. Soils variable; poorly drained clays on the plains.	Extensive pastoralism. Limited small-scale cultivation, wheat production and irrigated horticulture.
Eastern	600–1500 m altitude; 500–800 mm rainfall. Soils deep, infertile, coarse and medium textures.	Extensive small-scale cultivation with high incidence of crop failure. Partially integrated livestock production.
Arid Lowlands Zone		
	50–1500 m altitude; 150–500 mm rainfall. Soils mostly sandy loams, also clay plains; lava fields in semi-desert.	Very extensive pastoralism. Irrigation schemes on the Tana River.

Potential: low input	Potential: medium/high input	Constraints
Moderate—scope for expanding cultivated area.	Good—scope for irrigation and drainage, especially for sugar and cotton with increased inputs; more zero-grazed livestock.	Lake shore soils are exhausted; tsetse in south; <i>Striga</i> restricts cereal yields.
Zero—in forest. Slight—outside forest for zero-grazed dairying, pyrethrum, and vegetable production near main roads.	Slight—in forest. Good—outside forest for more tea, dairying, fast-growing trees and vegetables, especially potatoes.	Cultivators are encroaching on forest; soil conservation essential because of steep slopes and heavy rains; tea requires all-weather roads.
Good—with farm sub-division. Zero—without access to modern inputs.	Good—with or without sub-division for wide variety of crops and livestock.	Sub-division without access to inputs may jeopardise national production, especially of temperate cereals.
Good—for export horticulture and small-scale irrigation. Zero—without access to inputs.	Good—for all crops, especially if irrigation available and for dairying with improved fodder production.	Water rights may be suspended when electricity generation is threatened by low flows in Tana river during droughts; tea expansion will need all-weather roads.
Fair—cultivated area could be expanded. Good—with intensified land use and access to inputs especially for tree crops, horticulture and dairying.	Good—fodder grown below tree crops and increased sorghum production for intensive livestock especially dairy. Good—for major irrigation.	Soils are poor; tsetse in hinterland; rains tail off and become erratic further inland; the two major rivers may flood and there are localised areas of salinity.
Fair—in lower areas for ASAL crops with access to input where land is available.	Good—for beef and game ranching also for temperate cereals with conservation tillage.	Cold nights and strong drying winds in high areas; poor roads; incursion of wild animals.
Fair—for ASAL crops with access to input where land is available.	Moderate—for cereal production with conservation tillage and for ranching.	Poor roads; need to conserve basal flow of rivers for others below; incursion of wild animals.
Moderate—for ASAL crops with access to input where land is available.	Good—for irrigated horticulture.	Poor roads; incursion of wild animals.
Slight—opportunist crop production on seasonal streams and with flood-spreading. Some very limited irrigation opportunities from sand rivers. Small increase in offtake of animals.	Good—only with irrigation especially on Athi and Mount Kenya rivers. Slight—irrigation from Turkwell below hydro dam; ranching with improved water supplies and possible fodder production with rainwater harvesting.	Saline groundwater in some places; some alkaline deposits in possible irrigation areas.

AGRO-CLIMATIC DATA

Zone/ sub-zone	Altitude (m)	Mean annual temperature (°C) ¹	Mean annual rainfall (mm)	Type of rainfall distribution ²	Growing season (days)
Humid West Zone					
Lake Hinterland	1100–2200	23–16	800–2000	Prolonged unimodal	>100
Western Highlands	2000–4000	17–5	1300–2500	Prolonged unimodal	>100
Upland Plateaux	1800–2300	18–15	900–1200	Bimodal or trimodal	>100
Central Highlands Zone	1500–3000+	20–10	600–2500	Bimodal	>100
Coast Zone	<0–400	27–25	500–1400	Unimodal with tail	Varies
Semi-Arid Uplands Zone					
Northern	1000–2000	24–15	400–800	Bimodal or trimodal	<100
Southern	1000–2000	24–15	400–1000	Unimodal	<100
Eastern	600–1500	28–20	500–800	Bimodal	<100
Arid Lowlands Zone	50–1500	30–20	150–500	Bimodal or indeterminate	<100

Note: ¹ Localised frost occurs above 2000 m; cold night winds can pose severe limitations. ² Unimodal = one long wet season; bimodal = split wet season; unimodal with tail = wet season is drawn out; trimodal = three wet seasons.

Rainfall varies from 150 mm to 2500 mm and is concentrated on the coastal strip and on land over 1000 m in the interior. Its seasonality varies spatially as well as from year to year, varying from all the year round rainfall near Lake Victoria, through uni-, bi- and even trimodal patterns to an erratic and very low rainfall in the northwest. There can quite often be very heavy falls (of over 100 mm in 24 hours) in the lower altitude drier areas. Dry seasons are of varying length and severity.

Long-term trends suggest that there has been a slight increase in rainfall overall (comparing the period 1894–62 with 1963–91) and that this has been concentrated largely in November. There has also been some decrease in seasonality of the rains on the coast. Unlike countries in the higher latitudes of Africa, there is only a small positive correlation with the *El Niño*/Southern Oscillation events and this is thought to affect about 25% of the overall variability of the rains. (Rainfall distribution can be seen in Map 4.)

RENEWABLE NATURAL RESOURCES: REGIONAL VARIATION AND UTILISATION

Kenya is located in East Africa and is bordered by Somalia to the east, Ethiopia to the north, Sudan to the northeast, Uganda to the west and Tanzania to the south, the Indian Ocean lies to the southeast (see Map 1). The second highest mountain in Africa, Mount Kenya, in the south central part of the country on the Equator, rises to 5199 m. Kenya can be divided into five major natural zones or areas in which the physical environment possesses similar major features:

- Humid West Zone
- Central Highlands Zone
- Coast Zone
- Semi-Arid Uplands Zone
- Arid Lowlands Zone

The Humid West Zone and the Semi-Arid Uplands are subdivided to reflect particular agro-ecological sub-zones. The boundaries of the zones are shown in Map 1. Administratively, the country is divided into eight regions (Central, Western, Eastern, North Eastern, Rift Valley, Nyanza, Coast and Nairobi); population density for the 41 administrative districts is shown in Map 2. Relief and communications are given in Map 3.

HUMID WEST ZONE

Although accounting for only 9% of the surface area of Kenya, the humid west zone (zone 1 on Map 1) supports over 9.1 million people, almost half the rural population, at an average density of 250 persons/km². It can sustain these numbers (density exceeding 750/km² locally) because it enjoys a long rainy season associated with a temperate equatorial climate; this enables a range of subsistence and cash crops to be grown with a high degree of reliability.

Within this relatively small area, there are immense contrasts in elevation and geology which in turn give rise to a wide range of climate, soils and land use. It is convenient therefore to divide the Humid West into three sub-zones:

- Lake Hinterland—plains, catchments and hills surrounding the Lake Victoria Basin
- Western Highlands—mountain ranges that divide the Lake Victoria Basin from the Rift Valley
- Upland Plateaux—distinctive intermediate elevation undulating plains of the interior.

All three sub-zones are characterised by the length of rainy season and by relatively high humidity generated through proximity to Lake Victoria.

Lake Hinterland

Physical environment

This sub-zone comprises not only the land adjoining Lake Victoria but also the scarps and uplands surrounding the lake basin; to the north these include the Nandi Hills, to the south the Kisii Highlands. These are areas that are under the daily influence of lake winds. Consequently, except in immediate proximity to the lake, the rainy season—extending from March to November—is both continuous and reliable. Indeed, the hilly areas of the hinterland comprise some of the wettest parts of Kenya. A total annual rainfall of around 800 mm close to the lake increases rapidly inland to approach and sometimes exceed 2000 mm.

Although the geology and hence the soils are highly complex, the latter are generally not fertile. In the north, moreover, rooting depth tends to be impeded by the presence of hard ironstone or laterite. Much variation occurs over only short distances, the soils ranging from deep, fertile red clays to shallow, infertile sandy loams. Near the lake there are alkaline clay plains and discrete swamps. Soil quality

differences, though important locally, do not characterise the sub-zone as a whole; nevertheless, detailed knowledge of the soils is essential before embarking on development.

Land use

Throughout this area, population pressures are becoming increasingly serious, the average density of 325 persons/km² belying a marked variation between locations. Kisii District is under severest pressure, with more than 400 persons/km² overall (less than 0.1 ha per person in one location); population pressures are leading to fragmentation of holdings, landlessness and a decline in labour productivity. Food security is increasingly threatened.

Great contrasts in cropping pattern reflect altitude, rainfall reliability and soil differences. Close to the lake, holdings range up to 20 ha and are not intensively farmed. A significant proportion of the land is used for rough grazing by cattle. The main crops are maize, sorghum, cassava and cotton intercropped. Yields are low and modern inputs rarely used; malnutrition occurs widely. In contrast, the surrounding uplands are farmed intensively on holdings of 1–5 ha, with maize and beans the principal food crops: tea, coffee, dairying and, more locally, pyrethrum and passion fruit are the main sources of income. In addition to 20 000 ha of tea and 11 000 ha of coffee grown by smallholders, there are 20 000 ha of estate tea. Sugar is locally important with three factories east of Kisumu and a major centre to the north of Mumias, where 32 000 ha of cane are cultivated by 30 000 outgrowers for the 210 000-t capacity factory.

Potential

Other than close to the lake, there is little scope for increasing the area under cultivation, but considerable potential for raising yields by use of manure, fertilisers, plant protection and weed control. Early maturing crops of beans and vegetables need to be promoted near the lake where low rainfall coincides with cassava production and poor nutrition. Zero grazing of dairy cattle could be expanded. The lake basin is generally too dry for sugar cane, the intermediate elevations have too uniform a rainfall for quality coffee. Cotton may be more appropriate in the former areas, tea with dairying in the latter; and sugar concentrated north of the lake in the wet lower valleys of the Yala and Nzoia.

Fewer than 2000 ha of irrigation (mostly rice) have been developed in the lake basin. A pre-feasibility study has however indicated an irrigation potential of some 25 000 ha, complete realisation of which would require drainage of the Yala Swamps. Despite the high capital requirements, gravity-fed irrigation development will become more attractive as population pressures increase.

Close to the lake tsetse fly (which can spread trypanosomiasis to both cattle and people) is prevalent in South Nyanza. Livestock production could nevertheless be raised through improved husbandry, specifically aimed at disease control and more intensive feeding.

There are local problems with the root parasite *Striga hermonthea* which affects maize and sorghum production on the exhausted lake-shore soils and for which there is no easy solution.

Western Highlands

Physical environment

These comprise the range of mostly volcanic mountains which, rising to over 3000 m, form the western wall of the Rift Valley: the Cherangani Hills in the north, Tinderet Forest along the equator, and the Mau Escarpment to the south. The sub-zone includes the volcanic massif of Mount Elgon which rises to over 4000 m on the Uganda border north of the lake. This mountain country is high, wet and cold, often with steep slopes and scarps, and a tendency to night frost. Rains occur over some nine months of the year and even the dry season is marked by low levels of evaporation. The soils are of widely varying depth but with generally humic topsoil. On the Mau and lower slopes of Elgon, there are deep reddish-brown clays. Soils with impeded drainage occur on some plateaux and in valley bottoms.

Land use

Much of the land comprises Forest Reserve and has little or no population; outside the forest reserves, population density varies widely from 30 persons/km² in Narok to about 250 persons/km² on the footslopes of Mount Elgon. The presence of forest reserves prevents expansion in areas of high population density and threatens the livelihoods of those without sufficient land for subsistence.

Some of the higher hills have valuable stands of timber; about 100 000 ha of coniferous plantations supply sawmills and a pulpmill. Along the western borders of these reserves, there is some tea cultivation and pressure to open up more of the forest. In other areas where it is too dry or cold for tea, cultivation generally comprises potatoes, pyrethrum and cabbage, with maize only at the lowest altitudes. Above about 2700 m, wool sheep thrive where there is grassland; below this, dairying is undertaken.

Potential

Ideally, much of this sub-zone should be retained in, or planted to, forest. Where there are large farms and not too high a rainfall, wheat and sheep comprise the best combination of enterprises. On small farms, intensive vegetable production could prove rewarding though frost-pockets need to be avoided. Where slopes have been cleared and cultivated, soil conservation is crucial. In the wetter areas on gentle slopes, pyrethrum can be strip-cultivated on the contour, alternating with potatoes which are becoming increasingly important in this zone, while dairying will be profitable wherever proximity to a town or all-weather road permits.

Upland Plateaux

Physical environment

This high country comprises the Uasin Gishu and Trans-Nzoia Plateaux, together with the highest part of the Rift Valley west of Nakuru. The influence of Lake Victoria is less than in the other sub-zones, resulting in two separate rainy seasons, March–May and July–September, a less humid atmosphere and a distinct three-month dry season. Elevation ranges between 1800 m and 2300 m, while average annual rainfall varies from 160 mm to 1200 mm.

Much of the terrain is underlain by rather infertile red clays often with gravel sheets; in the bottomlands, soils are imperfectly drained and also of low fertility. In the Rift Valley, however, deep, highly fertile brown loams and clay loams occur on volcanic materials.

Land use

Traditionally an area of large farms—the 'White Highlands'—a number of these are still maintained. Although increasing rapidly, the population density is still relatively low at about 200 persons/km². A growing population may in the future lead to the break-up of large farms as the rural poor demand land for subsistence. Ethnic tensions may prevent an expansion of smallholder farming.

Cereal cropping predominates; the actual crop chosen is determined rather precisely by altitude. Because of low temperatures the highest altitudes are used for wheat and pyrethrum. At somewhat lower elevations (down to 1900 m), it tends to be too dry for pyrethrum; this is the principal area in Kenya for wheat, sometimes associated with dairying. Where it is warmer, especially in the Rift Valley below 2100 m, beef ranching represents the main economic activity accompanied by large-scale maize production. On the plateaux below 1950 m and especially in Trans-Nzoia, the climate is ideal for late-maturing hybrids of maize and sunflower.

Potential

Continuing subdivision of the remaining large farms is expected to lead to more pyrethrum, maize and livestock, less wheat and barley. Unless increased production can be achieved, the current saleable cereal

surplus will be endangered. Good husbandry, crop protection and the selection of disease-free varieties remain at the forefront of efforts to raise yields. In this, the local research services should focus on maize and wheat improvement in relation to environmental adaptability and disease resistance, while the Agricultural Development Corporation has a key role in maintaining grade cattle and in bulking quality seed. Careful crop selection is important both in relation to environment and size of farm. Support will continue to be required by the various agricultural machinery services based on Nakuru and the timely availability of fuel and inputs for the big commercial farmers.

CENTRAL HIGHLANDS ZONE

Physical environment

The distinguishing features of this zone (zone 2 on Map 1) are its elevation (above 1500 m) and bimodal rainfall. Depending on altitude and aspect, mean annual rainfall varies between 600 mm and 2500 mm; being split into two rains (March–May and October–December), each is unreliable and separated from the next by a dry season which can extend for 3–4 months. On the southern and eastern slopes of the mountains, however, rains tend to be prolonged, more reliable in occurrence and rendered more effective by persistent low cloud.

The principal volcanic ranges east of the Rift comprise Nyandarua (the Aberdares) and Mount Kenya, both of which rise to over 4000 m, while the granitic hills of Machakos and Kitui to the east ascend to 2100 m. Surrounding these mountains are plains at elevations of between 1250 m and 2500 m. The most important soils are the deep, dark red, friable clays known as 'Kikuyu red loam' on the southern and eastern footslopes of Mounts Kenya and Nyandarua. These permit arable cropping even on steep slopes due to their stable structure and high porosity. In contrast, soils on the granites are shallower and, though coarse-textured, are less porous; intensified cultivation or overgrazing tends to promote erosion. The soils of the plains are variable, often comprising impermeable black clay; the broad high-altitude plain south of Nyandarua is distinguished by poorly drained soils with clay pan.

Land use

Apart from Nairobi with 1.52 million population, 6 million people live in this zone. Although, overall, the population density averages 260 persons/km² (335 persons/km² excluding Forest Reserves and National Parks), the corridor from Kiambu to the Nyambeni Hills is more densely populated. In Kiambu District, an average density of about 400 persons/km² disguises locations with serious population pressure, e.g. Kinoo with 0.25 ha per household, equivalent to only 0.05 ha per person, with farm units too small to support a family. Some supplement their farm incomes by seeking outside employment, especially in nearby Nairobi. Further expansion of the population may lead to landlessness, declines in food security, increasing land conflicts, and ultimately migration to Nairobi and the arid and semi-arid land (ASAL) regions.

South and east of the mountains, the small-farming pattern comprises intensive mixed cropping of maize, beans, potatoes and vegetables with climatically adapted cash crops, particularly tea and coffee. Intensive dairying is important, with 80% of the cattle comprising improved breeds, mostly zero-grazed—such is the land pressure.

Murang'a District provides an example of cropping descending the eastern slopes of Nyandarua. Above 2200 m, the land is so wet, cold and steep that it is best left in forest. Below this is the principal area for tea production, vegetables and dairying which, in turn, is separated from the main coffee belt by mixed coffee and tea. Lower down, the soils are suitable for coffee but the rainfall is marginal; here coffee is produced with supplementary overhead irrigation. This merges into a maize-sunflower zone also producing pineapples. Smallholder coffee and tea cover, respectively, 63 000 ha and 29 000 ha, whereas estate coffee now only totals 22 000 ha.

Potential

Despite the intensive farming, food crop yields are well below potential: there is scope for wider use of inputs and improved farming techniques although most of the farms are now well conserved. However, with input costs prohibitively high with regard to farm-gate prices and the increasing demands of 'cost-sharing' in health and education, input use is likely to decline in the short term with consequent effect on production though without reducing the potential for later increases.

Coffee production has been constrained first by the national coffee quota and more recently by low prices and late payments, but any recovery in price is likely to stimulate production as management standards rise again. Tea production can be increased providing that more all-weather roads are built to convey smallholders' leaf to the factories, and factory capacity is also increased. Proximity of this zone to major population centres and Nairobi airport provides major opportunities and incentives for intensive horticultural production.

Standards of livestock production have been adversely affected recently by changes in the veterinary and artificial insemination services; if these were rehabilitated and made more responsive to farmers' needs, livestock output could be increased.

Opportunities exist for small pumped (and even smaller gravity) irrigation schemes although this will interfere with basal flow on which many users depend downstream. In droughts, too, irrigation bans may be imposed due to the need to conserve flow into the Tana River hydro-electric dams.

COAST ZONE

Physical environment

The coast (zone 3 on Map 1) combines high temperatures with high humidity. Though subject to the coastal monsoon, seasonal rainfall can vary greatly. Extending inland some 30 km there is a single rainy season, from August to April. Along the coast, rainfall generally declines from south to north, from 1400 mm a year at Gazi to under 600 mm a year near the Somalia border. Inland, rainfall decreases rapidly and the Arid Zone is reached within 75 km.

Apart from the Shimba Hills, much of the coast lies below 250 m. The soils are complex but share in common a lack of fertility; they range from beach sands to poorly drained clays. The flood plains of the Tana and Galana (Athi) rivers are fertile however, but subject to flooding and localised salinity. East of the Tana the clay soils are prone to waterlogging.

Land use

The rural population of the coast is about one million. Overall, the population is around 40 persons/km² with over 300 persons/km² in some locations. There are few signs of serious population pressure. Mombasa, Kenya's main seaport, has a population of nearly 500 000.

Farms on the coast average 6–8 ha, with low-intensity cropping dominated by maize. Cassava and sweet potatoes are important food crops. Nearly 50% of the arable land is under tree crops—mostly cashew, coconuts and mangoes. Most of the coconuts are near the south coast where the rainfall is greater, whereas the drier Kilifi coast north of Mombasa is better suited to cashew. High night temperatures constrain maize yields, detract from pineapple quality and inhibit citrus colouring when ripe.

Despite unsuitable soils, a sugar factory on the south coast used to receive cane from an estate of 4500 ha and 800 ha of outgrowers and this could possibly be revived. Otherwise the main arable cash crop is cotton, important to Kilifi, Tana River and Lamu Districts, though yields and quality are poor. In Kwale District, where the rainfall is high, the dye crop anatto is important. Rice is produced locally wherever surface water levels can be controlled. Largely owing to trypanosomiasis, few livestock are kept, numbers averaging one livestock unit per 13 ha. Grazing is extensive and mainly on communal land.

Remnants of coastal forest occur in localised pockets where protection has been effected, e.g. on the upper Shimba Hills south of Kwale and in Boni National Reserve adjoining the Somalia border. Of an estimated 45 000 ha of mangrove, about one third is merchantable timber.

Potential

Although this zone is not densely settled, potential for expansion is limited by soil fertility and rainfall variability, while expansion of livestock is checked by the tsetse in the interior. There is some scope for increasing the area under cultivation but the main opportunities for increasing production lie with intensified management and inputs. In this latter respect, there is need for more cropping and farming systems research (to include intercropping and mixed cropping) to give the extension service more effective messages.

Unquestionably there is potential for tree and root crops, as well as for tropical forages under tree crops in support of dairying. Milk production is feasible given high standards of husbandry; some of the demand is met with imported powdered milk. The buoyant tourist industry provides a ready market for fruits and vegetables, as well as for beef, pork, milk and poultry. Sorghum might prove a more successful cereal than maize if the people were prepared to grow it; there may nevertheless be scope for producing sorghum concentrates for stall-feeding pigs and poultry. On the sandier soils there are opportunities for expanding cashew and, on well drained but more fertile soils some 15–20 km inland, quality pineapples can be produced. On the flood plains of the lower Tana and Galana, small-scale irrigation of rice, sorghum and sesame could be expanded, though constrained by problems related to high water-tables, salinity and poor access. Of the total irrigation potential at the coast of some 25 000 ha, only a small proportion has yet been exploited.

SEMI-ARID UPLANDS ZONE

This zone (zone 4 on Map 1) comprises the country around the northern, southern and eastern margins of the Central Highlands, at elevations exceeding 750 m but featuring erratic rainfall often interspersed with severe dry seasons. Although subsistence cropping is risky, with total crop failure anticipated at least one year in five and partial failure every second year, because of overpopulation in the higher potential zones, these lands are rapidly becoming settled. Despite the low overall population density (25 persons/km²), given the poor resource base and the prevailing technology, the environment is already under pressure with localised soil erosion becoming more prevalent. High priority is given therefore to devising new technologies appropriate to these marginal areas; these will only emerge as a result of sustained long-term research.

Models are being developed to predict human carrying capacity in these critical environments. Although subject to considerable simplification, they do give some indications as to maximum population density. Based on a long-term carrying capacity defined by the lowest annual rainfall received over an average 10-year period and assuming that only half the land is actually cultivable, it appears that for areas with average rainfall of 750 mm the maximum human population may be some 35 persons/km². Below 380 mm, the population is forced to depend totally on livestock production which is less sensitive to rainfall but permits only a low human population of about 2 persons/km², a level which is already generally exceeded.

Northern

Physical environment

This sub-zone comprises the high-altitude (1600–2000 m) Laikipia Plains north west of Mount Kenya, together with the northern Rift Valley falling away to 1000 m north of Nakuru. The soils are derived from volcanic rocks and ash. On the plains they are mainly fertile clays; on the Rift Valley walls they are shallow and stony, and on the Rift Valley floor clay sediments are variably affected by salinity. The climate on the Laikipia Plains is cool and dry, with rainfall of 400–800 mm in indeterminate seasons,

each inadequate for cropping. The Rift is hotter with a similar total rainfall in one season, or in two short seasons.

Land use

The country is sparsely populated with about 20 persons/km². The creation of ranches has restricted the migration of pastoral groups and there is increasing evidence that absentee herd-owning is further threatening the livelihoods of these people leading to localised overgrazing, erosion and declining incomes. Increasing demands for land registration by larger herd-owners threaten the livelihood of poor pastoralists, possibly leading to declining food security and greater dependence upon drought relief and inappropriate cultivation techniques.

Agriculture is based on beef ranching and pastoralism. Local pressure of human population is carrying subsistence cropping well into the zone. Despite some expanses of open grassland, bushland and woodland predominate. The ranches of Laikipia are well developed with water and internal fencing, running improved zebu or cross-bred beef animals supplemented by immature stock bought in from northern Kenya. Elsewhere, extensive pastoralism is the main activity. In Laikipia there is a density of one stock unit per 4 ha; in the Rift Valley one stock unit per 8 ha. The land is hilly and the soils highly erodible with consequent risk of progressive sheet and gully erosion, both of which can be severe. Bush encroachment is prominent on slopes. Near Lake Baringo, a 415-ha irrigation scheme produces onions, while some 500 ha of traditional irrigation are centred on perennial streams and springs.

Potential

There is little potential for arable agriculture other than early maturing millets, sorghums and cowpeas, and green grams and pigeon peas. Little potential exists for irrigation from the Ewaso Ngiro River because of excessive and unregulated offtake in the upper reaches—and the areas of suitable soils and topography are limited. Each of the rains is often inadequate for crops although, in aggregate, more than adequate for cereal production, there is therefore considerable scope for water harvesting and moisture conservation. Under these dry, high-elevation conditions the best cereals are barley and teff especially if grown on a minimal tillage regime; in the event of drought either could be fed to stock. Otherwise, the main potential lies in large-scale beef and game ranching.

Southern

Physical environment

This sub-zone comprises high-altitude plains east and west of the Rift Valley, at 1600–2000 m, together with the dry floor of the Rift from 1900 m at Naivasha to 1000 m on the Tanzanian border. The soils of the plains are mostly clays, poorly drained with a characteristic open grassland. The Rift walls are steep with shallow, stony soils; below the soils range from loose, erodible sandy ash around extinct volcanoes to alkaline loams and clays in the valley bottoms.

The climate is cool and dry on the plains. Annual rainfall is 500–700 mm, rising to 1000 mm to the west of the Loita Plains and in the Loita Hills, though the benefit of this higher rainfall is offset by low night temperatures. The Rift Valley floor is warmer and dry, rainfall decreasing southwards from 600 mm around Naivasha to 400 mm on the Tanzanian border.

Land use

There is a population of some 250 000 at a low density of about 10 persons/km². Land adjudication has seriously threatened the livelihood of those living beyond group ranch boundaries and has led to subdivision of holdings into uneconomic units. Conflicts continue between the Maasai and migrating cultivators which further threaten the survival of pastoralism. If these trends continue poorer households are likely to become increasingly vulnerable and dependent upon wage labour and drought relief.

This is the homeland of the pastoral Maasai. Owing to the serious soil and climatic constraints, the greater part has to be regarded as essentially cattle country. Overall livestock density is estimated at one unit per 3.5 ha. The Maasai are not entirely nomadic, many having settled down to cultivate maize and vegetables near Kajiado and extensive wheat near Narok based on machinery co-operatives. Other cultivators have also moved into western Narok and into the Rift Valley south of Naivasha where they grow maize and, now, large areas of malting barley.

Kaputiei (in Kajiado District), where Maasai territorial rights are based on social groupings, was selected for introduction of ranching co-operatives with land title, known as 'Group Ranches'. At Kaputiei, each Group averaged about 15 000 ha and 50 families; the largest Group Ranch covers 135 000 ha.

The Loita Hills are protected as Forest Reserve; here the soils are shallow and unsuitable for cultivation. Parts of the plains are set aside as National Parks, principally the Maasai Mara (1600 km²). Numerous farms with overhead irrigation around Lake Naivasha produce horticultural crops and, farther south below the Nguruman Escarpment, traditional food crops are grown on surface irrigation.

Potential

Other than for ranching or pastoralism potential is seriously constrained by variable and often low rainfall, poor soils, widespread gully erosion and low night temperatures. There are moreover large areas with inadequate surface water supplies, while groundwater is either non-existent or seriously saline. The Naivasha-Suswa pipeline (extending 75 km south from Lake Naivasha), constructed at considerable expense to relieve water shortages in the Rift Valley, was ironically washed out by torrential floods. On the better more stable soils in upper Narok, there is scope for early maturing wheat, and for cold-tolerant sorghum at somewhat lower elevations. In general, there is rather better potential for cropping in Narok than in Kajiado District.

Eastern

Physical environment

This sub-zone comprises dissected plains and hills east of Mount Kenya, the Nyambeni Range and the Machakos Highlands, varying in altitude from 600 m to 1500 m, and traversed by the two main rivers of eastern Kenya—the Athi and the Tana. The soils are medium and sandy textured, generally deep but of low fertility and locally shallow as on the Kitui and Taita Hills. Annual rainfall is 500–900 mm, falling erratically in two equal seasons, March–May and November–December. Storms can be intense causing severe erosion. May to October is almost always dry.

Land use

The population is estimated at 1.7 million. Population density varies according to soils, water availability and historical patterns of settlement, from about 25 persons/km² in Kitui District, 50 persons/km² in lower Meru, 60 persons/km² in lower Embu, to 100 persons/km² in the Taita Hills. Further population growth will lead to subdivision of holdings, cultivation of land marginal for crops and increase the likelihood of crop failure. Declines in food security and increasing poverty and landlessness are the inevitable result without the growth of alternative employment opportunities.

In the past quarter century these lands experienced a major influx of population, such that extensive areas of bushland have been transformed into cultivation. In lower Embu/Meru between 1948 and 1982, land in the cultivation cycle increased from 12% of the area to 41%, i.e. by 3.5 times. Patterns of shifting cultivation with long resting periods are rapidly breaking down under pressure both from increasing population and from land adjudication. Average holding sizes vary from 2–4 ha in Embu/Meru to 3–10 ha in Machakos. Maize is the dominant cereal despite a high risk of failure; other common (and more appropriate) food crops include sorghum, millet, cowpeas, pigeon peas and green grams. About half the maize hectareage is intercropped with legumes. Cotton and tobacco are locally important cash crops. In lower Machakos (near Kibwezi) there is a 3200-ha sisal estate.

In the Kitui Hills, maize and beans are planted extensively—usually intercropped with pigeon pea—but the maize often fails; sorghum, millet and cotton are also grown. In contrast, on the Taita Hills, farms are small and intensive. Dominant food crops are maize and beans, with vegetables sold to coast markets. There are about 450 ha of coffee, but the area is marginal and yields are low.

The livestock population is about one unit per 10 ha, the numbers of sheep and goats being about the same as the cattle. Although there are few improved stock, many farmers own draught animals. Cattle are mostly grazed on communal land; overgrazing is severe locally. When, as all too often, crops fail, the population subsist by selling their small-stock, principally goats. Charcoal making and honey production are other significant sources of income. Despite the use locally of trash lines and stone bunds and the increasing construction of bench terraces, land degradation is well advanced, with general incidence of gullying and surface compaction; this leads to high runoff which, combined with low rainfall, implies little available moisture for vegetation.

The sub-zone includes the largest and most successful irrigation scheme in Kenya—at Mwea-Tebere where much of the country's rice is produced on black clays (3200 ha (FAO, 1991a)). There are several small-scale private pump irrigation developments along tributaries of the Athi, mostly for the commercial production of vegetables.

Potential

Because of the shortage of soil moisture, there are few suitable crops and these are limited to quick-maturing varieties of sorghum, millet, grams, cowpeas and pigeon peas with opportunist plantings of the two quick maturing maize varieties specially developed for the area: Makueni and Katumani composites. On black clays, chickpeas, sunflower, cotton and coriander usually succeed.

Adaptive research done by the Embu-Meru-Isiolo (EMI) Programme has pioneered new technology for these semi-arid areas. Early results indicated opportunities for greatly increasing yields by the use of animal manure, early planting and 1:1 water harvesting using narrow contoured catchment strips. There is also potential for small-scale irrigation in Meru where perennial streams flow off Mount Kenya although basal flow needs to be protected and the terrain makes gravity-fed schemes difficult to site. In general, priority needs to be given to technical support for smallholders, with emphasis on soil/water conservation, animal draught, storage of food crops, and improved husbandry. Small-stock, especially goats, play a key role and here the emphasis needs to be on nutrition and disease and parasite control.

The potential of the Taita Hills lies in raising existing yields along lines set out for the Central Highlands Zone (above). Here there is scope for providing supplementary irrigation by constructing small dams across ravines. Although there are opportunities for only localised irrigation from the upper Tana, feasibility studies completed on the Athi indicate potential for river regulation with a view to irrigating up to 13 000 ha below Kibwezi.

ARID LOWLANDS ZONE

Physical environment

The arid lowlands (zone 5 on Map 1) cover the whole of northern and eastern Kenya other than the coast and, in the south, extend as far west as the Rift Valley; they comprise approximately 70% of the total area. Annual rainfall is under 500 mm, falling to below 200 mm around Lake Turkana, generally bimodal with peaks in November and April; rainfall seldom, if ever, exceeds evaporation. Hot desiccating winds are a feature of the climate. Roughly 30% of the zone can be classified as semi-desert with average annual rainfall below 300 mm and evaporation regularly exceeding 3000 mm. The zone is characterised by cyclic variations in rainfall. The effect of these cycles on grassland composition and productivity can be very significant; periods of better rainfall give one effective growing season every nine months whereas drier cycles provide a growing season only once every 20 months, with serious consequences for the survival of perennial grasses.

Soils are mostly sandy, often sandy loams. Also clay plains occur and quite extensive areas have been overlaid by volcanic deposits. Plain landscapes predominate, but in western areas the relief is undulating or hilly and soils are often shallow. In the semi-desert areas, extensive lava fields occur with well-developed lava stone mantles. It is a characteristic of this zone, with its sparse ground cover, that most sites are either water-shedding or water-receiving; the vegetation production potentials of the two are vastly different.

Five significant rivers enter the zone: the Athi, Tana and Ewaso Ngiro in the east, and the Kerio and Turkwell flowing occasionally into Lake Turkana. The floodplains of the Tana, Ewaso Ngiro and Turkwell, though nowhere very wide, have some irrigable soils. Alkaline deposits flanking the flood plains present serious problems for irrigation. Groundwater resources are generally localised and often intensely saline; local tribesmen obtain water supplies in the long dry seasons by digging in the beds of sand rivers.

Land use

The total population in this zone is uncertain and, in any case, fluctuates as nomads move freely across the Uganda, Ethiopian and Somali borders. It is probably around 1.1 million, with an average density of about 3 persons/km². The population of this zone are most susceptible to the effects of drought. The Turkana have suffered more than any other pastoral group in Kenya over the past two decades. Attempts to introduce irrigated agriculture have not succeeded and have arguably reduced the circumstances of those intended to benefit and may have increased dependence. Poorer households are most at risk from the effects of drought and many find it impossible to restock after dry periods.

The zone has special importance for livestock production by pastoral tribes. Population and grazing pressures vary but, compared with the semi-arid zones, only small areas are unoccupied. However, significant land has been taken for wildlife, e.g. Tsavo National Park (20 000 km²). In the less arid areas, the characteristic vegetation is dry thorn-bushland with some woodland and grassland. In the semi-desert there is usually annual grassland, with or without dwarf shrubs; shedding surfaces are often completely barren. The pattern of pastoralism is free-ranging, since water is sparse and the grasses cannot withstand heavy grazing. Movements of people and livestock occur between wet- and dry-season grazing areas. Patterns of grazing are invariably complex and need to be understood thoroughly before any attempt is made to introduce innovation. Misuse results in rapid degradation of the habitat which can be difficult to rectify.

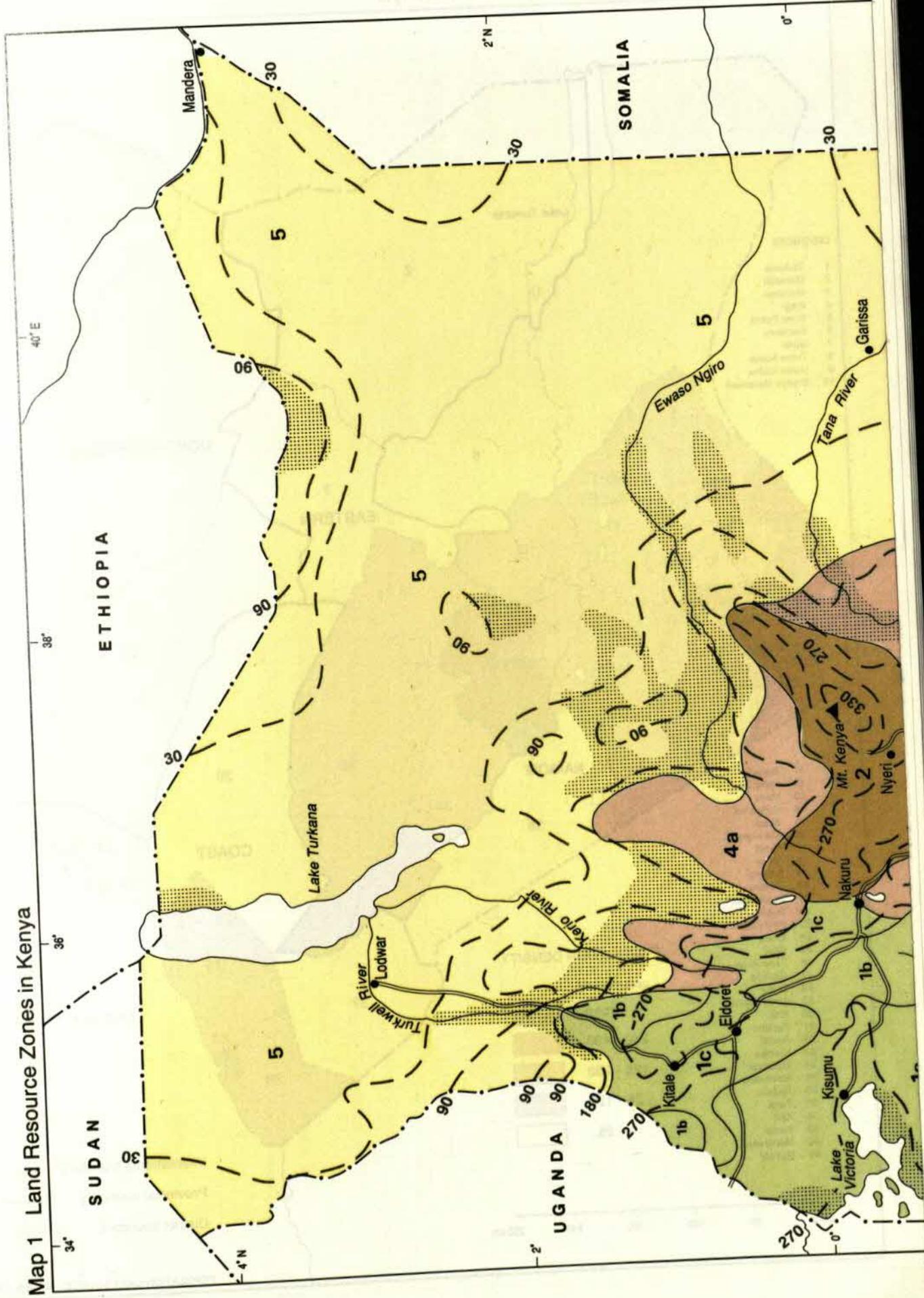
Overall, livestock average about 15 ha per livestock unit though, because of stock movements, this figure is almost meaningless. The worst drought-affected district is Turkana with 4 persons/km² and only one head of large stock and five of small-stock per person: hence their reliance on sorghum grown on floods and on periodic famine relief. In northern Kenya, camels supplement or replace cattle as the source of milk and some ethnic groups also take milk from small-stock. Goats fulfil an important role and may be the only domestic species capable of using lava bushlands. Annual offtake of immature cattle from northern Kenya averages about 15 000 animals.

There are few ranches in the arid lowlands zone. Perhaps the most significant is Kulalu Ranch (97 000 ha) adjoining Tsavo Park, where the Agricultural Development Corporation (with financial assistance from the Commonwealth Development Corporation) runs Boran crosses. Irrigation is confined to two schemes (Bura and Hola) totalling, when fully developed, 13 000 ha on the lower Tana, producing mainly cotton. These schemes face soil, management and socio-economic problems, and are not economically viable at present. Similar problems have caused the abandonment of a number of small schemes on the Ewaso Ngiro in Isiolo District.

Potential

For the foreseeable future this zone will remain livestock rearing country. A contribution to national economic development can be made by increasing the offtake from subsistence herds: in the moister areas, through combined breeding and fattening of zebu cattle; in the drier, through encouraging the sale of small-stock for slaughter and of immature cattle for finishing in areas of higher potential.

Map 1 Land Resource Zones in Kenya



Map 2 Population and Administration in Kenya

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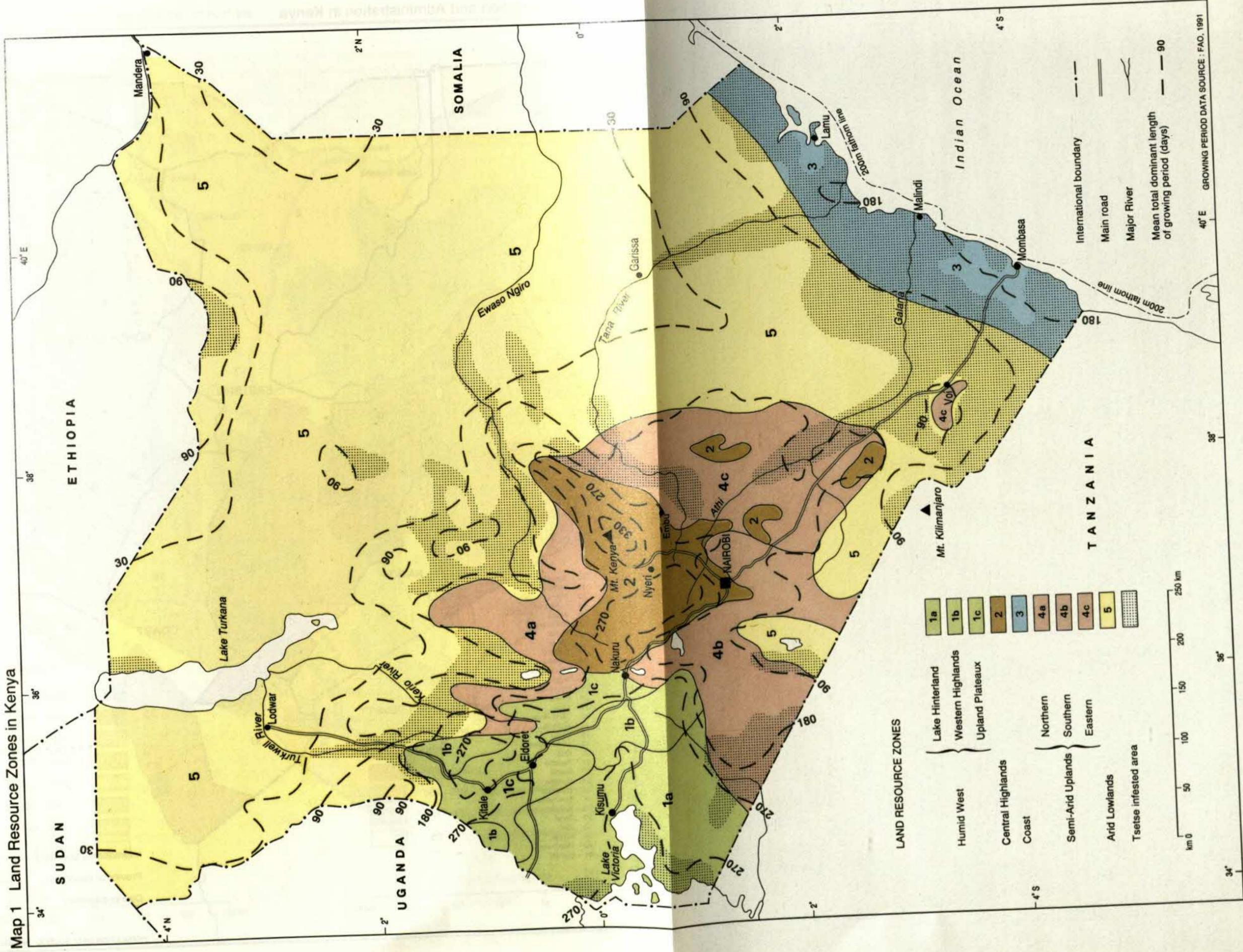
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Map 1 Land Resource Zones in Kenya



LAND RESOURCE ZONES

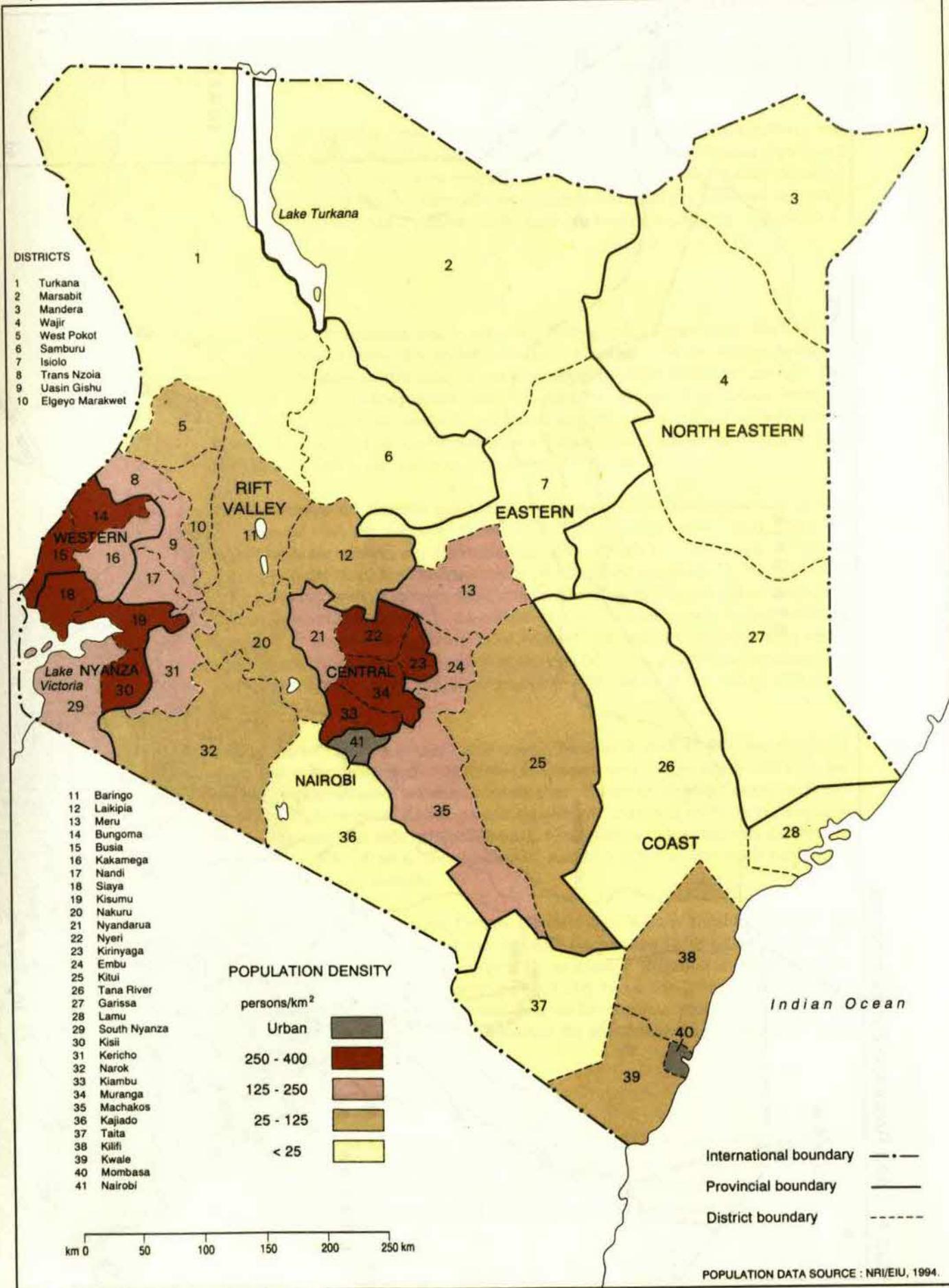
- 1a
 - 1b
 - 1c
 - 2
 - 3
 - 4a
 - 4b
 - 4c
 - 5
- Humid West
- Lake Hinterland
 - Western Highlands
 - Upland Plateaux
- Central Highlands
- Northern
 - Southern
 - Eastern
- Coast
- Semi-Arid Uplands
 - Arid Lowlands
- Tsetse infested area

km 0 50 100 150 200 250

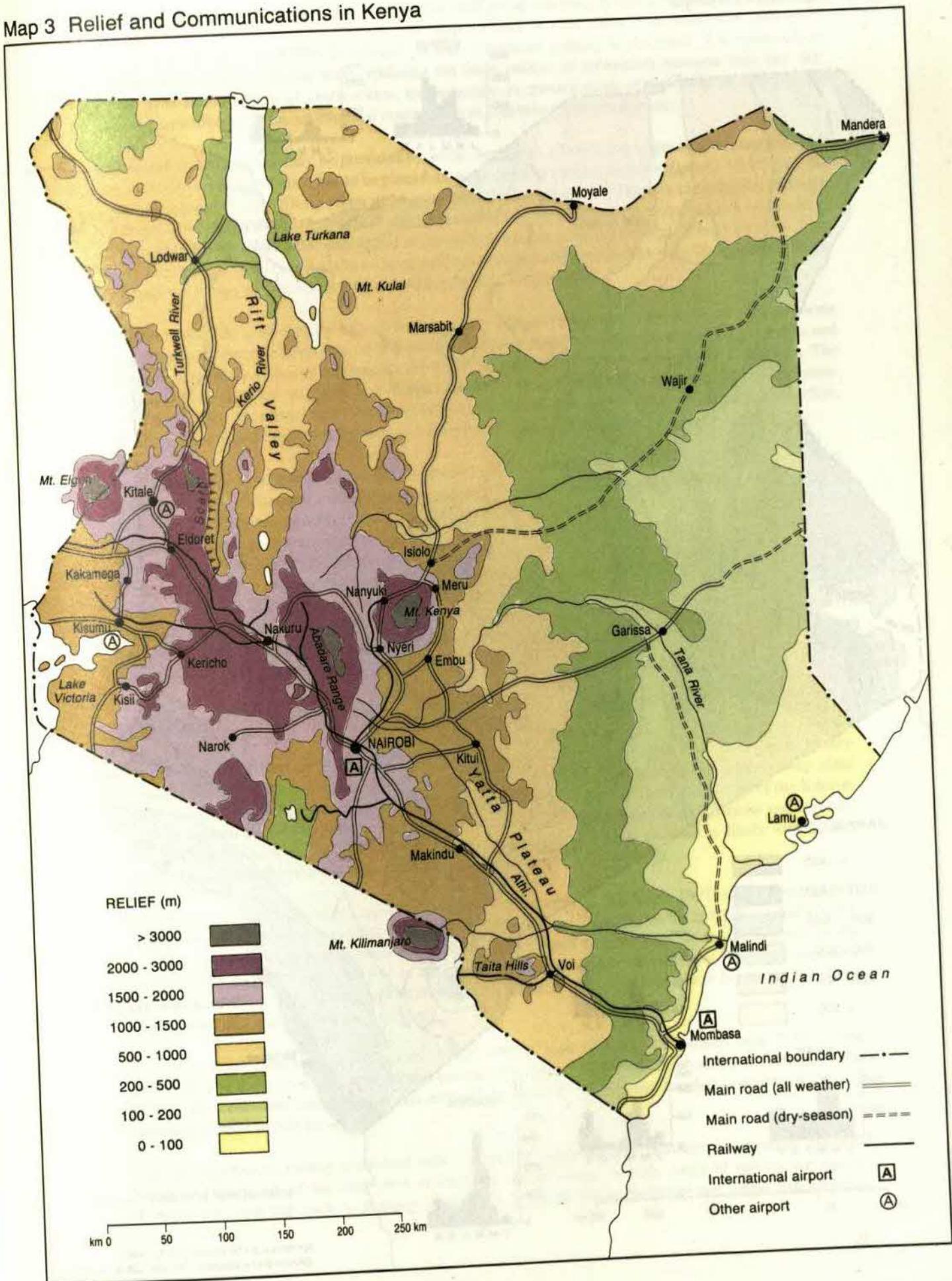
- International boundary
- Main road
- Major River
- Mean total dominant length of growing period (days)

40° E GROWING PERIOD DATA SOURCE : FAO, 1991

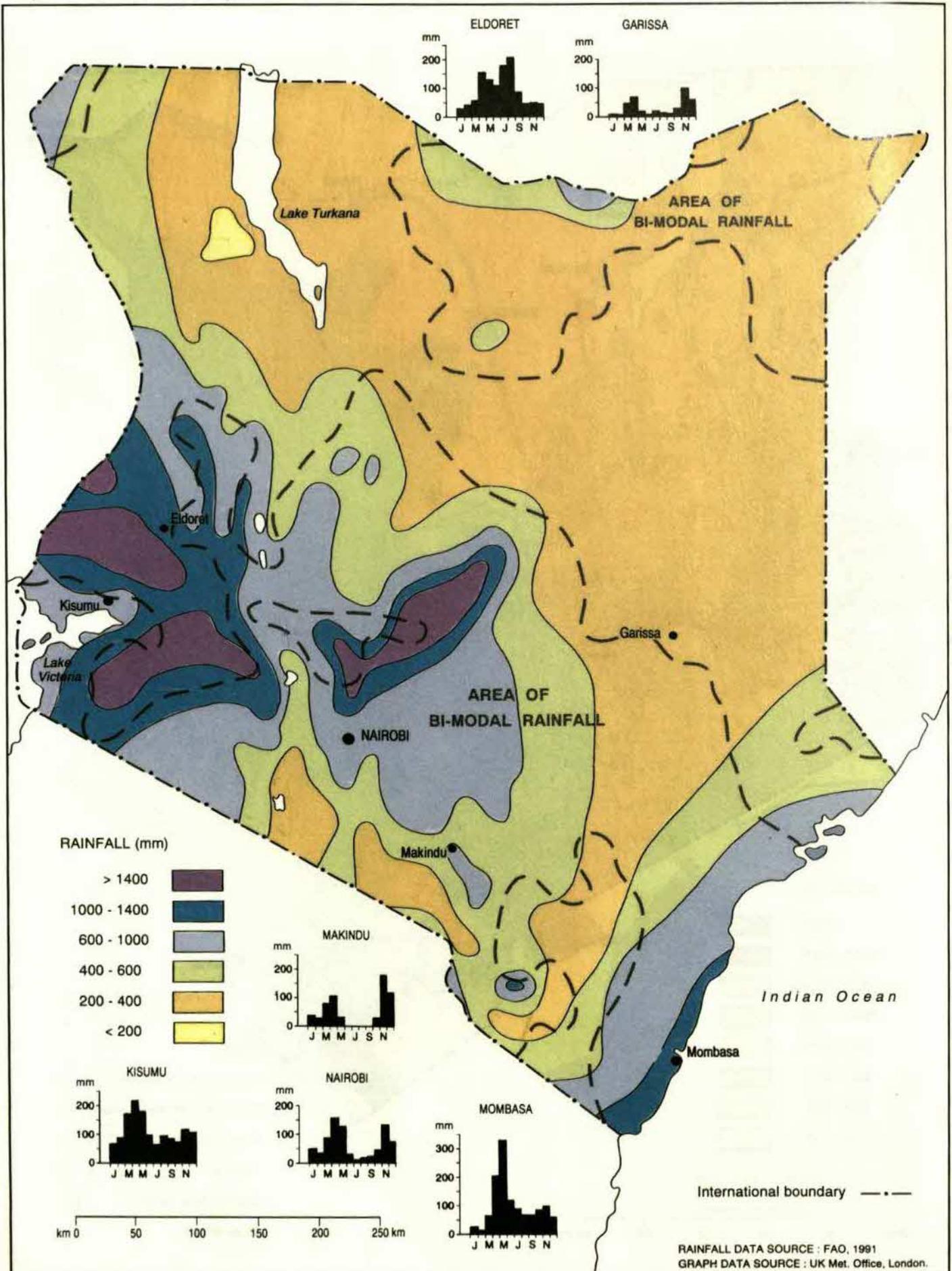
Map 2 Population and Administration in Kenya



Map 3 Relief and Communications in Kenya



Map 4 Rainfall in Kenya



In parts of Maasai, Kamba and Taita, commercial and group ranching is likely to continue despite the negative socio-economic consequences for the dispossessed; in drier areas, over-restrictive systems of grazing control have not generally worked. Where communal grazing is practised, it is necessary to provide large, flexible grazing units, retaining the basic pattern of movement between wet- and dry-season grazing. Provision of stock routes, infrastructure to remove stock at the onset of drought and disease quarantine facilities are essential components of a development programme.

Permanent water supplies may be provided by wells, boreholes or sand weirs, but where groundwater is non-existent or saline, reliance has to be placed on earth dams or surface excavated ponds which have the added advantage of only filling when good rains fall—and grass grows. There is considerable potential for water harvesting from surface runoff and water-spreading from ephemeral streams; such water can be used to produce sorghum grain and useful residues or to sustain grass production. Where livestock have died from drought, various efforts have been made to restock destitute families with flocks each of about 75 small-stock; this has been achieved in both Isiolo and Turkana.

Irrigation potential is limited by lack of surface water. Irrigation is moreover associated with problems caused by the inevitable incursion of livestock, inadequate management, remoteness from markets and high capital overheads; heavy sediment loads in all rivers are also likely to cause major difficulties. The Kerio and Turkwell flow so rarely as to restrict irrigation at present to lifting from shallow groundwater in the floodplain. However, now that the Turkwell has been dammed for hydro-electricity production, opportunities will arise for some irrigation on the lower reaches of this river.

The Ewaso Ngiro is so erratic a river that, coupled with the problems listed above and rapidly increasing and uncontrolled abstraction from its upper reaches, it is unlikely that irrigation will succeed. The Tana offers a major water resource (sufficient for triple cropping on 100 000 ha) but is associated with difficult soils; localised development on up to 50 000 ha could go ahead, but experience at Bura and Hola is not encouraging—there have been severe problems due to the river changing its course and with the pumps. Funds have not been available to convert the scheme to a gravity-fed operation because it would need a 40-km canal. The economics of cotton production (its main crop) have also changed to make the operation uneconomic. Better opportunities lie with irrigation from the Athi although most of this potential is likely to be taken up within the eastern semi-arid sub-zone. The water available is likely to limit irrigation to 20 000–40 000 ha throughout the course of the river.

FISHERIES

The sector is dominated by the Nile perch fishery of Lake Victoria. Kenya was the first riparian country to realise the full potential of the fishery and rapidly went ahead with investment in processing plant aimed at export markets. Perhaps as a result of this entrepreneurial stance, the perch stocks of the Kenyan sector have been the first to decline, and Kenya is now a major buyer of fish from Tanzania and Uganda. With the development of the industries in these countries this source of material is likely to decrease, leaving Kenya to reappraise the opportunities offered in fisheries development.

In 1989 the estimated annual per capita consumption of fish was 5.7 kg (FAO, 1991b), and about 31 500 people were directly involved in full-time fishing. The contribution of the sector to GNP is small (0.35% in 1989), but this is misleading since the fisheries contribution to GNP grew at an average rate of 8% between 1985 and 1989 making it one of the fastest-growing sectors in the economy. The most important component of the fishery in economic terms is Lake Victoria where the Nile perch boom has led to the development of a significant export industry.

In 1989 official estimates of production (FAO, 1991b) were 146 403 t of which only 7610 t were contributed by the marine subsector; of this marine production, 5669 t were from artisanal fishermen. The bulk of the freshwater catch is also from artisanal catches. In 1989 shrimp trawlers contributed 335 t of shrimp and 561 t of fish by-catch.

The artisanal marine fishery is pursued with a variety of gears, notably cast-nets, beach seine, gill-nets, hooks and traps; 5% of the total catch is from the marine sector. A wide range of species are caught, divisible into reef fish such as snappers (lutjanids), groupers (Epinephelanae) and rabbit fish (*Siganus*

spp.), and pelagics including kingfish (*Scomberomorus commersoni*), tunas, billfish, jacks (Carangidae) and sardines.

The shrimp fishery relies mainly on *Penaeus indicus*, *P. monodon* and *Metapenaeus monoceros*. Around 300 t shrimp are caught from trawling. There is a sport fishing industry which focuses on billfish, tuna and wahoo (156 t caught in 1987/88). Foreign tuna fleets operate in deep waters off the coast of Kenya.

The freshwater fishery is most important to Kenya, and much of the production comes from Lake Victoria. The introduction of the Nile perch (*Lates niloticus*) into the lake has had a dramatic effect on fish production. In 1976 the perch contributed only 1% to Kenyan catches, in 1990 this had risen to 31%, and 60% of all open water catches from Kenyan Lake Victoria were Nile perch. Production of perch from the lake was 333 005 t in 1990 of which Kenya produced 71 514 t. Other important fish are the pelagic *Rastrineobola argentea* (46 738 t in 1990) and tilapia, *Oreochromis niloticus* (13 101 t in 1990). The main gears in freshwater fishing are the gill-net, hooks and the beach seine, although the latter is now supposed to be banned due to its adverse effect on the recruitment of juvenile perch.

After a dramatic increase from 1978, Kenyan Nile perch catches have declined, and there has been a rapid drop in the catch per unit effort in the Nyanza Gulf since the mid-1980s. However, there is some evidence of an increase in the catches of *Rastrineobola* and of the recovery of the haplochromine species which dominated Lake Victoria prior to the introduction of the Nile perch. Expert opinions on the future of the fishery vary markedly with some predicting disaster and some suggesting a gradual decline to a stable fishery.

There is little scope for increasing production from the inshore reef fisheries and the same appears true of the shallow-water shrimp resources. It is likely that the maximum sustainable yield is reached or exceeded for existing commercial species. There is some indication that the North Kenya Bank could support a modest line fishery, and that there is scope for increased demersal trawling off Malindi and Ungwana Bay.

Official estimates (1986) suggested that fish farm production was 980 t. FAO (1990) quotes lower figures of 210 t in 1987 comprising 5 t of carp, 121 t of tilapia, 80 t of trout and 4 t of shrimp. Although the 1991 estimate is up to 1178 t, the industry cannot be said to have taken off in Kenya.

NATIONAL SOCIAL AND ECONOMIC DATA

OVERALL ECONOMIC PERFORMANCE

	Kenya	Sub-Saharan Africa
GNP per capita (1992)	US\$ 310	US\$ 530
Growth in GNP (1980-92)	0.2%	-0.8%
Average annual inflation rate (1980-92)	9.3%	15.6%
Total external debt (1992)	US\$ 6367 million	n/a
Total external debt as % of exports (1992)	230.1%	282%
Debt service as % of exports (1992)	27.1%	20%

Source: World Bank (1994)

Kenya experienced rapid growth of agricultural production between 1964 and 1988, food crop production grew at 4.6% per year and cash crop production at 5.5% (Bevan *et al.*, 1993). Growth in the 1960s was mostly in coffee, in the 1970s it was in tea and improved livestock (dairy cattle) and in the 1990s in tea and horticulture. Kenya already supplies 75 products to more than a dozen markets (Jaffee, 1992) and horticultural products overtook coffee as a foreign exchange earner in 1992, although coffee became the major export commodity again in 1993. It should be noted that most of this growth has occurred in the higher-potential agricultural areas. The economy has been subject to occasional shocks and periods of recession in response to changes in international prices for coffee, tea and increasing oil prices. However, the overall performance has been regarded as a remarkable achievement by some commentators (Lofchie, 1989).

However, these achievements must be viewed in the light of a growing population and the effect this has had upon per capita incomes which have shown little or no growth in the 1980s and early 1990s. There is a lack of productive employment opportunities in rural areas in the face of rapid labour force growth and wage rates have fallen by a third during this period. Stagnating economic growth is the major cause of continued income poverty in Kenya.

CONTRIBUTION OF RNR SECTOR

	Kenya	Sub-Saharan Africa
GDP in agriculture (1992)	27%	35%
Labour force in agriculture (1990-92)	81%	67%
RNR commodities as % of exports (1992)	55%	34%

Source: World Bank (1994); UNDP (1994)

Agriculture

The agricultural economy is dominated by the smallholder farming sector, 45% of all maize and 50% of other food crops being produced on smallholdings along with 60% of coffee, 35% of tea and 45% of sugar cane. However, in 1988 smallholder farmers' share of arable and permanent crop land was only 21.9% of the total area (Jaziary *et al.*, 1992). Around 30% of smallholder maize reaches the market.

Average annual growth rate of GDP was 4.0% between 1980 and 1992 compared with 1.8% for sub-Saharan Africa. Agriculture (including forestry and fisheries) accounted for 27% of GDP in 1992, industry 19%, manufacturing 12% and services 54%. Agricultural production grew at an average annual rate of 2.9% between 1980 and 1992 compared with a growth rate of 4.8% during the 1970s. In 1970 it accounted for 33% of GDP. Eighty-one per cent of the labour force are in agriculture, compared with 86% in 1965.

Exports are dominated by primary commodities (coffee, tea and horticultural products) although their share of total exports has declined from 75% in 1970 to 55% in 1992 suggesting some diversification in the economy (manufactures have increased from 12% to 29% of exports during the same period). Kenya is now considered a diversified exporter (an economy in which no single export category accounts for more than 50% of exports) by the World Bank (1994). Tourism has overtaken coffee and tea as the major source of foreign exchange earnings during the past decade.

Annual agricultural GDP growth has averaged 2.9% between 1980 and 1992 and has therefore barely kept pace with annual population growth at over 3% per year (see below).

Cereal imports were 387 000 t in 1980 and 669 000 t in 1992. Kenya received US\$ 68.9 million of food aid in 1992. The food import dependency ratio is around the average for the region although food imports have increased in recent years as the growth in food production has not kept pace with population growth.

Forestry

	Standing stock ('000 m ³)	Sustainable yields ('000 m ³ /year)
National forests	137 400	2 025
Wood biomass on large farms	40 000	3 438
Wood biomass on small farms	66 600	6 536
Parks/reserves	82 200	475
Woodlots	10 000	2 000
Plantations	27 400	850
Savannah bush	635 500	8 475
Savannah grassland	122 000	1 487
Rangeland	50 400	1 412
Total	1 171 500	26 698

Source: UNDP/World Bank (1987)

Deforestation is considered in the section on Key Development Issues (page 37).

OFFICIAL DEVELOPMENT ASSISTANCE

1991	Kenya	Sub-Saharan Africa
Official development assistance (ODA) receipts	US\$ 873 million	US\$ 16 158 million
ODA per capita	US\$ 35.0	US\$ 32.9
ODA as % of GNP	10.9%	9.3%

Source: World Bank (1994)

Kenya is classified as a severely indebted country by the World Bank (1994). Severely indebted means that the present value of debt service to exports is greater than 220% (Kenya 230% in 1992).

Long-term debt increased from US\$ 2499 million in 1980 to US\$ 5214 million in 1992. Kenya received US\$ 873 million in official development assistance in 1991 (down from US\$ 1053 million in 1990) which was the equivalent of US\$ 35.0 per capita or 10.9% of GNP. These figures are similar to the regional averages.

POPULATION AND DEMOGRAPHY

	Kenya	Sub-Saharan Africa
Population (mid-1992)	25.7 million	543 million
Average annual population growth rate (1980-92)	3.6%	3.0%
Population density (1992)	38 persons/km ²	22 persons/km ²
Urbanisation (1992)	25%	29%
Total fertility rate (1992) ¹	6.5	6.1
Crude birth rate (1992) ²	37 per 1000	44 per 1000
Crude death rate (1992)	11 per 1000	15 per 1000
Life expectancy (1992)	59 years	52 years

Source: World Bank (1994); UNICEF (1994)

Note: ¹TFR is the number of children that would be born to a woman if she were to live to the end of her child-bearing years and bear children in accordance with prevailing fertility rates. ²UNICEF figure is 44 for Kenya with 45 for the region.

Kenya had a population of 25.7 million people in 1992 and this was expected to reach 31 million by the year 2000 and 47 million by 2025; the annual growth rate was 3.6% between 1980 and 1992 but is expected to fall to 2.5% between 1992 and 2000 (World Bank, 1994). Half the population was below the age of 15 years in 1992. The labour force totalled 11 million in the same year and grew at a rate of 3.5% between 1980 and 1992 (World Bank, 1994). The combination of rapid population growth in the face of a limited supply of good quality agricultural land poses one of the major constraints to Kenya's development. The proportion of the population inhabiting urban areas has increased from 10% in 1970 to 25% in 1992 (World Bank, 1994). Nairobi, the capital city is home to 1.52 million (1990) or 6% of the total population.

Population distribution by Province

1989	Population ('000)
Nairobi	1346
Coast	1850
North Eastern	372
Eastern	3724
Central	3110
Rift Valley	4894
Nyanza	3558
Western	2543

Source: EIU (1993); Kenya Population Census (1989)

Note: See also Map 2.

Ethnic composition of population

1989	Number ('000)	% of total
Kikuyu	4456	20.8
Luhaya	3083	14.4
Luo	2654	12.4
Kalenjin	2458	11.5
Kamba	2448	11.4
Kisii	1318	6.1
Meru	1088	5.1
Mijikenda	1007	4.7
Others	2932	13.7
Total	21 444	100.0

Source: EIU (1993); Kenya Population Census (1989)

HEALTH, NUTRITION AND EDUCATION

	Kenya	Sub-Saharan Africa
Under-5 mortality (1992)	74 per 1000 live births	181 per 1000 live births
Infant mortality (1992)	51 per 1000 live births	111 per 1000 live births
Average daily calorie supply as % of requirements	93%	92%
Food import dependency ratio (1980-92)	9.4%	10.2%
Prevalence of malnutrition (1980-92)		
0-4 years underweight	14% ¹	31%
1-2 years wasted	5% ¹	12%
2-5 years stunted	32% ¹	49%
Access to safe water (1989-90)	49%	40%
Access to health services (1987-89)	77%	48%
Adult literacy rate (1992) (UNDP estimate)	72%	51%
Primary enrolment ratio (gross) ²	95%	69%

Source: UNDP (1994); UNICEF (1994)

Note: ¹Data relate to different year or period, differ from standard heading or relate to only part of the country. ²Gross ratio indicates the number enrolled at primary school, whether or not they are in the relevant age group, expressed as a percentage of the population in the relevant age group for primary education.

Indicators for health and nutrition in Kenya display improving trends and compare favourably with figures for the rest of sub-Saharan Africa. Stunting in children aged 2-5 years remains high at 32% and suggests widespread long-term under-nutrition. It is estimated that per capita calorie supply matches only 93% of requirements in Kenya. Recent figures suggest that only 60% of children are fully immunised and 31% partially immunised.

Forty-nine per cent of the population had access to safe water in 1990 (rural 43%, urban 74%). Around 77% of the total population had access to health services between 1985 and 1992 but only 40% of the rural population. During 1986-92 5% of central government expenditure was allocated to health. Current emphasis is on primary health care with programmes in 25 districts, but the urban, hospital-oriented service continues to receive most of the resources. Access to safe water and health services is significantly higher than the regional averages which is reflected in declining mortality rates and increased life expectancy (see Population and Demography above).

There is growing concern that the spread of AIDS will have a disastrous effect upon the economy and the allocation of the health ministry (EIU, 1994). The seventh national development plan forecasts that the HIV-positive population will rise from 448 000 in 1990 to 1.27 million in 1996 and that AIDS-related deaths will increase from 20 000 to 86 000 in the same period. It is estimated that caring for AIDS patients in the year 2000 could be equivalent to the entire allocation to the health ministry in the 1993/94 budget.

Adult literacy rates were 59% for females and 80% for males in 1990. Some 95% of the age group eligible for primary education are enrolled including 93% of females. Although enrolment is high the poorest members of society are unable to enrol all of their children. Only 29% of those eligible for secondary education are enrolled (25% of females) and, although this compares favourably with the regional average of 18%, very few of the poorest are able to enrol. It was estimated by Bevan *et al.* (1993) that 5% of heads of households in rural areas had been educated to secondary level in 1982.

Only 2% of the eligible population are enrolled in tertiary education. Primary teacher/pupil ratios have improved from 34 pupils per teacher in 1970 to 31 pupils per teacher in 1991. Between 1986 and 1992 20% of central government expenditure was allocated to education.

The Kenyan Government has given primary and secondary education an unusually high priority by African standards and has encouraged the development of a parallel system of private secondary schools (*harambee* schools). If a locality was able to self-fund such a school there are reasonable prospects of subsequent government funding.

Gender

	Kenya	Sub-Saharan Africa
Female agricultural wage as % of male	14%	51%
Female literacy rate	61%	41%
As % of male	74%	68%
Female primary enrolment rate	92	60
As % of male	96%	80%
Maternal mortality rate	170 per 100 000 live births	610 per 100 000 live births
Women as % of rural poor	64%	63%
Female-headed households	965 000	18 788 000
As % of rural population	30%	32%

Source: UNICEF (1994)

Kenya has an impressive record for women's education and literacy, and to some extent for female health matters. Female literacy is higher than the region's average and maternal mortality rates are well below regional averages. It is unclear how much the dramatic differential in male and female agricultural wage rates affects the mass of the smallholder population, in other words whether large numbers of women are employed on these terms. On the other hand, within peasant households, women are thought to work up to 2 h a day more than men.

Thirty per cent of rural households are headed by women and the incidence of severe poverty is significantly higher for such households. With divorce or separation women lose access to land and other assets, and as a result of historical and social factors the position of women in relation to property has declined in recent years. Where women do have access to land, the World Bank reports they use extension services and adopt extension recommendations as much as male farmers. Women's share of total wage employment increased slightly from 17.5% in 1981 to 19.7% in 1985 and 21.2% in 1987.

Key ministries serving the RNR sector are:

- * Ministry of Agriculture, Livestock Development and Marketing
- * Ministry of Lands and Natural Resources
- * Ministry of Land Reclamation, Regional and Water Development
- * Ministry of Environment, Planning and Technology
- * Ministry of Research, Technical Training and Technology
- * Ministry of Planning and National Development
- * Ministry of Planning and National Development (Kenya Research Monitoring Unit)
- * Ministry of Planning and National Development

Research organizations

The main research organizations involved in RNR are:

- * Kenya Agricultural Research Institute (KARI)
- * Kenya Forestry Research Institute
- * Kenya Livestock Research Institute
- * Kenya Marine Fisheries Research Institute
- * International Centre for Research in Agriculture
- * International Crop Research Institute for Semi-Arid Tropics
- * International Livestock Research Institute
- * International Centre for Tropical Agriculture (CIAT)

Non-governmental organizations

Principal non-governmental organizations working in the RNR sector are:

- * ActionAid
- * CARE
- * ITDG
- * Oxfam (UK)
- * World Aid
- * Christian Aid
- * Kenya Institute of Organic Farming
- * Wildlife Foundation

Parastatals

The main parastatals operating in the RNR sector are:

- * National Council for Product Board
- * Agricultural Development Corporation
- * Agricultural Finance Corporation
- * Kenya Tea Development Authority
- * Kenya Tea Export Development Authority
- * Horticulture Development Authority

INSTITUTIONAL CONTEXT

MAIN INSTITUTIONS SERVING THE RNR SECTOR

Government ministries

Key ministries serving the RNR sector are:

- Ministry of Agriculture, Livestock Development and Marketing
- Ministry of Tourism and Wildlife (includes Department of Fisheries)
- Ministry of Land Reclamation, Regional and Water Development (incorporates the former Ministry of Reclamation and Development of Arid, Semi-arid and Wastelands—the 'ASAL Ministry')
- Ministry of Environment and Natural Resources
- Ministry of Research, Technical Training and Technology
- Ministry of Planning and National Development (includes Department of Resource Survey and Remote Sensing, formerly the Kenya Rangeland Monitoring Unit)
- Ministry of Planning and National Development

also the Permanent Presidential Commission for Soil Conservation and Afforestation.

Research organisations

The main research organisations involved in RNR are:

- Kenya Agricultural Research Institute (KARI)
- Kenya Forestry Research Institute
- Kenya Trypanosomiasis Research Institute
- Kenya Marine Fisheries Research Institute
- International Centre for Research in Agroforestry
- International Crop Research Institute for Semi-arid Tropics
- International Livestock Research Institute
- International Centre for Tropical Agriculture (CIAT)

Non-governmental organisations

Principal non-governmental organisations working in the RNR sector are:

- ActionAid
- CARE
- ITDG
- Oxfam (UK/I)
- Water Aid
- FarmAfrica
- Kenya Institute of Organic Farming
- Bellerive Foundation

Parastatals

The main parastatals operating in the RNR sector are:

- National Cereals and Produce Board
- Agricultural Development Corporation
- Agricultural Finance Corporation
- Kenya Tea Development Authority
- Nyayo Tea Zones Development Authority
- Horticultural Crops Development Authority

- Tana and Athi Rivers Development Authority
- Coast Development Authority
- Lake Basin Development Authority
- Kerio Valley Development Authority (covers Baringo, Elgeyo Marakwet, Uasin Gishu, West Pokot and Turkana)
- Kenya Seed Company
- Kenya Veterinary Vaccine Production Institute
- Kenya Co-operative Creameries
- Kenya Meat Commission

(NB Commonwealth Development Corporation has investments in tea and sugar sectors)

REGULATORY FRAMEWORK FOR RNR MANAGEMENT

The following documents provide regulatory information:

- *Recovery and Sustainable Development to 2010*—Sessional Paper 1 of 1994
- *National Food Policy*—Sessional Paper 2 of 1994
- *1994–96 Development Plan*
- *Laws of Kenya: The Agriculture Act, Chapter 318, and The Chiefs' Act*

KEY DEVELOPMENT ISSUES FOR THE RNR SECTOR

AGRICULTURE

Development in high-potential areas

The development of export crop production (tea and coffee) showed remarkable growth rates in Central Province following Independence. Impressive growth was also achieved with pyrethrum production in the Kisii Highlands and sugar cane production in Western Kenya. In 1988 there were 145 000 smallholders providing green leaf tea to 39 factories operating without subsidy (Johnston, 1989). Much of this expansion has been attributed to farmers responding to price signals. More recent developments have been in the expansion of the dairy and horticultural sectors. Coffee production has been declining for a number of years as other crops become more attractive—although it remains illegal to uproot coffee bushes without authorisation.

Political elites and civil servants have invested in agriculture and, therefore, have a vested interest in its profitability which may have contributed to the growth in cash-crop production and incomes in high-potential areas (Johnston, 1989). This investment has continued more recently in an expanding horticultural export sector.

More than half of Kenyan cattle are found in the high-potential agricultural areas. Eighty per cent of the cattle in Central Province are exotics which has led to increases in consumption of milk by farm families and in sales. Diversification into dairy production since the 1970s has been aided by savings generated from cash-crop production.

The introduction of hybrid maize has significantly increased the production from this crop in the high-potential areas. The national average yield is 1500 kg/ha and 61% of the crop is grown in the highlands.

Future development of the high-potential areas is constrained by population growth, serious shortages of land relative to demand and the inability of farmers to afford the level of inputs necessary for increased production. Arable land per head of the agricultural population declined from 0.18 ha/person in 1965 to 0.11 ha/person in 1988, so the best prospects for future growth are still by increasing physical yields through increased inputs of fertilisers, seeds, herbicides and pesticides. Although further expansion of tea is possible and would be effective at current world market prices for tea compared with food crops, there is a danger that such a policy would jeopardise efforts to attain food self-sufficiency or would require further removal of natural forest.

Agricultural service provision

Government-sponsored research and extension has contributed to agricultural growth although the experience has been mixed. Research on the main export crops, coffee and tea, has been financed by a levy on the crops and has been of high quality with new coffee and tea varieties being developed. Research on food crops and other export crops has suffered from a lack of clear research priorities, uncertain general budgeted support and a lack of adaptive on-farm research. Nevertheless the hybrid maize programme has successfully developed an improved seed distribution system, facilitating rapid adoption of this maize in the high-potential areas (Bevan *et al.*, 1993). A similar efficient service for the ASAL areas has yet to materialise.

Extension services are widespread (one worker for every 450 smallholder families) but have not been effective in improving agricultural performance. Junior staff who perform most of the field work are poorly trained, the number of farmer visits achieved per worker is low; the visits tend to concentrate heavily on farmers that are already progressive. Staff morale is low because of a lack of incentives and promotion possibilities, poor personnel policies and limited support services, not least a chronic shortage of transport. It is claimed by Bevan *et al.* (1993) that innovations spread mostly by copying as smallholders become aware of neighbour or pioneer activity, education level having an important effect

upon willingness to consult extension services, and that innovative role models are gender specific. Female-headed households tend to copy other female farmers and likewise for males.

LAND TENURE AND ACCESS TO LAND

Individual freehold tenure is well established in the high-potential agricultural areas of Kenya following the Swynnerton Plan of land consolidation and land registration, which was introduced to the Kikuyu Reserves of Central Province in the 1950s during the Mau Mau Emergency, so that land is now widely bought, sold, leased and used as collateral. Most of the former African trust land in Central Province had been registered by the end of the 1950s and registration was nearly complete in Nyanza and Western Provinces by the mid-1970s. Land registration in the Eastern, Rift Valley and Coast Provinces began at a later date. By the end of 1981, over 6 million ha had been registered nationally (Barrows and Roth, 1989).

Several decades before land reform began, customary tenure was already undergoing individualisation in Mbeere and Kisii districts, as a result of land scarcity and fragmentation. Sellers were often those requiring money for land litigation and purchasers were often wealthy men, teachers, agricultural staff and other government officials. Maasai herders also began enclosing land to form individual ranches before the 1968 Adjudication Act in the face of increasing settlement by outsiders.

A major criticism of land reform is that it provided a mechanism for the transfer of wealth to those with better social or economic positions, assisting the wealthy and the influential to accumulate larger land holdings, while creating tenure insecurity amongst the poor (Barrows and Roth, 1989).

Some of these large farms belong to companies and may be subdivided between shareholders or offered for sale in small units. In ASAL areas, a number of group ranches were established by wealthier pastoralists, and some of these ranches have since been subdivided (e.g. in Laikipia), leaving farms which are not viable without off-farm income.

There has been considerable debate surrounding the effects of the privatisation and individualisation of land holdings in Kenya. Some argue that the expansion and growth of export crops in the highlands would have occurred without individualisation (Johnston, 1989). Others see it as an important incentive for investment in tree crops and land improvements, particularly in the semi-arid areas (Tiffen and Mortimore, 1993). There appears to be little correlation between the demand for credit and ownership of freehold land. Small farmers are reluctant to use land as collateral for loans for fear of losing the land. There is however a strong inverse relationship between capital investment per hectare and farm size (Odingo, 1985). Poor credit supply may account for some of the perceived reluctance of farmers to borrow for capital investment, although earnings from employment appear to play an important role in investment on smallholdings.

Individualised tenure has not created a well-functioning land market, and there is much speculation and purchasing of land by people with off-farm incomes, who are not necessarily interested in intensive land management and are therefore prone to leave areas uncultivated. In addition, there are examples where customary tenure persists, for example in Embu District, where multiple parcels of land are cultivated to disperse the risk of crop failure and to exploit the advantages of Mount Kenya's agro-ecological diversity. Twenty years after land registration, it was noted that lending, borrowing and multiple parcel ownership allow Embu households to continue to farm in a traditional manner.

There is evidence that failure to register transactions and successions is undermining the intent of freehold tenure and the associated security, since transactions lack legal recognition. The land register, therefore, does not necessarily provide an accurate basis for claims to land, and sale and rental is not as common as it would be if the register were efficiently maintained (Bevan *et al.*, 1993).

Registration in much of the ASAL may be premature as it is likely to produce little benefit in changing agricultural production. Where economic opportunities develop and land scarcity increases, traditional tenure rules appear to move toward individual rights. Under these conditions, registration may be

appropriate but cannot be viewed as a pre-condition for agricultural growth in the absence of access to credit, improved technologies and markets.

At present the Government has no mechanism for the recognition of customary forms of tenure which prevents pastoralists from establishing formal rights to grazing. They are therefore unable to prevent incursions by national parks, private ranchers and cultivators onto their traditional grazing resources. If these trends continue the survival of livestock production systems in the wetter parts of the ASAL may be threatened.

LAND DEGRADATION AND DEVELOPMENT IN THE ASAL

Arid and semi-arid lands (ASAL) account for 81% of Kenya's land area; they support only about 10% of the population but more than 50% of its livestock. These areas are classified as semi-arid and arid savannahs and woodlands (zones 4 and 5 on Map 1). Most of this area is rangeland populated by nomadic pastoralists keeping cattle, sheep, goats and camels. The semi-arid uplands zone is marginal for cultivation but land in this category has increasingly come under cultivation due to population pressures, with misuse of land frequently leading to environmental degradation (Evangelou, 1984). This degradation manifests itself as reduced ground cover, an impaired hydrological cycle and loss of the more valuable fractions of the topsoil (organic matter and fines). Consequently, there is flooding, sedimentation in rivers and reservoirs and depleted groundwater (Darkoh, 1990). Soil loss in districts such as West Pokot, Taita Taveta, Kitui and Embu can exceed 32 t/ha/year. Charcoal production for urban areas adds significantly to the removal of natural woodlands. Because of their low economic potential, these areas tended to be neglected in Kenya's development strategy until the mid-1970s when it was recognised that they merited special attention because their inhabitants were often among Kenya's poorest. In addition, they would have to support and feed their own growing population as well as population over-spill from the high-potential areas, and therefore faced probable further degradation (Adams, 1990).

Indigenous adaptation has occurred to attempt to combat these problems, particularly in Machakos District. However, areas of high population density are now critically short of land and subdivision of holdings is occurring.

Average land holdings in selected districts of the ASAL

	1969	1979 (ha/person)	1989
Narok	7.32	4.30	2.66
Lamu	3.36	1.76	0.93
Laikipia	2.09	1.03	0.55
Kitui	0.89	0.66	0.50
Kwale	0.79	0.57	0.42
Embu	0.58	0.39	0.28
Kilifi	0.53	0.38	0.28
Taita	0.45	0.34	0.26
Machakos	0.40	0.28	0.20

Source: Darkoh (1990)

In the arid lowlands intensive grazing of range is leading to bush encroachment, particularly in Eastern Province. Local overgrazing is exacerbated by expansion of other enterprises (ranches and game parks) in dry-season grazing areas or across migration routes and by security problems in frontier areas (Somalia).

Cattle and sheep populations have altered little between 1969 and 1988 in the ASAL (Rutten, 1992), partly as a result of a series of droughts in the mid- and late-1970s and 1984. However, tropical livestock units (TLU) per capita declined from 3.86 to 2.23 over the same period. The trend is for increasing numbers of sheep and goats at the expense of cattle. It is no longer possible for some pastoral groups to sustain a purely livestock-based existence, notably the Turkana, Samburu, Somali and Pokot.

Integrated rural development projects

The Ministry of Arid, Semi-Arid and Wastelands was set up in 1989 to oversee ASAL development but remained short of funds and staff to undertake the task. This ministry became the Department of Land Reclamation in 1993 as part of an expanded Ministry of Land Reclamation, Regional and Water Development.

By the end of the 1980s there were 14 donor-funded district integrated rural development projects (IRDPs) with natural resource development as their principal theme. Sustainable production increases in the ASAL have proved elusive. Small farmers, often women, are dependent upon erratic rainfall, and have little capital to invest in production. Extension services funded by IRDPs have not received adequate technical assistance or a single direct line of technical support. The introduction of the Training and Visit System (agricultural extension) appears to have made little impact (Adams, 1990). The development and maintenance costs of irrigation schemes have been unacceptably high, including those for destitute pastoralists in arid areas (Isiolo and Turkana). In Turkana district, after 20 years of developing irrigation schemes, it was concluded that the population had lower incomes than those following a traditional pastoral mode of production (Darkoh, 1990).

In pastoral areas tree planting has yielded poor results (Kerkhof, 1990). Diversification and the development of rural industry has also been lacking partly as a result of poor infrastructure, capital shortages, low levels of training and high transport costs. The district planning mechanism has failed as yet to develop participatory planning despite the initial intention to do so. The result of this failure has been an emphasis on technical solutions rather than the development of human capital and resources.

IRDPs in the ASAL have only succeeded in expanding a government bureaucracy and an under-resourced and poorly motivated agricultural extension service. Few investments have been made in small-scale enterprises, education or health. Food security has not improved in the last 10 years and, at current levels of population growth, the boundary between relief and development programmes will become less clear and food security measures will increasingly be needed (Adams, 1990).

Rangeland development

Rangeland development schemes have taken several forms in Kenya. Group ranches in Maasailand were established as early as 1964 and adjudication continued into the 1970s. Initial establishment took place in the face of increasing migration to grazing lands by farming Kikuyu and were modifications of earlier failed grazing schemes. In return for title the Maasai were expected to herd animals collectively and maintain agreed stocking rates. These schemes have not been considered a success partly as a result of poor planning and adjudication, but also because these ranches tended to be dominated by the wealthier members of society. Poor adjudication resulted in the creation of ranches that did not include year-round grazing within their boundaries, forcing herders to move their animals off the ranch during the drier period of the year (Graham, 1988). There was therefore little incentive for herders to limit the size of their herds as they still had access to communal grazing areas. This in turn led to increased pressure on communal land and threatened the livelihood of non-group ranch members who were denied access to the adjudicated areas.

Group ranches have increased the stratification of this society, wealthy members had better access to management inputs which resulted in demands for individual title and subdivision into individual holdings. With individual title, the land became a saleable commodity, a situation taken advantage of during periods of hardship (drought). This has led to the sale of the higher-potential land (often critical dry-season grazing) for crop farming.

Grazing-block development has been concentrated in the northern lower-potential rangelands. Grazing blocks are communal grazing areas whose physical boundaries are defined and services are provided for livestock herders (Muriuki, 1986). Land adjudication was not part of the development process, rather the emphasis was on rotational grazing, the provision of water, demarcation of pastures with motorable tracks and the provision of advice on stocking rates, grazing regimes and range management. Grazing blocks vary in size from 300 000 ha to 500 000 ha. They have generally not been successful in promoting changes in traditional management practices. Drought remains a serious constraint to their viability as herders seek alternative grazing during dry periods and drought. The provision of water has in some cases contributed to degradation by encouraging the concentration of animals. Herders have often been unwilling to pay for the service offered by grazing-block managers for water, dips and advice, considering these inputs to be free government services.

Future sustainable range development will be dependent upon the involvement of the traditional inhabitants of the range in the design and execution of projects. The few successes to date are those schemes that have recognised the indigenous knowledge of the people using the range (Barrow, 1988). As herders are increasingly in competition with farmers for resources, some security of tenure for pastoralists may be essential if their livelihoods are to be maintained. At present the Government of Kenya is following a policy of individualisation of landholdings which is inappropriate for rangeland and does not have a mechanism for the recognition of customary tenure.

In addition, mechanisms are required to remove stock profitably from the range when drought causes devastating shortages of fodder, to devolve control over local resources to producers, and to shift the emphasis from enforcement to one of monitoring critical developments and services local needs.

Future development

It appears unlikely that the ASAL will be able to produce surplus crops in the near future to boost GNP through inter-regional trade and export. Surpluses, particularly livestock, will be generated in good rainfall years but in average years the ASAL will continue to be net importers of food. Livestock production and wildlife management provide the greatest potential for increased incomes and prosperity. At present there are no effective mechanisms whereby local people can benefit from wildlife conservation and tourist-related activities, and further means will need to be devised.

Although successes are reported with crop and livestock production in Machakos district (mainly eastern semi-arid uplands), this climatic zone represents only 5% of Kenya, while about 81% is classified as ASAL. However, development in Machakos is noteworthy as it demonstrates that population increase is compatible with environmental recovery provided that market developments make farming profitable, albeit at the expense of natural vegetation and wildlife (Tiffen and Mortimore, 1993). This district does have good access to urban markets and good infrastructure by ASAL standards as well as many opportunities for off-farm income. Environmental degradation is likely in those ASAL districts of lower population density where incentives for investment in land improvements are weak due to lack of demand for agricultural products, and poor communications and transport. Under these conditions extensive fallowing systems persist as land is cheap and abundant, and labour and capital are scarce.

WATER RESOURCES

Hydro-electric power and major irrigation schemes power have dominated water resource planning and river basin development in Kenya. There has been little attempt to devolve decision making to local communities or to assess the demands for water for domestic use, crops or livestock.

Legislation is in place to control abstraction of water from rivers, dams and groundwater supplies but it is often not effectively enforced. Since most of the perennial river flow is in the upper, high-potential areas, the rewards from irrigation sourced from these rivers can be high. However, such irrigation is only practised during dry periods and so is from basal flow. This reduces low-season flows further in the dry areas below, with serious consequences to the people for whom these rivers may be their only water source. Irrigation as a means of overcoming the arable land shortage has thus far not proved successful. There is growing scepticism about the cost-effectiveness of large-scale schemes and the rate of return on existing schemes is low.

Most of Kenya's towns experience periodic water shortages due to either financial mismanagement (the municipalities have to purchase their bulk supplies of treated water from the Government and often fail to pay for it and so are cut off) or breakdowns or deficiencies in capacity of pumps and reticulation. The cost of installing or rehabilitating piped water supplies to urban centres is high and often beyond the ability of their residents to pay, although for the main Kenyan towns there are usually plenty of suitable sources.

A pipe-borne water supply to a small proportion—let alone all—rural dwellings is unattainable in the short term as the costs would prove prohibitive. From studies that highlight the labour shortage at critical stages of the agricultural season, and the large amount of time and effort required to fetch water for domestic use, it is clear that the rewards of improving rural water supplies are substantial. Rainfall, an impervious collecting surface, and a receiving tank capable of holding some water for a few months are all that is needed at a homestead: the challenge is to bring their cost down to an affordable level. If successful, this will also open the way to rural self-sufficiency in fruit and vegetables as well as providing water for domestic livestock, which can be important when lactating or draught animals are kept during the dry season.

Much natural grazing in the drier part of the ASAL cannot be exploited because of the lack of water supplies. Deep boreholes are unaffordable and raise problems of ownership and maintenance responsibilities. Such boreholes often lead to unsustainable concentrations of people and livestock with consequent destruction of the grazing resources as well as degradation of the area unless strict controls are enforced—unlikely in the present political and economic climate. The alternative is to rely on *hafirs*¹ (which may require costly linings where the ground is not sufficiently impervious to hold water for long periods) from which water can be drawn by hand. The users know that they can rely on them after good rains have fallen which is the period when the grazing resource is most productive.

DEFORESTATION

It is estimated that 71% of Kenya's fuel needs are met by wood and charcoal. When there are periodic shortages of the alternative fuels (electricity and petroleum gas) this has the effect of temporarily raising charcoal consumption further. There is concern that the current standing stock of fuelwood (see page 24) will not be sufficient to meet the demands of a growing population. Sustainable yields of timber for fuel are considerably lower than estimated demand; this demand is certain to increase with population growth in the absence of few alternative sources of energy.

However, much of the current demand is largely met from planted trees harvested in a sustainable way from both large and small farms (e.g. by pollarding *Grevillea*) as well as from commercially managed forests, and charcoal produced as a by-product from clearing land in the ASAL—either virgin land or after a prolonged bush fallow. The latter is clearly not sustainable in the long run as fallows become inexorably shorter with increasing density of settlement. Planting trees in the ASAL is much more difficult and more risky than in the high-potential areas. Suitable species are few, mostly slow-growing, vulnerable to uncontrolled grazing animals, rodents and termites when young, and compete with crops and pasture for moisture thus limiting their production. However, if prices rise sufficiently, timber may

¹ Arabic word for large excavated water storage structures where water is stored substantially below ground level as opposed to dams where it is mainly stored above the ground.

become increasingly attractive as a crop though at the same time greatly increasing economic hardships for the urban poor whose fuel needs cannot be addressed in this way.

Estimated demand for fuelwood

	1985	1990	1995	2000
	('000 m ³ roundwood equivalent)			
Domestic, urban				
Fuelwood	300	500	700	900
Charcoal	5 200	7 300	10 100	14 000
Domestic, rural				
Fuelwood	14 900	16 500	18 700	21 200
Charcoal	3 600	4 000	4 400	4 800
Industrial				
Fuelwood	5 000	6 600	8 800	11 400
Charcoal	1 900	2 700	3 400	4 400
Total fuelwood	20 200	23 600	28 200	33 500
Total charcoal	10 700	14 000	17 900	23 200
Total woodfuel	30 900	37 600	46 100	56 700

Source: UNDP/World Bank (1987)

WILDLIFE AND NATIONAL PARKS

The total area of national parks and reserves is 42 000 km², or about 8% of the country, and there are 1741 known species of fauna and 6500 known species of flora in the country.

Kenya's wild life resources are well known and have become a subject for international concern as well as being the attraction to which half of Kenya's tourism income can be attributed. (Tourism has been the largest single source of foreign earnings since 1987.) There are also signs that the national parks are being better managed and poaching contained, if not greatly reduced, although there is still the ever-present danger of their carrying capacity for tourists being exceeded to the detriment of both the wildlife and the tourist industry itself. Problems are occurring—and become increasingly severe—where wildlife reserves are situated in more densely settled areas where either wild animals cause unacceptable levels of damage to growing crops, or people continue to enter the reserve to exploit its resources (wood, plants, farm land, grazing, etc.) at an unsustainable rate. There are no mechanisms to compensate farmers who lose crops and animals to protected wildlife, or farmers who traditionally had access to areas for hunting, herding and gathering, which are now gazetted wildlife or forest reserves.

In some wildlife reserves, some animal species are now so effectively protected that their population may rise to an ecologically unsustainable level, with knock-on effects on the environment adversely affecting other protected species.

The Kenya Wildlife Service has operated national parks on the principal of exclusion of indigenous communities. There is no provision for the removal of plants and animals for subsistence use even on partially protected areas. On ungazetted land animals cannot be culled for subsistence or sale. Indigenous human populations are becoming involved in the management of wildlife, and local communities are now beginning to receive some of the benefits that accrue, through revenue sharing

arrangements with County Councils. However, as yet there are insufficient projects which encourage recognition of the economic value of wildlife. Improved distribution of benefits through joint management by Government and local land users appears to offer the best prospect for sustainable wildlife management in future years.

Wildlife populations

Main fauna (1990)	Number
Burchell's zebra	194 000
Grant's gazelle	184 000
Topi	110 000
Impala	104 000
Wildebeest	100 000
Thompson's gazelle	99 000
Giraffe	56 000
Buffalo	45 000
Oryx	38 000
Ostrich	38 000
Eland	31 000
Warthog	23 000
Gerenuk	23 000
Kongoni	23 000
Elephant	17 000
Kudu	13 000
Grevy's zebra	6 000
Waterbuck	6 000
Hunter's hartebeest	3 000

Source: Ministry of Environment and Natural Resources (1991)

POLICY ENVIRONMENT

The Kenyan Government has been able to maintain a pattern of commodity pricing that provides adequate incentives for producers of a wide variety of agricultural commodities. For example, domestic prices for coffee since independence have followed world market prices and payments to farmers as a percentage of the price received by the boards was remarkably high (around 90%). The Government has not relied on taxation of agricultural exports to a significant degree. Public policy has been for private and public agencies to coexist and the state has resisted conferring monopoly status on sectors such as credit, education, coffee and transport. The recent development of horticultural exports has been dominated by the private sector.

Kenya is undergoing a Structural Adjustment Programme which aims to change incentives in favour of exportables through, for example, trade and exchange rate reform, liberalisation of the import regime, budgetary discipline and a commitment to balance between the needs of urban and rural sectors. While

this programme is expected to benefit cash crops, the liberalisation of grain trading should also favour food production.

The official exchange rate was rarely distorted by more than 20% in the 1980s and this prevented the dissipation of foreign currency into illegal channels. Thus Kenya's industrial sector has been able to operate at a high percentage of installed capacity and there have been few shortages of imported agricultural inputs. Some parastatals, particularly those for coffee and tea, are considered to have performed well although the Maize and Produce Board and Kenya Co-operative Creameries have experienced high administrative and transport costs, delayed payments to producers and inflexible pricing which have invited criticism.

Maize is by far the most important food crop grown in Kenya and is estimated to provide 50–70% of the calorific intake of the population (Lofchie, 1989). Maize production has been treated rather differently from export-crop production and the Government adopted a policy of strictly regulating the price at all levels, not only the price paid to the producer, but also the price that can be legally charged at the processing and retailing levels. There is some debate about the success of this policy, although food imports have increased in recent years. Generally it is felt that the Government has been unsuccessful in its attempt to control the price of maize via the Maize and Produce Board due to a shortage of transport equipment and storage and the self-interest of some powerful players. The result was farmers in surplus areas were unable to sell to the Board, while farmers in deficit areas could not count on being able to buy as much as they wanted at the Board's floor price. These difficulties have led to the removal of some of the restrictions on trade in maize (1991) although permits were still required to move maize across district boundaries up until the end of 1993. The World Bank expects competition between private traders for the purchase of maize to increase the farm-gate price and reduce the retail price.

Decentralised planning was initiated in Kenya as early as 1967 and extended further in later years with the establishment of District Planning Units under the District Development Committee. District programmes were developed under this administration which was extended by the Government of Kenya's District Focus on Rural Development policy of 1983, which required districts to produce an Annual District Development Plan. District rural development was to be under the supervision of a District Development Committee and Subcommittees at divisional and locational level to include involvement of the community in their own programmes. There have, however, been marked differences between densely settled farming areas where local subcommittees are active, and remote pastoral areas where committees rarely met and are dominated by a handful of officials and politicians. In addition, resource allocation for development at district level is controlled by line ministries, within centrally defined programmes and strategies. As a result, rural development planning throughout much of the ASAL has remained a top-down process with little participation by local communities.

There is currently concern that Kenya will not be able to achieve high growth rates in agriculture because of a limited supply of high- or medium-potential arable land and a high rate of population increase. Agricultural output per person has been declining for some years and agricultural production has fluctuated widely during the present decade because of poor rains, difficulties with inputs and ethnic unrest displacing farmers in some of the high-potential areas. With low inputs and existing technology (three-quarters of the estimated 2 700 000 smallholders use little or no fertiliser), it is hard to reverse this adverse trend without mining resources (principally soil—its inherent fertility as well as its physical loss by erosion) and thus further exposing farmers to the effects of bad growing seasons.

Non-agricultural employment is not growing at a sufficiently high rate to absorb a growing agricultural labour force. Therefore it appears likely that the country will continue to suffer higher levels of unemployment and stagnating per capita income. This problem along with the development of the ASAL poses the greatest challenge to the future development of Kenya. There is a danger that already high income disparities will increase as landless households migrate to urban centres and ASAL communities continue to suffer the effects of drought and land degradation.

POVERTY, INEQUALITY AND HOUSEHOLD FOOD SECURITY

Income is very poorly distributed in Kenya, the highest 20% of earners receiving 61.8% of total income or consumption. The lowest quintile receives just 3.4% of income and the fourth quintile 6.7%. UNDP (1994) estimated that 52% of the population lived in absolute poverty between 1980 and 1990 (55% of the rural and 10% of the urban population). There has been no improvement in the incidence of poverty during this period. The most vulnerable groups in Kenya are pastoralists, women, unskilled urban wage earners, members of the informal sector, landless people and poor smallholders.

Income inequalities reflect the patterns of access to basic resources, both between and within regions and agro-climatic zones. Since agriculture is the major economic activity, the patterns of land ownership and access to land are closely related to income inequalities. The situation is compounded by the small proportion of the country which can be used for arable production in which all the major crops are produced.

As most of the population is concentrated in the higher potential areas, so are most of the poor: in 1992 almost 25% of the poor were in the six districts with the highest agricultural potential. This concentration has been mitigated by emigration from the highlands to semi-arid districts, such as Machakos and Kitui, over the last few decades. This in turn has led to the displacement and impoverishment of pastoralists.

The arid districts, which account for 60% of the area of Kenya, but only around 5% of the population, have not been included in national poverty surveys. Incidence of poverty in these districts, whose inhabitants are mainly pastoralists, is thought to be very high as a result of the cumulative effects of several droughts, range degradation in some areas, and under-utilisation of range owing to ethnic and other conflicts elsewhere.

Indications from national surveys suggest that income distribution is becoming worse and a large number of people are becoming dispossessed as they forfeit land in the face of indebtedness (Juma, 1991). It was estimated that 13% of the rural population were landless in 1991. The 20% of the population with the largest landholdings owned 84% of the land in 1976-79 (Jaziary *et al.*, 1992). It is unclear whether this situation has altered since that time. Wage labour is of increasing importance to the landless, both male and female. Real wage rates of agricultural workers declined by 7.3% between 1978 and 1987.

Access to food has recently been used as an indicator of poverty. In 1992 it was estimated that 37% of the population was food poor (unable to consume 2250 calories per day). It has been estimated that about 64% of the total expenditure of poor smallholders is devoted to purchasing food and non-alcoholic beverages. Studies conducted in the 1970s revealed high rates of food poverty which adversely affected children in Eastern, Nyanza and Western Provinces (Juma, 1991). Yields of maize have been stagnant throughout the 1980s and small farmers' yields are estimated to be as little as one-fifth of those achieved on research stations.

Food security problems are exacerbated by land speculation and a recent estimate suggested that as much as 35% of available arable land may be lying fallow. The largest farms in the high-potential areas still exceed 1000 hectares. The efficiency of many large-scale operations is low and the sector has been protected by subsidised credit and import tax advantages.

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