United Nations Environment Programme

KENYA

NATIONAL STATE OF THE ENVIRONMENT REPORT

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FOREWORD

A national state of the environment report is a report that describes the status of the nation's environmental system. It provides a baseline against which future changes in the environment could be judged, a documentation of progress made in dealing with environmental problems, identification of opportunities where further effort could be expected to have significant results and an examination of the interrelationship between people, resources, environment and development. Most important is that the report should be prepared to confront the public and decision-makers with environmental quality indications so that the former would appreciate the consequences of its own actions and the latter would understand what needs to be done and where.

At its thirteenth session in 1985, in decision 13/23, the Governing Council requested the Executive Director to assist Governments in the preparation of examples of national state of environment reports. In response to that decision, UNEP is publishing this series of reports, each dealing with the state of the environment in a particular country.

It is my sincere hope that this series of reports will be found useful in providing baselines against which future changes in the quality of the environment in the different countries can be measured and evaluated. It is also hoped that these reports will provide more up-to-date information which can be used in regional and global assessments of the state of the environment.

Mostafa K. Tolba
Executive Director

Nairobi, May 1987

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" This report is an edited version of the text submitted by the National Environment Secretariat of Kenya to UNEP "

State of the Environment : Kenya

Corrigendum

Page 16, last para, line four : insert in instead of is

Page 23, 1st para, last line : insert been instead of be

Page 25, 3rd para, line three : insert and instead of and

Page 40, last para, line eight: insert not instead of no

Page 44, 1st line : insert man-made instead of mand-made

Page 44, 2nd para, last line : insert monitor instead of monitore

Page 44, 4th para, line seven : insert prices instead of proces

Page 45, 3rd para, line one : Delete has

Page 46, 3rd para, line three : Insert Kiambu instead of Kiambo

Page 60, 1st para, line three : Insert determines instead of setermine:

Page 69, Leather Industries, 1st para line 2 : insert Already commissioned instead of to be Commissioned shortly

Page 72, last para, line four : insert train instead of trail

Page 80, Common Law and Pollution - line three : insert but instead of bu

Page 80, Law on Chemical Substances, line five : insert of instead of oc.

PREFACE

The National Environment Secretariat (NES) was established in 1974 to co-ordinate all matters pertaining to the environment in Kenya. At the beginning "co-ordination" was difficult to define. Over the years, however, the mandate and activities of the NES became more sharply defined in the light of increasing awareness and better understanding of the concepts and dimensions of the environment. Co-ordination has started to have its impact. The Interministrial Committee on Environment (IMCE), established under the auspices of the NES, has served as a useful bridge between the NES and the different Ministries. There is now a growing realization among all Ministries about the necessity of environmental protection and conservation.

The present report on the State of Environment in Kenya was prepared by the National Environment Secretariat to provide a basic assessment of the environmental situation in Kenya and the problems encountered. Since this is the first report of its kind, it is hoped that will serve as a basic document for wide discussion and exchange of views.

This report is primarily addressed to all Kenyans. After all, they are the ones who are directly affected by the environmental problems encountered. They also are responsible, in most cases, for environmental degradation. It is hoped that this report will increase the awareness of the decision-makers at all levels and the Kenyan public at large about the interrelationships between their activities and aspirations for better living and the environment, which constitutes the basic capital they have. It is also hoped that through the information presented in this report, ideas and common action programmes will be developed regionally and/or internationally to deal with problems common to developing countries.

The preparation of this report was based on guidelines published by the United Nations Environment Programme. A great deal of information was gathered by the NES staff from various Ministries, private bodies and individuals. To all those who provided us with information, we are most grateful. The report was ably put together by the following staff of the National Environment Secretariat : Mr. S.K.Mugera, Mr. F.K. Lelo, Mr. V.K. Njuki, Miss S.W. Maghanga and Mr. W.K. Mutero.

Nairobi, May 1987

A.K. Kiriro
Director, National Environment Secretariat

I. INTRODUCTION

1. PHYSICAL GEOGRAPHY :

The Republic of Kenya is located approximately between latitudes 4° 21' N and 4° 28' S and between longitudes 34° and 42° E. It is almost bisected horizontally by the equator and vertically by the 38° longitude. It is bordered by Uganda to the west, Ethiopia and Sudan to the north, Tanzania to the south and Somalia and the Indian Ocean to the east. Kenya covers an area of about 580,367 km², of which 11,230 km² are covered by water.

Kenya has a great diversity of landforms ranging from glaciated mountain peaks under permanent snow cover, through a flight of plateaux to the coastal plain. The country consists of eight physiographic regions : the coastal plain, the Duruma-Wajir Belt, the low Foreland Plateau, the Kenya Highlands, the Kenya Rift Valley, the Nyanza Lowlands, the Nyanza Plateau, and the northern Plainlands (Fig. 1).

The country is split by the Great Rift Valley, which is about 60 km wide and up to 330 m deep. A large part of this Valley is occupied by range lands. The region at the east of the Rift Valley lies at about 2,000 m above sea level and is dominated by Mount Kenya (5,230 m), the highest mountain of Kenya, and by the Aberdare mountains, reaching almost 4,000 m. In the west, the country slopes down to Lake Victoria, but this side shows also the mountains of the Mau Range, and Mount Elgon (4,320 m) on the border with Uganda. The highlands, forming most of the south-west and central parts of the country have an elevation from 1,400 m to 2,800 m above sea level, and are well watered and fertile. On the contrary more than half of the northern and north-eastern part of Kenya is semi-arid.

From the geological point of view (Fig. 2), sedimentary successions of Carboniferous to Recent ages cover the eastern and south-eastern parts of Kenya. These successions are represented by different carbonate rocks, sandstones, shales, conglomerates, lacustrine and alluvial sediments, and other sedimentary deposits. Volcanic associations of Tertiary age cover wide areas in central, northern and western Kenya (especially around the Rift Valley). These volcanic rocks consist mainly of alkaline rocks (e.g. alkali basalts, phonolites, nephelinites, trachytes, alkali rhyolites, etc). The floor of the Rift Valley contains several volcanic plugs and cones, e.g. Silali, Menengai, Longonot, Suswa and Shombole. The tops of these cones form craters while that of Menengai forms a caldera. Volcanic highlands in the west include Mt. Elgon, Mau Hills, Kamasia Hills and Taiti Range; in the east they include Mt. Kenya, Aberdare Range, Nyambene and Ngong Hills. The Pre-Cambrian complex (consisting mainly of granites, gabbros, anorthosites and metamorphosed rocks, etc) occur mainly in the central part of Kenya from south to

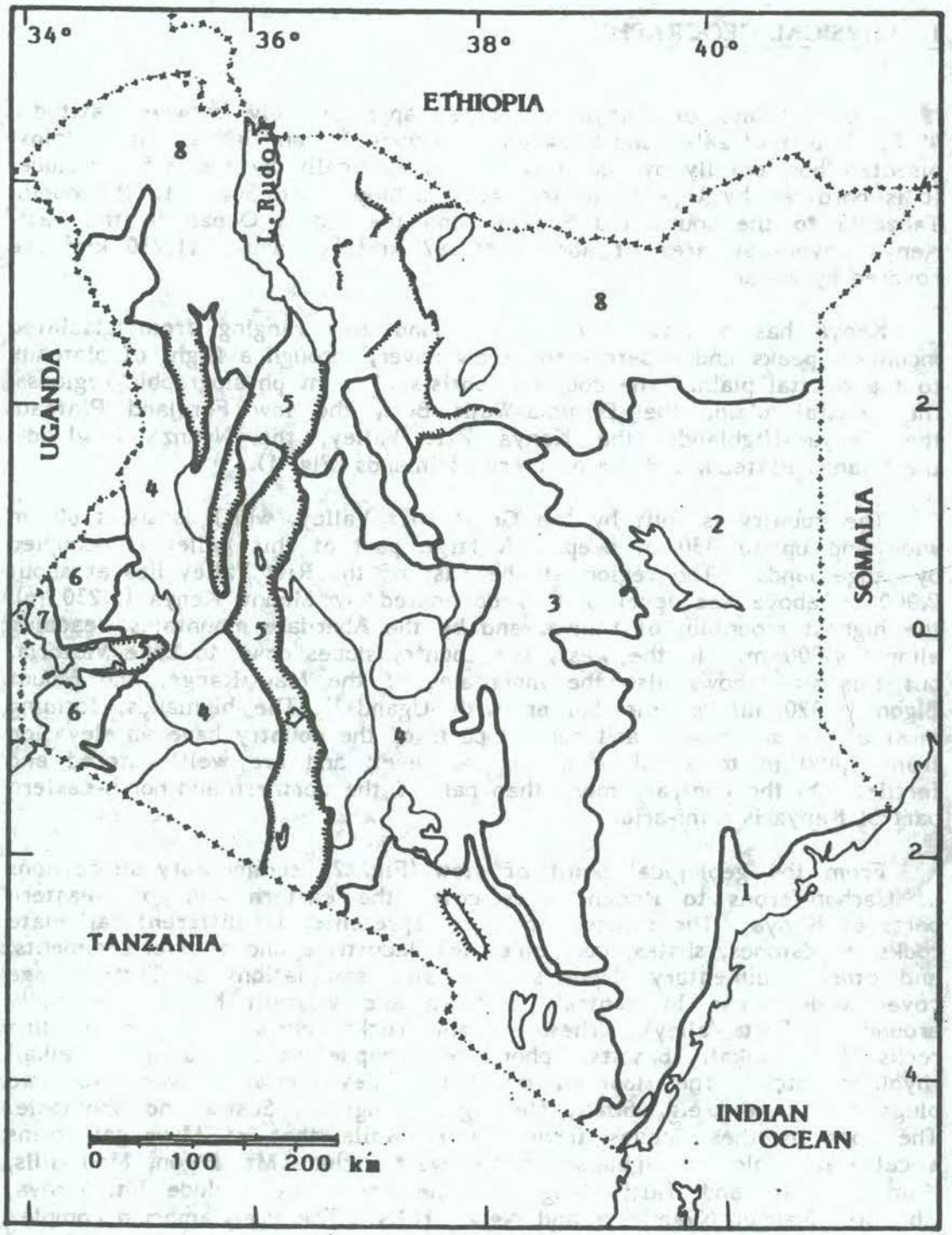


Fig. 1 Physiographic Regions of Kenya

1. The Coastal Plain
2. The Duruma-Wajir Belt
3. The Low Foreland Belt
4. The Kenya Highlands
5. The Kenya Rift Valley
6. The Nyanza Lowlands
7. The Nyanza Plateau
8. The Northern Plainlands

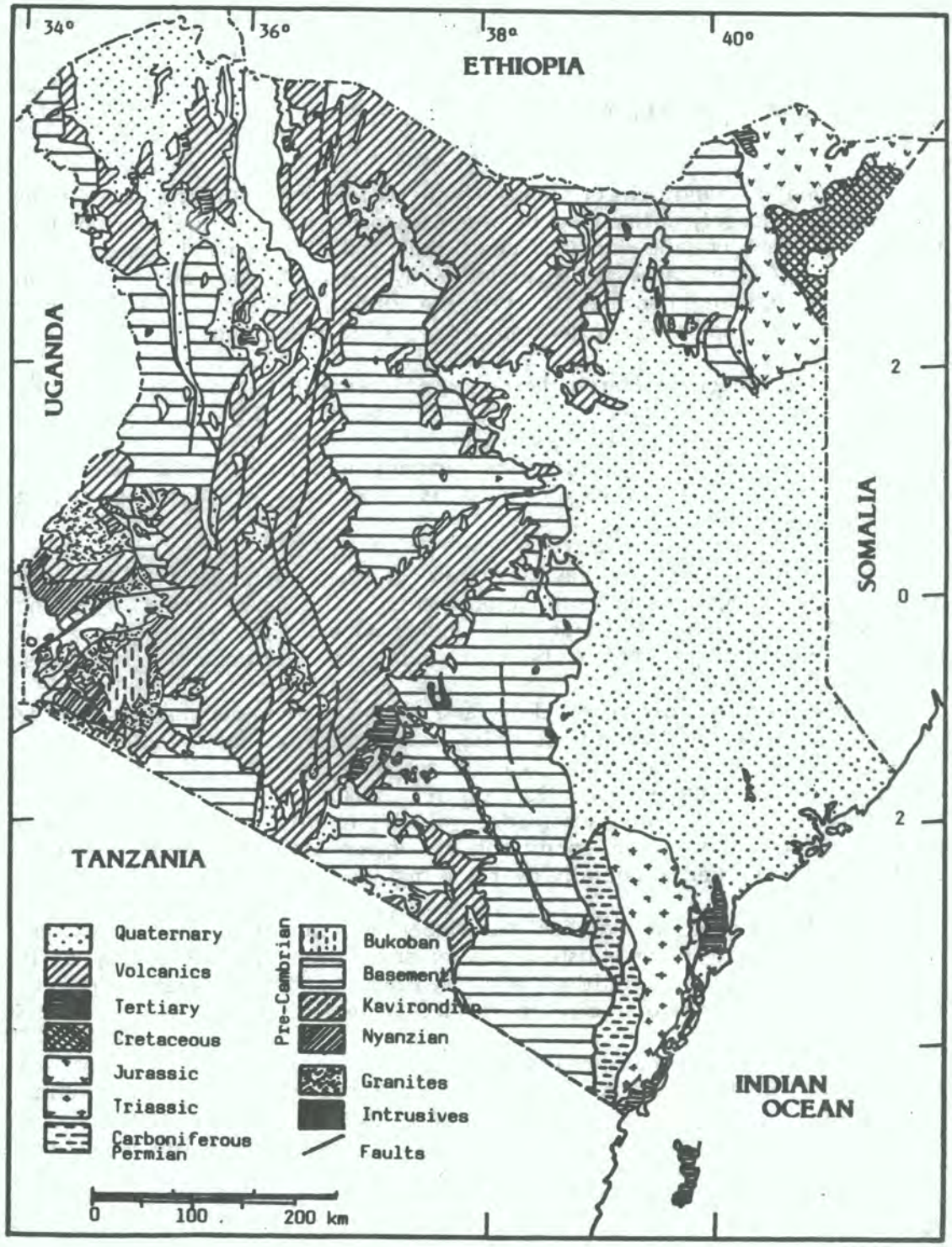


Fig. 2 Geological Map of Kenya

north; other occurrences in the west and north-eastern parts are also known.

2. THE CLIMATE OF KENYA :

The major wind circulations which determine climatic conditions in Kenya are largely influenced by the equatorial location and the position of the country on the Indian Ocean seaboard. The wind systems are controlled by the large-scale pressure systems of the western Indian Ocean and adjoining continents. But the climatic diversity characteristic of the country is largely a reflection of its varied topography.

From December to March the country is generally under the dominance of the north-east monsoon system. Pressure conditions result in a predominantly north-easterly flow of air mass in the north of the country. South of the equator, the direction changes to northerly and eventually north-westerly. Since this air mass is essentially a subsiding air, it is comparatively dry.

From March to May the direction of the air mass flow changes to an easterly position in both hemispheres. This is a period of strong incursion of maritime air from the Indian Ocean It is the period of heavy rains brought about by favourable meteorological conditions.

In the months of June, July and August, the dominance of the south-east monsoon gradually sets in, establishing a south-easterly flow of air over much of the area. To the north of the equator the direction changes to south-easterly. During this period much of the country is dominated by the air subsidence which inhibits rainfall over much of the country. Weather conditions are more stable, leading to rather dull and cold weather, especially over the highlands.

From September to October, November and December, the north-east monsoon begins to re-establish its dominance over the area. By early December, the air circulation and weather conditions clearly reflect the dominant influence of the northern meteorological conditions.

There are three main regions of heavy rainfall. A relatively wet belt extends along the Indian Ocean coast. A second area of high rainfall covers western Kenya just east of Lake Victoria, linking this part of Kenya with similarly located regions on the Uganda and Tanzania sides of the lake. A third type of region receiving heavy rainfall coincides with the main mountain ranges. Valley barriers tend to stand out as dry areas.

Annual rainfall follows a strong seasonal pattern. These seasonal variations are most pronounced in the dry lowlands and the north and

east, but weakest in the humid highlands of the Central and Rift areas. Broadly three major rainfall regions emerge: the Indian Ocean coastal area; the eastern, north-eastern, south-eastern and central area; the western Rift and Lake Victoria area. Along the Indian Ocean coastal area, January to March is generally dry. The main rains come between the end of March and May. From June to August rainfall at the coast decreases. Some rain occurs between October and November. From December, rainfall decreases rapidly to a minimum during January and February.

In the eastern, north-eastern, south-eastern and central areas, there are two distinct rainy seasons from March to May and from October to December. The period from June to September is dry. April is generally the rainiest month although some years have recorded the heaviest rainfall during October and November.

The western Rift and Lake Victoria areas have no real dry season. Rainfall is generally high from March to September. In the areas away from the highlands proper, the months of April and May tend to experience heavier rainfall. Most of the highland area west of the Rift experiences one long rainy season from March to September.

Table 1 gives the mean annual rainfall over some selected stations, and Fig. 3 illustrates the ditribution of rainfall in Kenya.

Table 1 Annual Rainfall Over Selected Stations

Station	Maximum (mm)	Minimum (mm)	Mean (mm)
Nairobi	1570	437	879
Mombasa	1887	709	1208
Nakuru	1515	541	871
Eldoret	1826	462	973
Nyeri	1321	460	922
Wajir	513	74	249
Kisumu	1884	942	1278
Magadi	621	153	398
Lodwar	498	19	165

Source : Ministry of Water Development.

Droughts and floods are common features of the Kenyan climate. Both these extremes are due to rainfall anomalies. Climatological records show that droughts with serious effects on man and animal wealth have occurred in the following periods : 1928, 1933-34, 1939,

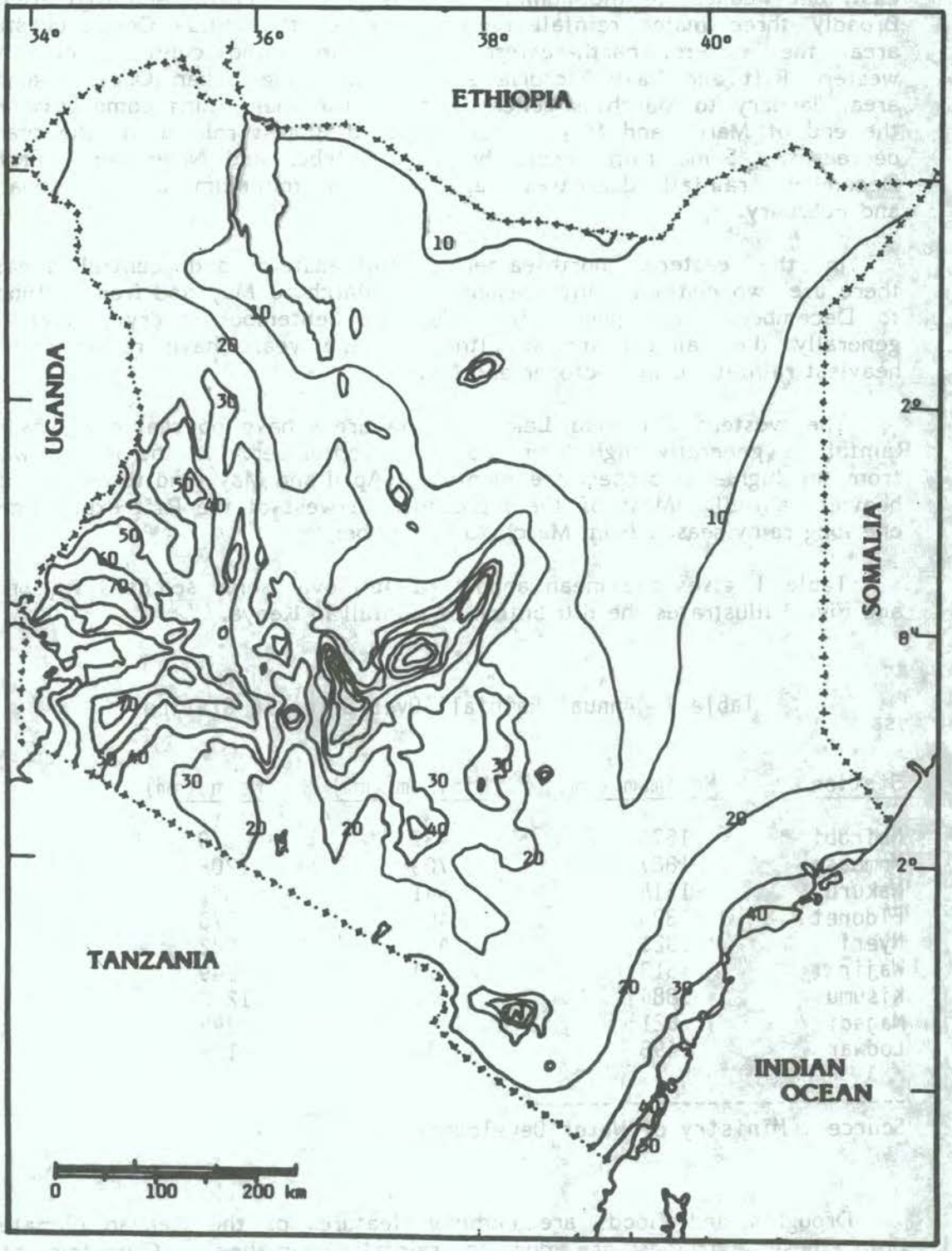


Fig. 3 Mean Annual Rainfall in Kenya (in inches)
(After Ojany and Ogendo, 1985).

1942-44, 1952-55, 1960-61, 1965, 1981, and 1984. Major floods in certain low-lying parts of the Nyanza Gulf, and the lower Tana Basin occurred in 1937, 1947, 1957-58, and 1961. These anomalies in rainfall have caused widespread famine as drought brings about crop failure while excessive rain brings flooding of the fields during the crucial growing period.

Altitude exerts the greatest influence on temperature in Kenya. There is a wide range between the maximum and minimum temperatures; from below the freezing point on the snow-capped Mt. Kenya to over 40°C in some parts of the north and north-east. Generally, the low-lying northern plainlands are the hottest areas and here maximum temperatures commonly exceed 35°C with March as the hottest month. Table 2 gives the annual mean maximum and minimum temperatures and relative humidity recorded at some stations.

Table 2 · Annual Mean Maximum and Minimum Temperatures and Relative Humidity Recorded at Some Stations

Station	Height (m)	Mean Maximum Temperature °C	Mean Minimum Temperature °C	Relative Humidity %
Lodwar	506	34.9	23.7	30
Wajir	244	33.6	22.1	48
Garissa	128	34.3	22.5	45
Lamu	30	29.2	24.1	75
Mombasa	16	30.1	23.4	72
Voi	560	30.5	19.4	45
Nairobi	1798	23.6	11.6	52
Nanyuki	1946	23.7	8.5	51
Magadi	613	35.0	23.2	35
Nakuru	1836	26.4	10.0	47
Kisumu	1146	29.4	17.1	47

In summary, seven climatic regions have been identified in Kenya (Fig. 4) :

1. Equatorial Climate of the Coast : This region has no dry season and is characterized by high temperatures and humidity throughout the year. The Kenya coast receives much lower annual rainfall than typical equatorial climate.

2. Tropical Climate of the Kenya Highlands : This region is much cooler than a tropical continental climate and may be described as a highland subtropical climate. The amount of rainfall received at different places depends on the position of the station in relation to the rain-bearing winds. Thus Meru on the north-eastern slopes of Mt.Kenya receives

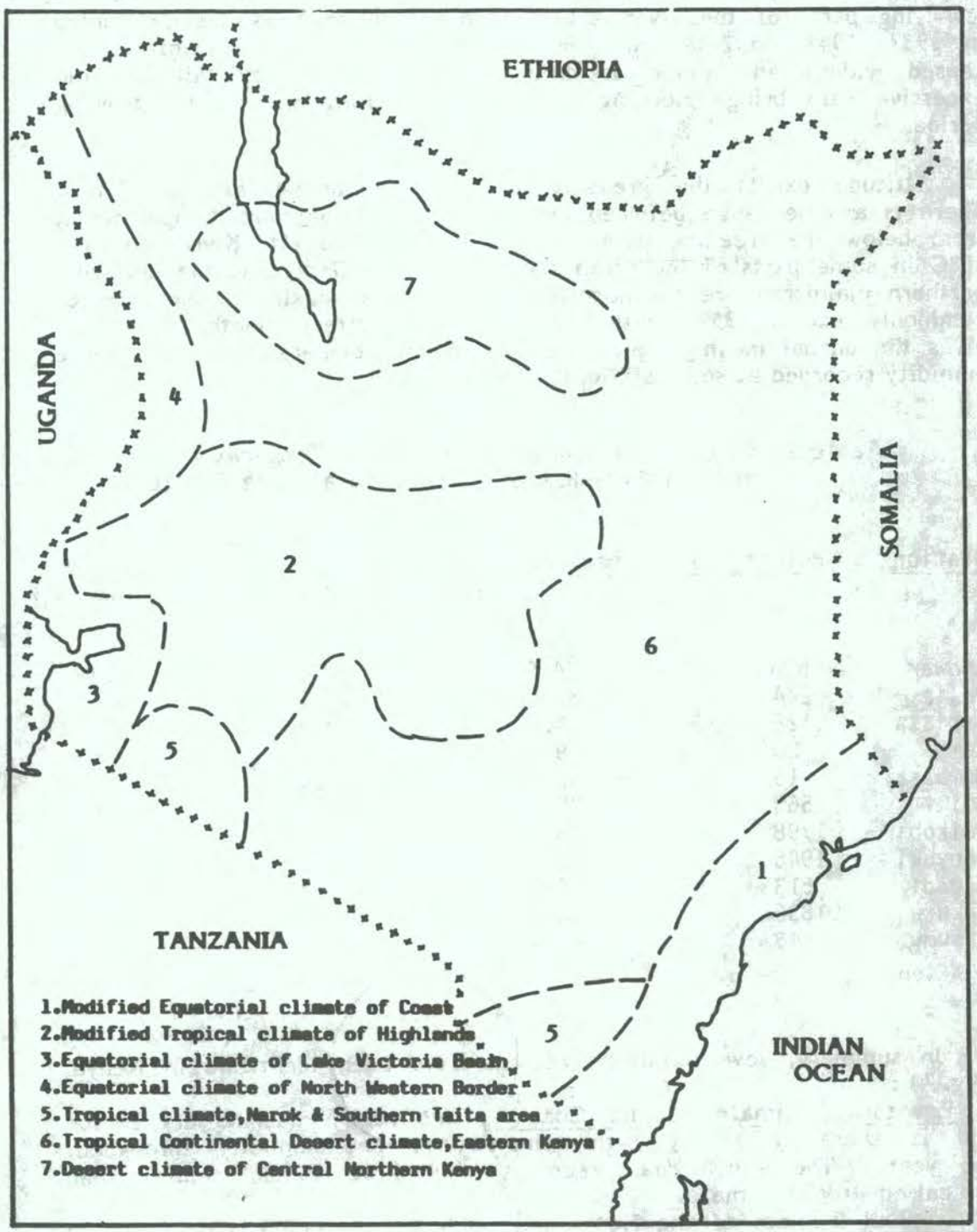


Fig. 4 Climatic Regions of Kenya

1320 mm annually, while Nyeri on the south-western slopes receives 737 mm.

3. Equatorial Climate of the Lake Victoria Basin : Although there is really no dry month in this region, rainfall shows considerable variations and is much lower than in a typical equatorial climate. The enclosed basin of Lake Victoria tends to increase the temperature, although the lake itself exerts a cooling effect; temperatures are generally lower than in an equatorial climate.

4. Equatorial Climate of the North-Western Border : This climate is a continuation of the climate of eastern and northern Uganda and is best exhibited in the Karasuk areas. High relief introduces low temperatures in parts of this area.

5. Tropical Climate of the Narok and Southern Taita/Kwale Areas : This is part of the tropical climate which dominates the central mainland of Tanzania. The high relief of such hills as Loita exerts a cooling effect; the climate here is more tolerable than in the semi-desert climate of eastern Kenya.

6. Tropical Continental/Semi-Desert Climate of Eastern Kenya : This vast region receives less than 500 mm of rainfall per year. The mean temperature is about 22-27°C.

7. Desert Climate of Central Northern Kenya : This region receives less than 250 mm of rain per year and may be regarded as a desert.

3. SOCIO-ECONOMIC INDICATORS :

Population :

Kenya's population has been rising very rapidly. The population rose from 5.4 million in 1948 to 8.6 million in 1962, an increase of 59 % in 14 years. In 1969, the total population of Kenya was 10.9 million and by 1979 the figure reached 15.3 million. At present the population of Kenya is estimated at about 20 million.

Kenya has one of the highest population growth rates in the world. Before 1962, the annual growth rate was about 3 % ; between 1962 and 1969 it increased to 3.3 % and between 1969 and 1979 it reached 3.8 %. At present the annual rate of population growth is about 4.1 %.

The population growth in Kenya is largely a product of fertility and mortality since international migration is negligible. The total fertility rate is quite high in Kenya and has been increasing over the last 30 years. The fertility level increased from 6.5 births per woman in the early 1950s to about 8.1 in the early 1980s. Due to these high fertility rates, the birth rate (number of births per 1000 population) has remained very high, between 50 and 55 over the last 30 years.

The death rate (number of deaths per 1000 population) has been steadily declining due to improved sanitation and health care. The death rate decreased from 20 in 1962 to 14 in 1979 and to 12 at present. The infant mortality rate declined from 119 per 1000 live births in 1969 to 83 by 1977 and 81 by 1983. The life expectancy at birth has increased from 49 years in 1969 to 54 years in 1979 and 57 years in 1983. Projections of population growth in Kenya are given in Table 3.

Table 3 Projected Population Growth in Kenya

Year	CASE A	CASE B	CASE C
1980	16,667,000	16,667,000	16,667,000
1981	17,342,000	17,342,000	17,342,000
1982	18,035,000	18,047,000	18,044,000
1983	18,748,000	18,784,000	18,775,000
1984	19,482,000	19,555,000	19,536,000
1985	20,241,000	20,365,000	20,333,000
1986	21,021,000	21,212,000	21,163,000
1987	21,826,000	22,100,000	22,030,000
1988	22,657,000	23,032,000	22,936,000
1989	23,513,000	24,009,000	23,883,000
1990	24,397,000	25,034,000	24,872,000
1991	25,308,000	26,109,000	25,905,000
1992	26,247,000	27,236,000	26,985,000
1993	27,214,000	28,418,000	28,113,000
1994	28,211,000	29,657,000	29,292,000
1995	29,237,000	30,956,000	30,522,000
1996	30,292,000	32,315,000	31,806,000
1997	31,375,000	33,738,000	33,144,000
1998	32,487,000	35,226,000	34,538,000
1999	33,626,000	36,782,000	35,991,000
2000	34,792,000	38,409,000	37,505,000

Case A : Assuming a decrease in fertility to 5.5 by the end of the century and a decrease in mortality.
Case B : Assuming constant fertility but decrease in mortality.
Case C : Assuming that both fertility and mortality rates will remain constant.
Projections A and B assume that by the end of the century, the expectation of life at birth will have increased to 58.8 years for males and 61.5 years for females and infant mortality rates would have dropped to 60 per 1000 live births.

The above-mentioned high rate of population growth will undoubtedly frustrate development efforts in Kenya. Some of the effects of this rate of growth have already been manifested through high and growing dependency burden, unemployment, unplanned parenthood and increasing demand on basic services such as health, education, nutrition and shelter. The high rate of population growth became a priority issue to the Kenya Government since the 1962 Census.

In the early 1960s, the Family Planning Association of Kenya was established as a non-governmental organization to help those Kenyans who needed family planning services. In 1967, a National Family Planning Programme was officially launched. Acceptance of family planning services was to be wholly voluntary and individual customs and values were to be fully respected and emphasis was to be placed on family size and spacing of children. In 1975, the Government launched a 5-year Family Planning Programme (1975-1979) with an aim of reducing the rate of population growth from 3.3 % per year to 3 % per year and to improve on the health of the mothers and children. Other private organizations such as the International Planned Parenthood Federation (IPPF) and the Family Planning Association of Kenya (FPAK) have also been actively involved in these areas. In spite of all these efforts, the 1979 Census recorded a growth rate of 3.8 % per year. This high rate of growth was a result of high birth rate of 52 per 1000 and a reduction in crude death rate to about 14 per 1000.

In renewed effort in 1982, the Government established the National Council for Population and Development. The Council was set up to formulate population policies and strategies and to co-ordinate population-oriented activities aimed at reducing Kenya's population growth rate. One of its priorities is to provide all relevant audiences in Kenya with information on the implications of rapid population growth and its effect on the welfare of individuals. Documentation, evaluation of population activities, research, education and public services and information will be the major areas of concern for the Council. To achieve its objectives, the Council will involve Government Ministries and other organizations. The target is to reduce the rate of population growth to 3.3 % by 1988, through the recruitment of about 1.5 million acceptors of family planning.

National Economy :

In the first ten years after Independence, the gross domestic product in Kenya grew at an average annual rate of 7.9 % (the annual rate of growth in agriculture was 6.2 %, in industry, 12.4 % and in services, 7.6 %). However, in the decade that followed (1973-1984) the annual growth of GDP dropped down to 4.4 % (in 1977 the economy experienced a coffee boom and during the boom period GDP grew at a rate of 8.8 % but the effect of the boom subsided in 1978). The main factors responsible

for this slowing of the rate of growth of GDP include inflation caused by increase in oil prices, large deficit of the balance of payments and stagnation in marketed agricultural products and a high rate of population growth. In 1984, the GDP was about 5,140 million US $ (current prices). The structure of the GDP was 31 % agriculture, 21 % industry and 48 % services (World Bank, 1986).

The per capita gross national product (GNP) grew at a rate of 2.1 % in the period 1965-1984 (World Bank, 1986). The average annual rate of inflation increased from 2.3 % in the period 1965-1973 to 10.8 % in the period 1973-1984. Table 4 gives the per capita GNP for the period 1963-1984.

Table 4 GNP Per Capita in Kenya

Year	US $	KSH.
1963	103.8	726.60
1964	109.68	767.80
1965	107.68	753.80
1966	120.65	844.60
1967	122.71	859.40
1968	130.31	912.20
1969	133.00	931.00
1970	144.14	1009.00
1971	150.85	1056.00
1972	166.08	1162.00
1973	179.20	1254.40
1974	211.48	1480.40
1975	239.11	1673.80
1976	279.25	1954.80
1977	348.62	2440.40
1978	264.80	2648.00
1979	291.74	2917.40
1980	293.90	2939.00
1981	326.04	3260.40
1982	296.00	3480.80
1983	314.23	3770.80
1984	310.00	4340.00

Sources : Central Bureau of Statistics and World Bank (1986).
Exchange rates used : 1963-1977, 1 US$ = 7.0 Kshs.
1978-1981, 1 US$ = 10 Kshs.
1982-1983, 1 US$ = 12 Kshs.
1984 1 US$ = 14 Kshs.

II. WATER RESOURCES AND WATER QUALITY

1. WATER RESOURCES :

Kenya's water resources are divided into five drainage or catchment areas (Fig. 5). Table 5 gives the annual mean run-off in the different drainage areas.

Table 5 Annual Mean Run-off in Different Drainage Areas

Drainage Area	Annual Mean Run-off (million m^3)
Lake Victoria Basin	7,292
Rift Valley Basin	810
Athi River Basin	1,295
Tana River Basin	4,700
Ewaso Ngiro Basin	739
Total	14,836

Source : Ministry of Water Development.

Of the five catchment areas, Tana river basin is the largest and has numerous series of dams and storage reservoirs of which Masinga storage dam is the biggest. The basin has also the largest turn-over in terms of sediment yields. Athi river basin ranks second and has been studied by Tana and Athi River Development Authority (TARDA) to explore its future development. Kerio and Lake Victoria Basin Authorities are undertaking similar studies.

Although Kenya has numerous permanent and seasonal rivers, only five of these are permanent (Tana, Athi, Nzoia, Yala and Mara). Most other rivers dry-up or have minimal flows during the dry seasons. The problem is most acute in the arid and semi-arid regions which comprise the largest areas in Kenya. During the wet seasons, the rivers and streams are swollen and silt-laden indicating extensive soil erosion. Flooding in flat areas is common during the rainy season. Table 6 gives the characteristics of the major rivers in Kenya.

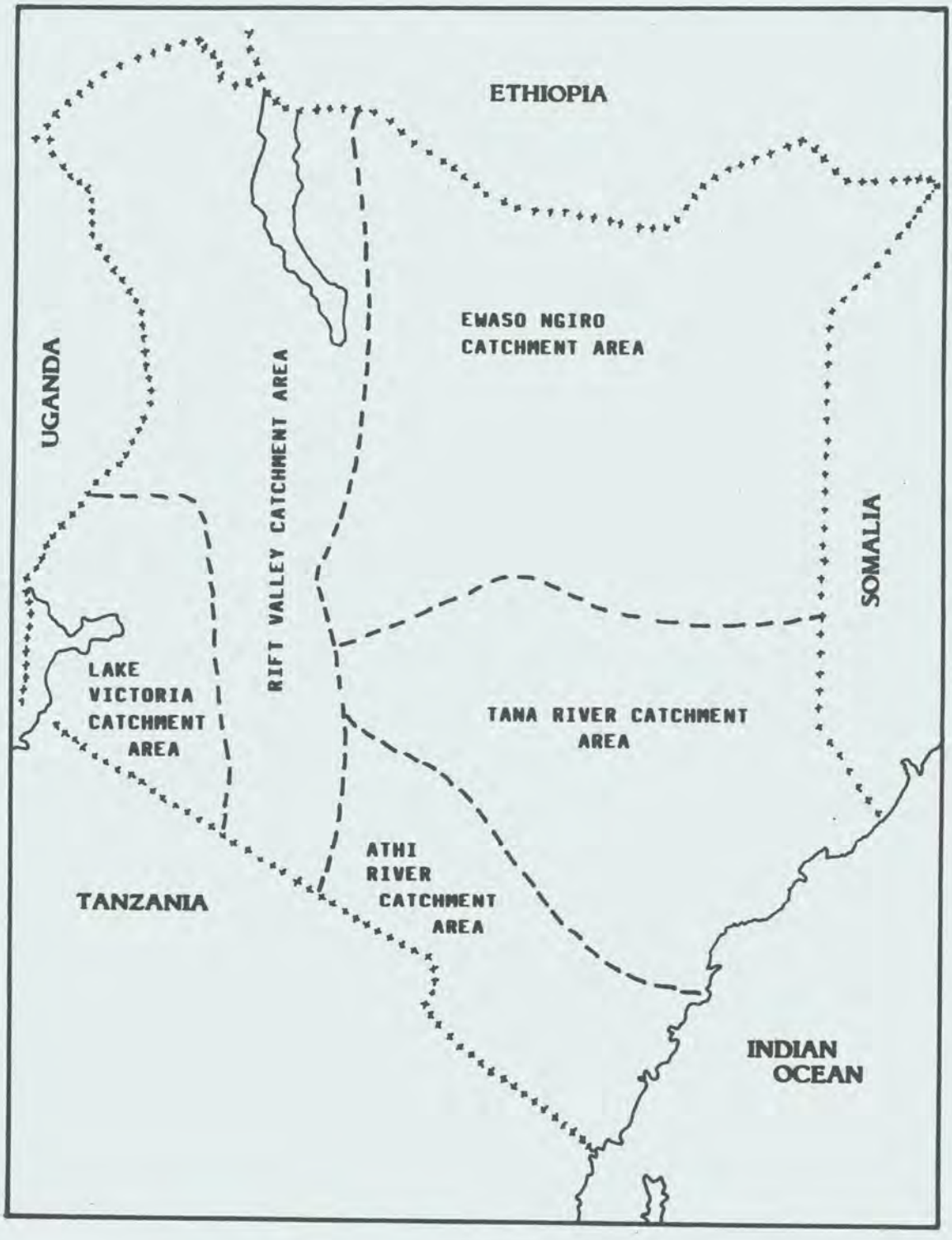


Fig. 5 Drainage Areas in Kenya

Table 6 Characteristics of Major Rivers in Kenya

River	Length(km)	Station	Width(m)	Depth(m)	Flow(m^3/sec)
Tana	725	Kiganjo	12.00	0.36	0.35
		Tharaka	43.28	3.68	63.59
		Garsen	63.00	3.45	61.99
Athi	591	Thika	26.00	0.10	1.50
		New Kibwezi	5.70	0.48	0.38
		Lugard Falls	102.58	0.30	4.88
Ewaso Ngiro	471	Archers Post	14.17	0.25	0.90
		Lorian Swamp	6.24	0.57	0.38
Kerio	320	Tambach	2.30	0.34	13.00
		Tot	0.70	0.10	0.01
		New Lokori	14.10	0.18	0.30
Turkwel	305	Turkwel Gorge	20.50	0.29	1.84
Nzoia	240	Webuye	28.69	1.77	10.14
		Moiben	4.70	0.31	0.44
		Mambale Market	26.00	1.86	23.30
Miriu	150	Matunda	1.60	0.11	0.01
		Sondu	35.00	0.72	4.73
		L.Victoria	17.00	0.83	5.74
Nyando	125	Ahero	16.00	0.50	1.88
		Muhoroni	10.48	0.40	1.14
		Lodiani	3.50	0.38	0.08

Data for 1984, Source : Ministry of Water Development.

Several inland lakes exist in Kenya, nearly all the major ones are found in the Rift Valley. With the exception of Lake Victoria, Lake Naivasha and Lake Baringo which have fresh water, Lake Turkana is brackish (slightly saline) and all other lakes are saline. The latter include Elementaita, Nakuru, Magadi and Lake Bogoria. Table 7 gives the general characteristics of inland lakes in Kenya.

Table 7 Characteristics of Inland Lakes

Lake	Area (km^2)	Depth (m)
I. FRESH WATER :		
Naivasha	115	6.5
Victoria (Kenya side)	3785	43.0
Baringo	130	10.0
II. BRACKISH :		
Turkana	6405	120.0
III. SALINE :		
Elementaita	18	1.1
Nakuru	5-30	seasonal
Magadi	100	Not Determined
Bogoria	34	10

Sources : National Atlas of Kenya, 1970 ; Ministry of Water Development.

As for groundwater resources in Kenya, there is no sufficient information at present concerning the extent of the aquifers, their structure and the volume of groundwater. However, many areas depend on groundwater and the annual withdrawals from aquifers have been estimated at about 17 million m^3; the annual recharge of the aquifers has been estimated at about the same amount.

2. WATER QUALITY :

The different water resources of Kenya vary greatly in their quality depending on their extent, distribution, terrain, hydrogeological characteristics, types of economic activities within each drainage area, etc. For these reasons, the quality of the water is a single river may vary from one point source to another. In general terms, however, the quality of inland waters in Kenya is acceptable for domestic and other purposes, after the conventional methods of treatment. Only in isolated cases, the quality of the water has deteriorated due to eutrophication of water bodies, chemical and/or bacteriological reasons.

Tables 8--18 gives the physical and chemical characteristics of inland waters in Kenya.

Table 8 Water Quality of Tana River (1983/1984)

Parameter	Upper Zone (Masinga Dam)	Middle Zone (Garisen)	Lower Zone (Indian Ocean)
pH	7.1	8.0	7.7
Colour (mg Pt/l)	55.0	-	-
Turbidity (NTU)	28.0	-	80.0
Oxygen Abs.(mg O_2/l)	25.0	0.4	42.0
Conductivity (µS/cm)	77.0	170.0	151.0
Iron (mg Fe/l)	2.2	-	-
Manganese (mg Mn/l)	0.13	-	0.07
Calcium (mg Ca/l)	5.0	20.0	18.0
Magnesium (mg Mg/l)	2.5	9.6	10.0
Sodium (mg Na/l)	7.0	-	-
Potassium (mg K/l)	-	15.0	-
Total Hardness (mg $CaCO_3$/l)	33.0	90.0	87.0
Total Alkalinity (,,)	20.0	216.0	90.0
Chloride (mg Cl/l)	6.6	14.0	6.9
Fluoride (mg F/l)	0.25	0.25	0.5
Sulphate (mg SO_4/l)	5.8	5.0	-
Orthophosphate (mg P/l)	0.04	-	0.07
TDS (mg/l)	44.0	285.0	91.0

Source : Ministry of Water Development
Values given are mean values

Table 9 Water Quality of Athi River (1983/1984)

Parameter	Upper Zone (14 Falls)	Middle Zone (Kibwezi)	Lower Zone (Indian Ocean)
pH	6.8	7.8	8.0
Colour (mg Pt/l)	70.0	-	90.0
Turbidity (NTU)	20.0	90.0	65.0
Oxygen Abs.(mg O_2/l)	35.0	47.0	42.0
Conductivity (µS/cm)	245.0	305.0	594.0
Iron (mg Fe/l)	2.0	-	-
Manganese (mg Mn/l)	0.6	-	-
Calcium (mg Ca/l)	8.2	16.0	26.0
Magnesium (mg Mg/l)	3.5	8.5	19.0
Sodium (mg Na/l)	58.0	-	-
Potassium (mg K/l)	9.0	-	-
Total Hardness (mg $CaCO_3$/l)	45.0	76.0	161.0
Total Alkalinity (,, ,,)	64.0	123.0	193.0
Chloride (mg Cl/l)	22.0	14.0	63.0
Fluoride (mg F/l)	0.72	0.53	1.1
Sulphate (mg SO_4/l)	7.3	6.8	42.0
Orthophosphate (mg P/l)	0.36	0.23	0.06
TDS (mg/l)	147.0	183.0	371.0

Source : Ministry of Water Development

Table 10 Water Quality of Ewaso Ngiro River (1983/1984)

Parameter	Upper Zone	Middle Zone
pH	7.5	8.0
Colour (mg Pt/l)	245.0	40.0
Turbidity (NTU)	30.0	28.0
Oxygen Abs. (mg O_2/l)	24.0	53.0
Conductivity (µS/cm)	198.0	313.0
Iron (mg Fe/l)	-	2.2
Manganese (mg Mn/l)	-	0.2
Calcium (mg Ca/l)	13.0	21.0
Magnesium (mg Mg/l)	8.8	13.0
Sodium (mg Na/l)	-	-
Potassium (mg K/l)	-	-
Total Hardness (mg $CaCO_3$/l)	67.0	96.0
Total Alkalinity (,, ,,)	79.0	57.0
Chloride (mg Cl/l)	9.0	14.0
Fluoride (mg F/l)	0.3	0.4
Sulphate (mg SO_4/l)	1.7	1.2
Orthophosphate (mg P/l)	0.08	0.27
TDS (mg/l)	119.0	188.0

Source : Ministry of Water Development

Table 11 Water Quality of Kerio River (1983/1984)

Paramter	Upper Zone	Middle Zone
pH	7.6	8.0
Colour	-	-
Turbidity (NTU)	104.0	76.0
Oxygen Abs. (mg O_2/l)	27.0	28.0
Conductivity (µS/cm)	145.0	230.0
Iron	-	-
Manganese (mg Mn/l)	-	0.06
Calcium (mg Ca/l)	13.0	23.0
Magnesium (mg Mg/l)	15.0	5.9
Sodium	-	-
Potassium	-	-
Total Hardness (mg $CaCO_3$/l)	81.0	86.0
Total Alkalinity (,, ,,)	114.0	102.0
Chloride (mg Cl/l)	3.0	6.0
Fluoride (mg F/l)	0.5	0.5
Sulphate (mg SO_4/l)	2.5	-
Orthophosphate (mg P/l)	0.13	0.23
TDS (mg/l)	100.0	120.0

Source : Ministry of Water Development

Table 12 Water Quality of Turkwel River (1983/1984)

Parameter	Upper Zone	Middle Zone	Lower Zone
pH	7.4	7.7	7.7
Colour (mg Pt/l)	12.5	250.0	500.0
Turbidity (NTU)	4.3	21.5	600.0
Oxygen Abs.(mg O_2/l)	4.0	5.5	0.4
Conductivity (µS/cm)	77.5	100.0	208.0
Iron (mg Fe/l)	0.35	0.9	0.01
Manganese (mg Mn/l)	0.1	0.06	0.01
Calcium (mg Ca/l)	9.4	14.5	23.0
Magnesium (mg Mg/l)	4.4	4.3	0.5
Sodium (mg Na/l)	4.8	5.4	7.5
Potassium (mg K/l)	2.4	2.7	3.5
Total Hardness (mg $CaCO_3$/l)	42.0	53.0	60.0
Total Alkalinity (,, ,,)	53.0	76.0	96.0
Chloride (mg Cl/l)	1.0	1.0	2.0
Fluoride (mg F/l)	0.21	0.19	2.0
Sulphate (mg SO_4/l)	4.1	1.0	2.5
Orthophosphate (mg P/l)	0.53	0.63	0.05
Nitrate (mg N/l)	0.67	0.75	0.44
TDS (mg/l)	40.0	68.0	120.0

Source : Ministry of Water Development

Table 13 Water Quality of Nzoia River (1983/1984)

Parameter	Upper Zone (Kipkareen)	Middle Zone (Siranga)	Lower Zone (L.Victoria)
pH	7.4	7.0	7.7
Colour (mg Pt/l)	50.0	150.0	30.0
Turbidity (NTU)	12.0	65.0	9.6
Oxygen Abs. (mg O_2/l)	28.0	30.0	23.0
Conductivity (µS/cm)	125.0	83.0	162.0
Iron (mg Fe/l)	-	-	2.5
Manganese (mg Mn/l)	0.2	0.1	0.03
Calcium (mg Ca/l)	9.4	3.7	12.0
Magnesium (mg Mg/l)	4.4	1.8	4.2
Sodium	-	-	-
Potassium	-	-	-
Total Hardness (mg $CaCO_3$/l)	37.0	27.0	48.0
Total Alkalinity (,, ,,)	56.0	36.0	77.0
Chloride (mg Cl/l)	4.0	3.0	12.0
Fluoride (mg F/l)	0.2	0.17	0.15
Sulphate (mg SO_4/l)	-	-	2.2
Orthophosphate (mg P/l)	0.02	0.03	0.03
TDS (mg/l)	73.0	48.0	97.0

Source : Ministry of Water Development

Table 14 Water Quality of Miriu River (1983/1984)

Parameter	Upper Zone	Lower Zone
pH	7.0	7.1
Colour (mg Pt/l)	20.0	10.0
Turbidity (NTU)	7.8	7.0
Oxygen Abs. (mg O_2/l)	15.0	12.0
Conductivity (µS/cm)	58.0	69.0
Iron (mg Fe/l)	0.88	1.2
Manganese (mg Mn/l)	0.01	0.01
Calcium (mg Ca/l)	3.2	4.0
Magnesium (mg Mg/l)	1.0	1.3
Total Hardness (mg $CaCO_3$/l)	12.0	15.0
Total Alkalinity (,, ,,)	21.0	32.0
Chloride (mg Cl/l)	6.3	7.0
Fluoride (mg F/l)	0.58	0.45
Sulphate (mg SO_4/l)	0.76	6.0
Orthophosphate (mg P/l)	0.03	0.02
TDS (mg/l)	35.0	42.0

Source : Ministry of Water Development

Table 15 Water Quality of Nyando River (1983/1984)

Parameter	Upper Zone	Middle Zone	Lower Zone
pH	7.8	7.8	7.7
Colour (mg Pt/l)	360.0	45.0	25.0
Turbidity (NTU)	46.0	25.0	15.0
Oxygen Abs. (mg O_2/l)	40.0	27.0	18.0
Conductivity (µS/cm)	297.0	215.0	255.0
Iron (mg Fe/l)	0.87	2.1	2.1
Manganese (mg Mn/l)	0.02	0.1	0.02
Total Hardness (mg $CaCO_3$/l)	103.0	178.0	88.0
Total Alkalinity (,, ,,)	132.0	93.0	114.0
Chloride (mg Cl/l)	6.4	5.3	7.9
Fluoride (mg F/l)	0.46	0.32	0.52
Sulphate (mg SO_4/l)	3.0	2.3	0.93
Orthophosphate (mg P/l)	0.56	0.13	0.14
TDS (mg/l)	172.0	129.0	120.0

Source : Ministry of Water Development

Table 16 Water Quality of Fresh Water Lakes (1983/1984)

Paramter	Lake Naivasha	Lake Victoria	Lake Baringo	Lake Turkana
pH	8.3	8.0	8.6	9.3
Turbidity (NTU)	25.0	4.1	70.0	21.0
Oxygen Abs. (mg O_2/l)	38.0	20.0	21.0	35.0
Conductivity (µS/cm)	429.0	140.0	838.0	2730.0
Iron (mg Fe/l)	16.0	-	10.0	-
Manganese (mg Mn/l)	0.6	-	0.15	-
Calcium (mg Ca/l)	16.0	5.7	8.1	4.3
Magnesium (mg Mg/l)	8.4	5.5	4.5	2.6
Sodium (mg Na/l)	32.7	-	-	189.3
Total Hardness	95.5	37.0	50.0	22.0
Total Alkalinity	124.5	53.0	360.0	914.0
Chloride (mg Cl/l)	20.0	9.3	48.0	400.0
Fluoride (mg F/l)	1.8	0.35	55.0	8.8
Sulphate (mg SO_4/l)	1.3	2.6	7.1	28.0
Orthophosphate (mg P/l)	0.88	0.01	0.35	1.3
TDS (mg/l)	259.0	86.0	510.0	2138.0

Lake Turkana is brackish water. Source : Ministry of Water Development

Table 17 Water Quality of Saline Lakes (1983/1984)

Parameter	Lake Elementaita	L. Nakuru	L. Magadi	L. Bogoria
pH	10.2	9.5	9.7	9.7
Turbidity (NTU)	6.0	21.0	-	253.0
Oxygen Abs. (mg O_2/l)	172.0	197.0	200.0	115.0
Conductivity (µS/cm)	21000	9158	58500	41380
Iron (mg Fe/l)	-	1.2	-	0.55
Manganese (mg Mn/l)	-	0.7	-	0.15
Calcium (mg Ca/l)	1.5	5.7	13.0	1.1
Magnesium (mg Mg/l)	2.0	2.4	16.0	0.3
Sodium (mg Na/l)	-	-	-	15400
Total Hardness	4.0	16.0	88.0	130
Total Alkalinity	7384	5747	23500	38920
Chloride (mg Cl/l)	2432	1049	6325	2818
Fluoride (mg F/l)	598	167	112	899
Sulphate (mg SO_4/l)	369	55	140	142
Orthophosphate (mg P/l)	-	0.3	-	-
TDS (mg/l)	12900	5494	32100	24830

Source : Ministry of Water Development

Table 18 Quality of Groundwater

Parameter	(1)	(2)	(3)	(4)	(5)	(6)	(7)
pH	7.5	7.6	7.9	7.7	7.9	8.0	8.0
Colour (mg Pt/l)	7.5	50.0	-	9.3	-	10.0	15.0
Turbidity (NTU)	10.0	10.0	65.0	6.4	20.0	3.3	10.0
Oxygen Abs. (mg O_2/l)	15.0	30.0	73.0	6.0	12.0	15.0	39.0
Conductivity (µS/cm)	12	799	1080	506	460	1506	6640
Iron (mg Fe/l)	0.42	2.0	1.6	1.0	2.8	1.4	0.24
Manganese (mg Mn/l)	0.08	0.11	0.1	0.12	0.09	0.4	0.15
Calcium (mg Ca/l)	32.0	28.0	-	20.0	20.0	104	149
Magnesium (mg Mg/l)	7.3	21.0	-	2.2	15.0	65	149
Sodium (mg Na/l)	35.0	180.0	-	148	-	8.0	2450
Potassium (mg K/l)	4.0	-	-	20.0	-	-	42
Total Hardness	107	163	180	64	90	141	1044
Total Alkalinity	123	295	337	192	165	377	-
Chloride (mg Cl/l)	7.0	-	85.0	40.0	46.0	205	1623
Fluoride (mg F/l)	0.7	3.4	7.4	3.5	1.3	0.7	0.9
Sulphate (mg SO_4/l)	0.7	52.0	51.0	15.0	17.0	51.0	716
TDS (mg/l)	127	560	649	304	275	870	4090

(1) Nayanza and Western Provice (1984)
(2) Rift Valley Province (1984)
(3) Eastern Province (1983)
(4) Nairobi Province (1985)
(5) Central Province (1984)
(6) Coast Province (1984)
(7) North-Eastern Province (1984)
Source : Ministry of Water Development

3. WATER USE :

Water use in Kenya takes many different forms varying from traditional well supplies to modern irrigation systems and hydroelectric generation stations. The total water use at present is about 600 million m^3 per year (18 % for domestic use; 69 % for agriculture and 13 % for industry). The demand for water is expected to increase rapidly and it has been estimated that the total water use in Kenya will reach 2,500 million m^3 per year in 2000. Urban centres like Nairobi and Mombasa will have to look for alternative sources of water to meet the rapidly increasing demand. In Nairobi, for example, the present demand for water is about 50 million m^3 per year which is met from Tana River, while Athi River supplies only about 19 % (9.5 million m^3/year). When rainfall is short parts of Nairobi face water shortages. The principal water sources for Mombasa are the Mzima Springs (providing about 13 million m^3 per year) and coastal waters (providing about 7 million m^3 per year). With the expansion in tourist activity in the area, alternative water resources have been developed to meet the increasing needs of the Kenyan coastal zone.

In 1980, about 85 % of the urban population (2,051,000) were served with safe drinking water; the percentage in rural areas was only 15 % (about 2 million people were served). As for sanitation, 89 % of the urban population was served by facilities , while in the rural areas 19 % were served with adequate sanitation (WHO, 1984). The targets set by the Kenya Government within the framework of the International Drinking Water Supply and Sanitation Decade are to provide safe drinking water to all the urban population by the year 1990 (about 6 million people) and to 60 % of the rural population (about 11 million to be served). The targets for sanitation are 71 % for urban areas (about 4 million people to be served) and 43 % for rural areas (about 8 million to be served).

4. WATER POLLUTION CONTROL :

Water bodies are subjected to pollution from different sources, the most important of which are runoff from agricultural land, discharges of municipal and/or industrial wastewater. Table 19 gives an estimate of the amounts of discharges into the different water bodies.

Table 19 Discharges into Water Bodies

Type of Discharge	Amount (million m^3) discharged into Rivers	into Lakes
Municipal Wastewater	10.8	1.7
Industrial Wastewater	41.0	1.7
Mixed Wastewater	60.0	7.4

Municipal wastewater is treated using biofiltration, stabilization ponds and/or activated sludge processes. Biofilters are being phased-out and replaced by stabilization ponds which are cheaper to operate. The major urban areas have stabilization ponds (primary, secondary and maturation ponds); the treated effluents are then discharged into watercourses. The discharged effluent has the following characteristics:

- BOD (5 days at 20°C)..... less than 20 mg/l
- Suspended solids ..... less than 30 mg/l
- pH ..... Between 6 and 9
- Coliform bacteria count..... less than 1000/100 ml

Industrial wastewater is also treated, the process of treatment varies from industry to another and depends on the nature of the wastewater and the amounts involved. In general, the effluents should adhere to the above-mentioned specifications before being discharged into watercourses. These specifications are based on the assumption that the rivers in Kenya will have a dilution capacity of 1.8.

III. THE MARINE ENVIRONMENT

The topography of the Kenya coastal area is diverse and presents a very mixed pattern. The main topographic feature is a relatively steep, partly cliffy land rising from the ocean front to an elevation of about 30-60 m above sea level is some places from which the terrain flattens out over the coastal plain.

In the north, near the Somali border, a chain of coral islands enclose lagoons where climax mangrove forest grows, and where large populations of certain seabirds breed, especially roseate, white-checked, and bridled terns. South of this there are extensive areas of mangroves near Lamu and the home of a fairly large population of a threatened animal, the dugong. At and near Malindi the Kenya waters consist of a rather narrow strip between 10 and 100 fathom depth contours, the southern part of which is influenced by the outflow of the Sabaki River. From here southwards most of the coastline is protected by a fringing coral reef, about 1.5 km offshore, and low coral cliffs alternate with beaches of white coral sand. The Malindi-Watamu Marine National Parks (about 15 km^2) include different varieties of coral reefs at Malindi, in the Watamu lagoon, and at the mouth of Mida Creek. The parks are surrounded by a much larger area of reserve; both harbour a great variety of fish species.

Marine Pollution :

Different discharges from land-based sources find their way into the marine environment in Kenya, the most important are municipal and industrial wastewaters and discharges from the Ramisi, Tana ans Sabaki Rivers. Although the quantities of these discharges are not accurately known, it has been estimated that about 10,000 m^3/day of untreated municipal wastewater (mainly from Mombasa) and about 1,660 m^3/day of industrial effluents (mainly from the petrochemical industry) are discharged into the marine environment. The amount of outflow from the Ramisi, Tana and Sabaki Rivers into the Indian Ocean has not been estimated.

No systematic monitoring has, hitherto, been carried out to determine the quality of the marine environment. Some studies (NOR Consult Report on Mombasa Sewerage, 1975) gave the following concentrations of some heavy metals in sea water : Zn (2.8-7 ppm), Pb (0.2-10 ppm), Cd (0.05-0.1 ppm), Cu (0.5-1.6 ppm). The concentration of dissolved hydrocarbons in sea water has been found to be 0.28 ppb at Ngomeni and 0.58-0.89 ppb at Malindi. In 1982, the concentration of tar on the beaches was as follows : 2.7 g/m^2 at English Point, 0.3 g/m^2 at

Mombasa Hotel Beach, 1.0 g/m² at Malaika, 12.0 g/m² at Kikambala Cottages and 2.5 g/m² at Kilifi.

The major impacts of marine pollution so far noticed in Kenya include the destruction of mangroves due to silt-laden waters from Tana and Sabaki Rivers. The sediments also smother the coral polyps, reduce light and increase erosion at the base of the coral formations. A healthy coral reef provides a barrier to sea waves, is a breeding ground and a habitat for many important fish species and provides sand for the beaches. The destruction of the reef will, therefore, result in excessive beach erosion.

Oil pollution of the marine environment results from normal discharges from ships and from oil spills (from tankers and/or pipelines and other facilities of the oil industry). Oil pollution is common at the Kilindini Harbour.

IV. LAND, AGRICULTURE AND FOOD PRODUCTION

1. LAND USE :

The total area of Kenya is about 580,367 km², of which about 11,230 km² are covered by water. About 72 % of the area of Kenya receives less than 500 mm of rainfall per year; 13 % receives 500-750 mm; 12 % receives 750-1250 mm and 3 % receives over 1250 mm. Therefore, on the basis of water availability for agriculture, 85 % of Kenya is of low and medium potential and 15 % is of high potential. In other words, 85 % of the area of Kenya is considered sub-humid, arid and semi-arid.

In the high and some parts of the medium potential areas, forests and grassland occur below the snow line and land cover is variable, consisting of moist woodland, bushland and wooded grassland. Trees in these areas are characteristically broad-leaved. In parts of the medium and the low potential areas, natural land cover consists of woodland, wooded grassland and bushed grassland. Various trees and grasses found in these areas include : Commiphora , Acacia reficiens, Cenchrus ciliaris, Choris roxburghiana and Chrysopogen aucheri.

At the beginning of the present century many areas of Kenya which are now cultivated were heavily forested but in the 1920s and 1930s settlements started in the highlands. This resulted in significant land clearance and the introduction of intensive mixed farming, commercial livestock husbandry and plantation crops in large-scale farms. Concurrently, in other high potential areas, the upsurge of human population resulted in more land clearance, more pressure on soils through shortening of fallow periods and fragmentation of the land. In 1960s a massive re-settlement programme in the high potential areas resulted in fragmentation of the former large scale farms and the settling of small holders. This subdivision of land has continued until the present time. The low potential areas, on the other hand, remained largely under traditional pastoral nomadism until the late 1970s. In some areas grazing lands have been shared with wildlife.

The marked increase in the population has exerted considerable pressure on land. At present, land use interests such as agriculture, tourism, ranching, wildlife management, forestry, water conservation- each of them valid and rationally productive- are in some cases competitive and often conflict over large areas of the country. Such pressure on land resources is one of the causes of land degradation.

In 1981 it was estimated that in the high potential areas the average land area per capita was 0.7 ha ; in the medium potential areas it was 1.8 ha while in the low potential areas it was 28 ha.

According to FAO, the land area of Kenya can be classified into the following categories :

- Arable and Permanent Cropland (4%) : 23,215 km²
- Meadows and Permanent Pasture (7%) : 40,626 km²
- Forests and Woodland (4%) : 23,215 km²
- Other Land (85 %) : 493,312 km²

Values are for 1981-1983; Source : WRI/IIED (1986)

At present, agriculture is the predominant land use in the high potential areas whereas livestock production and wildlife management predominate in the low potential areas. Traditional farming areas currently occupy over 56 % of the total area farmed and contain 80 % of the farming population.

From the agro-climatic point of view, the following zones have been identified :

Agro-climatic zone	Approximate Altitude (m)	Rainfall (mm)	Land use
Afro-alpine	> 3,000	1100-2700	Water catchment Tourism
Upper Highland	2,200-3,000	1000-1600	Dairying, sheep farming, pyrethrium, wheat, barely, dryland ranching
Lower Highland	1,900-2,200	800-1400	Tea, dairying, maize sheep ranching, pyrethrium, horticulture.
Upper Midland	1,300-1,900	600-1100	Tea,coffee, maize, dairying, sunflower, sorghum, millet
Lower Midland	800-1,300	450-900	Sugarcane,cotton, sorghum, millet, maize, horticulture, grazing
Lowland (Rangeland)	0-800	150-550	Ranching, sugarcane, coconut, cassava, maize. sorghum,rice.

Sources : Ministries of Agriculture & Livestock Development and Lands, Settlement and Physical Planning.

Land Degradation and Soil Loss :

As a result of the rapid increase in population in the highland areas, people started to migrate from the high potential areas in pursuit of opening up of new lands in the more fragile marginal or semi-arid zones. As a result, land which was only marginally suited to cultivation is being cultivated beyond its carrying capacity with the ultimate result of increasing land degradation.

The mounting pressure on land and the resulting intensification of land cultivation have resulted in the shortening of fallow periods in shifting cultivation. Thus the land is not given enough time to regain its natural fertility and, therefore, becomes vulnerable to degradation. At present, some districts (e.g. Machakos, Kitui, Kisii, Kakamega, Nyeri, Muranga, Kirinyaga, Kiambu and some parts of the Coast Province) have reached and even exceeded their carrying capacities.

Non-agricultural causes of land deterioration in Kenya are destruction of habitat by wildlife, mining and quarrying, unplanned settlement, inappropriate man-made structures and floods. In wildlife-inhabited low potential areas, high densities of wild animals have caused over-grazing and land degradation. For instance in the Mara and Loita Plains of Narok District, wild herbivore populations, especially wildbeasts increased considerably between 1961 and 1982 which led to an increase in the percentage of bare land. In the period between 1966 and 1982, bare land in Mara increased from 11 % to 25 %, while in the same period bare land in Loita increased from 30 % to 55 %. This destruction of habitat as a result of high wildlife densities has been aggravated by reduction in the area of rangelands as a result of encroachment by wheat cultivators. This trend of overgrazing, habitat destruction and the attendant land degradation is a common feature of many areas inhabited by wildlife (and livestock), e.g. the Amboseli grazing lands. The greatest damage is done during drought periods.

Recently, it has been realized that abandoned mines and quarries cause a variety of environmental problems; the Kenya Government has, therefore, accorded high priority to the rehabilitation of mined areas. This, has successfully been done in a few areas.

Unplanned settlements such as is the case in many settlement areas of northern Kenya cause land deterioration mainly through vegetation destruction and overgrazing. In the pastoral areas, large quantities of wood are used in addition to the requirement for building and fuel, for construction of night enclosures. Likewise, problems such as deforestation, heavy machinery clearance of vegetation, etc, have contributed to land deterioration. The Bura Irrigation Scheme is an example of a settlement which was planned without consideration of the environmental impacts of the project. As a result, vegetation destruction and over-

grazing caused land deterioration in and around the scheme. Corrective measures are now being instituted to rectify the situation at the scheme.

Man-made structures that are inappropriately planned such as roads and tracks, ditches, water points, dips, dams, markets, school compounds,etc. have caused land deterioration through overgrazing and soil erosion. For example, roads which are not suitably aligned have often discharged accumulated water into agricultural land causing erosion and soil loss, whereas dams in heavily stocked areas are causing localised overgrazing.

The dangers of soil erosion increased in Kenya in the 1960s when the nature of approach to soil conservation changed from enforcement to advisory, which led to a temporary breakdown of soil conservation activities. In response to this situation, Kenya stepped up her efforts to conserve the soil in the 1970s with emphasis on advice and training to farmers, training of extension workers and funding of soil conservation programmes.

Although success has been achieved in certain parts, the dangers of soil erosion are still eminent. Soil erosion is still widespread in both the high and low potential areas. This is mainly due to the high erosive effect of rainfall, the topography of the land, the type of vegetative cover and the land use practices. Soil erosion is most severe in arid and semi-arid areas (85% of Kenya), moderate in high and medium potential regions and least in forested and improved grazing areas. Considerable soil loss (as much as 20 tonnes/ha/year) has been reported in certain high potential areas suitable for arable agriculture, such as Muranga District. Estimates show that in high potential areas where erosion takes place, about 2.5 cm of top soil can be removed in about 15 years; a rate which exceeds the rate at which soil can be formed by natural processes. In the high and medium potential areas of Bungoma District, Nyanza and Central Provinces, gully erosion is eminent.

Soil loss due to running water and wind which is above the permissible amounts (10 tonnes/ha/year) is noticeable in marginal and semi-arid areas due mainly to overstocking and overgrazing by livestock and wildlife. Such soil loss has been reported in parts of Machakos, Kwale, Kilifi, Embu, Kitui, Kijiado, Nakuru, Meru, Samburu, West Pokot, Taita Taveta, Narok, Laikipia, Baringo, Elgeyo, Marakwet, and Marsabit. In West Pokot, Kijiado, Nakuru, Taita, Kitui and Embu soil losses exceed 32 tonnes/ha/year. From Kitui District and the surrounding areas alone, about 200,000 tonnes of top soil were already lost to the Indian Ocean by 1983. It has been predicted that, in the absence of conservation measures, about 50 % of the Amboseli grazing lands will be stripped of their soil cover within 50 to 125 years, depending on the future rate of soil erosion.

Special soil conservation programmes are underway in over 36 districts in the high and low potential areas; reasonable success has been achieved. In the rangelands, however, the control of stocking

rates of both livestock and wildlife has been a disturbing factor. With the setting up of the Permanent Presidential Commission for Soil Conservation and Afforestation, considerable progress has been achieved and it is hoped that soil conservation work will be sustained.

Although the same processes leading to desertification are operational in almost all areas of Kenya, it is in the arid , semi-arid and sub-humid areas that desertification occurs most. Of the total population of Kenya, about 20 % live in the arid and semi-arid marginal areas; of this population about 2 million people are directly threatened by desertification.

In Kenya's drylands the basic problems underlying the immediate causes of desertification are socio-economic, cultural and political in nature. These problems have led to the creation of physical as well as institutional processes which have in turn led to the degradation of land resources, reduction in agricultural productivity and consequently to desert encroachment. Rapid population growth and modernization in some sectors of the economy have disrupted traditional systems of land use which were usually well adapted to the fragile ecosystems of arid and semi-arid areas. This has left the inhabitants with the choice between starvation or actions to increase food production even at the expense of degradation of the environment.

In general, desertification in the arid and semi-arid areas of Kenya is triggered off by the destruction of rangeland vegetation and overgrazing accompanied by water resource depletion, declining crop yields (in snatch cropping) and land fragmentation. The situation is aggravated by the existence of constraints upon development of such areas such as limited water resources, climate, soil conditions, energy sources, low primary productivity and the low carrying capacity of grazing lands.

Of the total area of Kenya, about 483,860 km^2 (i.e. about 83 %) are already affected by desertification to varying degrees. About 110,000 square kilometres (i.e. 19 % of the total area of Kenya) can be considered to be already severely affected while 53,000 km^2 show moderate signs of desertification. In the desertified areas of northern Kenya, sand dunes, shallow, stony and calcareous soils exist. A considerable portion of these arid and semi-arid areas has saline and/or alkaline soils. The widepread occurrence of salinization and alkalinization, particularly in the north eastern parts of Kenya, is due to natural processes that took place in ancient times due to a high saline groundwater table prevailing at those times.

In general, it is predicted that the situation in the arid and semi-arid areas of Kenya, which suffer from desertification, might improve in the future in the light of current programmes undertaken in these areas. These programmes include : range improvement and rehabilitation, water development, desert-crop development and several arid land

research projects. The Integrated Project on Arid Lands (IPAL) and the follow-up project, the Arid Land Research Centre (ALRC) deserve special mention as they have produced valuable information necessary for the formulation of rational land use plans for arid and semi-arid areas. The preliminary results from the IPAL study have emphasized the rehabilitation of degraded land and improvement of productivity through reduction of livestock numbers, redistribution of grazing pressure, water development and an appropriate marketing structure.

Land Reclamation :

Land reclamation is underway in Kenya in some districts; the largest project is the Yala Swamp Project in Nyanza Province. Other isolated reclamation efforts have taken place around Lake Naivasha and in isolated valley areas in Kisii District. There are proposals to reclaim some flood-prone areas bordering Lake Victoria.

Although the Yala Swamp covers an area of about 43,300 ha , only 2,700 ha have so far been reclaimed and have been under cultivation by the local residents for the past ten years. Under the Kisii Valley Bottom Development Programme, about 2,850 ha are to be reclaimed.

Reclamation of swampy areas and valley bottoms will result in the disappearance of certain plant communities. It has been suggested that an inventory be established of plants growing in these areas before they are fully reclaimed. If certain rare species are to be found, some reserves might be established to conserve such genetic resources.

2. AGRICULTURE :

Agriculture is generally considered the most important sector in Kenya's economy. In 1984 about 31 % of the Gross Domestic Product (GDP) originated from the agricultural sector, while about 60 % of the value of exports comprised raw or processed agricultural products. An important fact is that the majority of Kenya's population lives in rural areas and is dependent on agriculture for its livelihood. Kenya's population is also growing very rapidly, and agriculture is likely to continue as a vitally important sector in the economy.

Kenya has a strong production base for important cereals like wheat, maize, barely, oats, sorghum, millet and for industrial crops such as coffee, tea, sisal wattle, cashewnuts, coconuts, pineapples and pyrethrum. Besides root crops, vegetables, pulses (legumes) and other food crops are produced. Whereas the production of rice is confined to irrigation schemes and swampy areas, sugarcane is grown mainly in areas of black cotton soils in western Kenya and the Coast Province.

Table 20 gives the main crops grown in Kenya and Table 21 gives data on exports and imports of some crops. Over the past years, the production of the major cash crops- tea, coffee, sugarcane, rice, pyrethrum- has increased, though inconsistently, mainly as a result of an increase in small holder production. Although Kenya has realized surpluses in most food crops, frequent droughts have adversely affected production in some years and this has necessitated importation of such crops. The crop yields given in Table 20 are subject to large deviations due to agro-climatic conditions and agricultural practices adopted. Thus, although the average yield of maize is reported to be 2250-2700 kg/ha, yields may be as high as 7800 kg/ha or as low as 1000 kg/ha. At present, high yield or more suitable varieties of seeds (e.g. varieties of maize, wheat, barely, sorghum, beans, pigeon peas, sunflower, potatoes, cotton, sugarcane, coffee, tea and pyrethrum) are being introduced.

Modern agricultural practices introduced in some areas have led to the creation of stable farming systems in which yields have been maintained or improved without adverse effects on the environment. This is illustrated mainly by the increase in the proportion of cropland protected by some conservation measures such as cut-off drains, terraces or grass strips and the change in crop production methods due to increased use of inputs such as improved crop varieties, fertilizers, pesticides, irrigation and mechanization.

Table 20 Major Crops Produced in Kenya

Year	Coffee	Maize	Tea	Wheat	Rice	Cotton	Sugarcane	Pyrethrum
1978	81,429	1,739,681	93,400	175,000	35,427	35,442	236,276	8,121
1979	72,888	1,603,952	99,300	172,400	37,476	29,213	296,586	10,405
1980	91,009	1,767,569	89,900	212,900	39,944	26,783	340,239	14,703
1981	98,751	2,502,000	90,000	250,800	38,765	24,258	368,970	19,000
1982	86,923	2,347,730	119,700	270,000	27,000	23,531	308,019	8,073
1983	85,450	2,133,000	116,500	230,000	29,000	18,257	326,329	3,155
1984	128,941	1,413,000	147,500	121,000	33,000	33,581	372,114	3,101
1985	NA	2,610,000	147,100	NA	38,400	NA	345,345	NA
Average yield	1800-3000	2250-2700	3000-8000	1980-3620	2250-9000	1000-2000	190,000	1,700

Notes :
- Values for coffee : green coffee in tonnes.
- Values for maize in tonnes
- Values for tea : made tea in tonnes
- Values for wheat, paddy rice in tonnes. All values for rice are for irrigated paddy.
- Values for cotton : Seet cotton in tonnes
- Values for sugarcane : milled white sugar in tonnes
- Values for pyrethrum : tonnes of flowers
- Average yield refers to 1984 in kg/ha

Source : Ministry of Agriculture and Livestock Development

Table 21 Exports and Imports of Major Crops

I. Exports

Commodity (tonnes)	1979	1980	1981	1982	1983
Coffee	77,241	80,066	86,108	100,968	90,444
Maize	120,475	20	991	949	122,514
Tea	94,023	74,799	75,350	80,413	99,941
Cashewnuts	73	10,700	4,222	3,372	5
Sisal	25,941	40,397	36,358	40,428	38,931
Cotton	1,886	4,020	2,557	-	726
Pyrethrum Flowers	564	65	50	-	13
Pyrethrum Extract	390	285	149	215	221

II. IMPORTS

Commodity (tonnes)					
Wheat (unmilled)	21,152	48,462	49,239	139,326	81,946
Maize (unmilled)	18	323,873	77,394	89,056	-
Rice	241	1,239	4,573	11,880	44,768
Sugar	12,504	1,751	1,756	2,216	2,402
Tea	8,597	6,244	10,070	8,261	9,351
Tobacco	1,754	328	444	281	3

Source : Kenya Central Bureau of Statistics

The present area covered by large-scale irrigation schemes in Kenya is about 9,518 ha (mainly in Mwea, Ahero, Bura, West Kano, Bunyala, Perkerra and Hola). Besides these schemes, there are also small isolated irrigated areas and plans exist to increase the area of irrigated land in future. The main crop grown in these schemes is rice, although vegetables and sugarcane are also grown to a lesser extent.

In Kenya, mechanization and use of improved modern farm implements are by and large still features of large-scale farms. In these farms, mechanization by the conventional four-wheeled tractor, harvesters and mechanized spraying of crops are popular. Operations which are usually mechanized include ploughing, harrowing, planting, weeding, spraying, harvesting (wheat), hay and silage making and milking. In smaller farms, on the other hand, the use of ox-plough and hand implements is common although the four-wheeled tractor is occasionally used. Generally, the small size of many small holdings does not allow mechanization on a large scale.

The use of chemical fertilizers has increased in Kenya with increase in agricultural production. The use of nitrogenous fertilizers increased from 26,700 tonnes of nitrogen in 1980/81 to 31,000 tonnes in 1983/84 while phosphates increased from 25,900 tonnes of P_2O_5 to 49,100 tonnes in the same period. However, the use of potash fertilizers decreased from 9,000 tonnes of K_2O in 1980/81 to 6,700 tonnes in 1983/84 (FAO Fertilizer Yearbook). The rate of application of different fertilizers varies from one crop to another; in general, the average rate of fertilizer consumption is 37 kg/ha of arable land (World Bank, 1986).

A great variety of pesticides are used in Kenya to control pests. Table 22 gives the average annual amounts of different types used, and Table 23 gives a list of the most commonly used pesticides (it has been estimated that about 1,500 products are used in Kenya for agriculture, food storage and control of vector-borne diseases). The Food, Drugs and Chemical Substances Act (Cap.254) has established the tolerance levels of different pesticides in the soil and the crops on which they are used. A survey on pesticide use in Kenya in 1973 showed that eleven active ingradients per hectare were used during that time. At present, more active ingradients are most probably being used per hectare; the exact amounts of pesticides used in various crops are difficult to quantify. However, it should be noted that DDT is widely used on maize and cotton, Malathion is used in the storage of grains and Cabaryl in cotton. In addition to these, large quantities of fungicides are used in cash crops such as coffee and horticultural crops.

Table 22 Average Annual Amounts of Pesticides Used in Kenya

Pesticides	Annual Amounts Used (tonnes)
Insecticides	876
Fungicides	3,610
Herbicides	656
Acaricides	67
Nematocides	27
Fumigants	472
Rodenticides	12
Hormones	10
Insect Attractants	1
Soil Sterilants	18
Seed Dressing	1
Biological Insecticides	24

These average annual figures are for the period 1979-1983; fluctuation from the average 5 %
Source : National Agricultural Laboratories

Table 23 List of the Most Commonly Used Pesticides

I. Insecticides :

1.Acephate
2.Alicarb
3.Aldrin
4.Allethrin
5.Amitraz
6.Azinophos-Ethyl
7.Azinophos-Methyl
8.Azocyclotin
9.Bendiocarb
10.Binapacryl
11.Bioresmethrin
12.Brodifacoum
13.Bromophos
14.Bromopropylate
15.Camphechlor
16.Carbaryl
17.Carbofuran
18.Chloralose
19.Chlordane
20.Chlorfenvinphos
21.Chlorophacinone
22.Chlorpyrifos
23.Chlorpyrifos Methyl
24.Coumatetralyl
25.Cyfluthion
26.Cynexation
27.Cypermethrin
28. DDT
29.Deltamethrin
30.Demeton
31.Demeton-S.Methyl
32.Dialifos
33.Diazinon
34. 1,3-DOC
35.Dichlorvos
36.Dicofol
37.Dicrotophos
38.Dieldrin
39.Dienochlor
40.Difenacoum
41.Diflubenzuron
42.Dimethoate
43.Dinobuton
44.Dinocap
45.Dioxacarb
46.Diphacinone
47.Disulfotan
48.Endosulfan
49.Ethiofencarb
50.Ethion
51.Ethioprophos
52.Etrimfos
53.Fenamiphos
54.Fenitrothion
55.Fenpropathrin
56.Fenthion
57.Fenvalerate
58.Flucythrinate
59.Fluvalinate
60.Formothion
61.Lindane
62.Heptachlor

II. Herbicides :

1.Alachlor
2.Allosydium
3.Ametryne
4.Asulam
5.Atrazine
6.Bentazone
7.Benzoylprop Ethyl
8.Bromacil
9.Bromoxnil
10.Butachlor
11.Chloroxuron
12.Chlothal Dimethyl
13.Chlortoluron
14.Cyanazine
15.Dalapon
16.Di-allate
17.DiCamba
18.3,4-Dichloropicolinic Acid
19.Dichlorprop
20.Diclofop Methyl
21.Difenxoquat
22.Diquat
23.Diuron
24.EPTC
25.Ethidimuron
26.Flamprop-Isopropyl
27.Fluazifpp
28.Fluometuron
29.Fluorodien
30.Glyphosate
31.Karbutilate
32.Ioxylnil
33.Hexazinone
34.Lenacil
35.Linuron
36.MCPA
37.Mecoprop
38.Methab
39.MSMA
40.DSMA
41.Metobromuron
42.Metolachior
43.Metoxuron
44.Metribuxin
45.Nonflurozon
46.Oxadiazon
47.Oxyfluorfen
48.Paraquat
49.Pendimenthalin
50.Perfluifone
51.Picloram
52.Prometryne
53.Propachlor
54.Propanil
55.Sodium Chlorate
56. TCA
57.Terbutryne
58.Thiazfuron
59.Tri-Allate
60.Trifluralin
61. 2,4-D
62.Malathion
63.Metaldehyde
64.Methacrifos
65.Methiocarb
66.Nidosamide
67.Oxamyl
68.Phoxim
69.Pyrethrins
70.Zinc Phosphide

Table 23 (Continued)

71.Resmethrin
72.Sulprofos
73.Tetrachlovinphos
74.Tetradifon
75.Thiocyclam
76.Thiometon

III. Fungicides :

1.Anilazine
2.Benalaxyl
3.Benodanil
4.Benomyl
5.Binapacryl
6.Bitertatol
7.Bupirimate
8.Captafol
9.Captan
10.Carbendazium
11.Carboxin
12.Cuprous oxide
13.Copper oxychloride
14.Cymoxanil
15.Dimethirimol
16.Dinobuton
17.Dinocab
18.Dithianon
19.Edipenphos
20.Dodine
21.Fentin Acetate
22.Fesetyl
23.Guazatine
24.Prodione
25.Menb
26.Metalaxyl
27.Oxycarboxim
28.Prochloraz
29.Proprioneb
30.Prothocarb
31.Quinomethionate
32.Quintozene
33.Sulphur
34.Thiabendazole
35.Thiram
36.Triadimefon
37.Tridemorph
38.Triforine
39.Vinclozolene
40.Ziram

Source : National Agricultural Laboratories

The use of pesticides in Kenya resulted in a number of environmental impacts, the following are examples of these impacts :

1. The extensive use of DDT, Toxaphene and other pesticides to control pests in cotton farms in the Kitale area in the early 1960s resulted in a resurgence of cotton bollworm, tobacco budworm, cotton aphid, spider mite and loopers in cotton. The resurgence of these pests was mainly due to the destruction of their natural enemies (through the use of pesticides) coupled with the development of resistance to pesticides among the different pests. Fungicides have also created pest outbreaks. The use of Benomyl to reduce populations of entomopathogenic fungi caused an increased survival of velvet bean caterpillars and cabbage loopers in the Central Province, especially in Muranga and Kiambu Districts where cabbages are grown on a large scale.
2. Although it is difficult to estimate the number of cases of poisoning due to pesticides, it was reported in 1983 that, on the average, two people reported everyday at the Kenyatta National Hospital with chemical poisoning. Most of the health hazards associated with pesticides result from inexperience with the handling and application of these rather hazardous chemicals. Efforts are now underway to increase the awareness of farmers about the hazards associated with pesticides and to train them on how to handle and use the pesticides in a rational way.

Post-Harvest Losses and Crop Residues :

It has been estimated that about 15-30 % of the cereals and legumes produced are lost annually. Although no data are avialable for losses

in industrial crops, it is believed that such losses are considerable. Most of the post-harvest losses are due to insect damage, fungal infection and damage by rodents. Fungal infection and rotting are common if grains were harvested with a high moisture content or get wet after harvesting. The latter is normally the case in years when surplus grain production is realised and all grain cannot fit in the stores of the National Cereal Produce Board (NCPB). The farmers have poor granaries which in most cases cannot cope with the surplus grain. Losses in horticultural produce arise from poor handling, packaging and delays in marketing.

To control the post-harvest losses, the Government has a programme by which all the stores of the NCPB are fumigated periodically. Post-harvest pesticides (2% Malathion and 2 % Bromophos) are available to farmers for dusting their grain to control insect attack. Farmers are also advised to store their grain in structures that are inaccessible to rodents. Farmers are also advised to harvest their crops when they are dry; maize and other cereals should be harvested when their moisture content is less than 13.5 % to avoid fungal infection.

Agricultural and agro-industrial residues are many and varied; they are put into different uses. The most common use of such residues is for fuel. Residues are also used for feeding livestock or for mulching. Residues from the coffee industry (prunnings, pulp and parchment) are most used as fuel, either directly or after conversion to charcoal. Some of the coffee residues are composted and used as fertilizer. Residues from the sugarcane industry are also used as fuel (bagasse is used as fuel by the industry itself) and/or fertilizer.

Livestock Production :

Livestock is raised throughout Kenya in both the high and low potential areas. In the high potential areas, livestock is kept in combination with cash and food crops and there is competition between both for the available land resources. More than 80 % of the farms in high potential areas are small scale and in many of these farms mixed-farming is practised. There are only few large-scale farms where commercial livestock production is undertaken. Cattle and goats are kept for meat and milk; sheep, pigs and rabbits are kept for meat; poultry is raised for meat and eggs; bees are kept for honey while donkeys are kept as beasts of burden.

The low potential areas of Kenya (arid and semi-arid) are used mainly as rangelands to support livestock and wildlife. Whereas in the semi-arid areas, livestock raising might be accompanied by growing of resistant crops such as millet and sorghum, in the arid areas, pastoral nomadism and ranching are the predominant systems. It is estimated that the arid and semi-arid lands currently support 50 % of the entire

livestock population in Kenya, the greater percentage consists of sheep and goats although cattle, camels and donkeys are also kept.

Table 24 gives the distribution of livestock in Kenya. The data show an increase, though an inconsistent one, in livestock numbers since the 1960s. This increase is partly due to improved husbandry practices. Of the estimated 11.5 million cattle, 1.8 million are improved dairy cattle (e.g. Friesians, Ayshires and their crossbreeds with local zebus) while about 10 million are beef cattle.

Table 24 Livestock in Kenya (in thousand head)

Type	Average Annual (1964-1972)	Average Annual (1973-1981)	1984	1985
1.All Cattle	8,634	10,158	9,722	11,500
Dairy Cattle	565	1,163	2,040	
2.All Sheep	4,001	5,545	6,419	7,000
Wool Sheep	556	646	551	
3.Goats	5,451	6,974	6,854	8,000
4.Pigs	45	64	85	
5.Poultry	10,563	14,584	15,372	19,000
6.Camels	1,265	638		600
7.Donkeys	163	183		300
8.Rabbits		70	145	

Source : Ministry of Agriculture and Livestock Development, 1986

Intensive livestock production systems involving stall feeding (zero grazing) are a feature of the large scale and medium scale commercial farms. However, at present many small scale farms in the high potential areas have adopted such systems because of shortage of land. Intensive systems are used for dairying, beef cattle, pigs, poultry and sheep (meat and wool). Rabbits and bee-keeping are undertaken mainly by groups of farmers using intensive systems of production. The use of the modern beehive is becoming popular among such groups. Intensive systems using supplemental feeding with concentrated livestock feeds, hay and silage have become popular in many small scale farms whereas in large scale commercial farms they are almost mandatory.

The dairy cattle population is concentrated in the high potential areas of Kenya Highlands and Rift Valley, which account for more than 80 % of the country's improved dairy herd. Productivity of dairy cows varies from 150 litres of milk per year for zebu cattle to 850 litres for improved dairy cattle, to over 1,000 litres per grade cattle.

More than 80 % of the total milk production is from small holdings. About 75 % of the pig production is under small holders. It is estimated that there are over 20,000 rabbit keepers in Kenya today, 75 % of whom live in rural areas, most of them young people organized in self-help groups, missionaries and very few semi-commercial private rabbit producers.

In most of the low potential areas and in some parts of the high potential areas, many small scale farmers still operate on the traditional free range systems of livestock production which require few modern technological innovations. Although under such systems, practices such as livestock vaccinations, pasture improvement, dipping and spraying, quarrantine,etc are popular, the ones that do not necessarily involve direct government intervention such as the practices of supplemental feeding, artificial insemination, selective livestock breeding, milk recording, etc are uncommon.

In the arid and semi-arid areas, livestock production is based mainly on traditional systems (nomadic pastoralism) which allows for movement of people with their animals. However, recently, within the framework of programmes to improve rangeland productivity and to conserve the environment, organized grazing in the form of group, company, cooperative and commercial ranches and grazing blocks have started. The organized grazing allows the application of modern, intensive range management practices such as rational grazing and in addition makes it possible to regulate stocking rates. It makes it easier to control diseases of livestock and the ones transmitted from wildlife to domestic animals.

Certain problems do exist with livestock production. Overgrazing results from overstocking (i.e. when the stocking rate exceeds the carrying capacity of the land). It manifests itself in the arid and semi-arid areas of Kenya. The ecological constraints imposed upon the pastoral economy in such areas include the arid and variable climate; impoverished and eroded soils; low and variable primary productivity and the limited tolerance to exploitation of arid zone vegetation; densities, distribution and the consumption, production and offtake levels of livestock population; and the carrying capacity of the grazing lands.

Northern Kenya, like many other arid regions of the world, suffers from periodic droughts which have frequently occurred in recent historical times. The impacts of droughts have become more severe with recent increases in population, claiming the lives of large numbers of livestock and wildlife. As a result of high herd mortalities during droughts, some pastoral families have become destitutes and reliant upon famine relief. This has chiefly contributed to the fact that affected communities have no developed the capability to cope with droughts whenever they occur. However, due consideration is now given by the Kenya Government to the impacts of drought.

Although major diseases like Rinderpest and Anthrax are under control in Kenya, few diseases and conditions still cause concern. Tick-borne diseases such as East Coast Fever and Anaplasmosis are still a major problem. In the high rainfall areas Gastro-intestinal Helminthiasis, Pneumonia and Ecto-parasites are common.

Fisheries :

The nominal fish catch in Kenya increased from 33,700 tonnes in 1970 to 51,745 tonnes in 1979 (FAO, 1979, 1985) and reached about 91,000 t in 1984. Table 25 gives the fish catch in 1982-1984.

Table 25 Fish Catch in Kenya (in tonnes)

Water Type	1982	1983	1984
Inland Waters	74,000	91,000	84,000
Marine Waters	7,100	6,400	6,800
Aquaculture (Fresh)	500	600	700
Aquaculture (Marine)	6	7	10
Total	81,606	98,007	91,510

Source : Statistics Section, Ministry of Tourism, Fisheries Department

Fresh water fish dominates Kenya's fish production and accounts for about 92 % of the total fish catch. Most of this fish comes from Lakes Victoria, Tukana, Baringo, Naivasha, Jipe and Chala; and from some rivers and Tana river dams (reservoirs). The fresh water fish is dominated by Lates, Engraulicypris and Tilapia. Marine fish is dominated by demersal species followed by pelagic species, shark/rays, deep sea fish, crustaceans and other marine products. Table 26 gives the nominal fish catch from different water bodies and Table 27 gives the catches of the different species.

Overfishing in inland waters in a major threat to fishery resources in Kenya. This is especially serious in Lake Victoria; Tilapia species has been greatly affected. The decline of indigenous Tilapia is also attributed to the pedatory behavious of the Lates Niloṭica and the increase in the water level of Lake Victoria in 1961-1964 which has destroyed some of the breeding grounds of Tilapia. Fishing in other inland waters is also threatened. The increase of silt loads deposited

Table 26 Fish Catch from Different Water Bodies (in tonnes)

Water Body	1982	1983	1984
I. FRESH WATER			
Lake Victoria	60,958	77,327	71,854
Lake Turkana	11,040	10,113	8,448
Lake Baringo	401	352	297
Lake Naivasha	411	9,692	320
Lake Jipe	409	463	396
Lake Chala	90	10	2
Aquaculture	440	585	711
Other areas	268	1,526	2,172
subtotal	74,017	91,068	84,200
II. MARINE WATER			
Fish :			
Lamu	1,298	1,346	1,112
Tana	266	22	24
Kilifi	1,287	1,070	708
Mombasa	2,380	1,854	3,372
Kwale	743	818	762
Sport fishing	94	148	91
Other areas	844	540	-
subtotal	6,622	5,798	6,069
Crustaceans :			
Lamu	83	69	73
Tana	4	3	2
Kilifi	33	35	59
Mombasa	234	302	413
Kwale	72	65	60
subtotal	426	474	607
Other Marine Product:			
Lamu	7	2	4
Kilifi	14	19	11
Mombasa	37	85	71
Kwale	10	15	14
subtotal	68	121	100
GRAND TOTAL	81,133	97,461	90,976

Source : Statistics Section, Ministry of Tourism, Fisheries Department

Table 27 Fish Catch by Species (in tonnes)

Species	1983	1984
I.FRESH WATER		
Alestes	4	1
Bagrus	1,243	88
Barbus	155	110
Black Bass	41	64
Clarias	1,336	877
Engraulicypris	16,444	19,437
Haplochromis	612	41
Labeo	2,437	1,325
Lates	55,572	44,698
Mormyrus	218	89
Protopterus	374	94
Schilbe	22	3
Symodontis	47	75
Tilapia Esculenta	108	99
Tilapia Nilotica	2,796	6,136
Tilapia (others)	6,101	5,400
Trout	169	275
Cray Fish	116	43
Carps	132	174
Unspecified	3,141	5,115
subtotal	91,068	84,200
II. MARINE FISH		
Demersal	3,098	2,786
Pelagic	1,091	940
Sharks	228	280
Sarames	370	337
Sport fishing	148	91
Deep Sea	540	840
Unspecified	323	795
subtotal	5,798	6,069
III. CRUSTACEA		
Spiny Lobster	56	57
Prawns	300	405
Craks	56	65
Others	62	80
subtotal	474	607
GRAND TOTAL	97,340	90,876

Source : Statistics Section, Ministry of Tourism,
Fisheries Department

in mand-made reservoirs behind dams has affected the exploitation of fish resources. Eutrophication in Lake Naivasha and the spreading of salvinia molesta have caused serious threats to fishing; in 1986 the lake was closed to fishing. Efforts are underway to control and remove the weeds from Lake Naivasha and restore its quality.

Although marine fisheries represent about half of the potential source of fish available for exploitation in Kenya, the annual amount of marine fish catch has been quite low due to limitation in fishing technology. If marine fisheries are to be developed, due consideration will have to be given to control pollution from land-based sources and to monitore the quality of the marine environment to ensure sustainable yields.

3. FUTURE OUTLOOK :

Although crop yields have generally increased in Kenya, they are still considered low to moderate. Efforts are underway to introduce high-yield varieties of seeds and drought-resistant ones. But to achieve a major breakthrough, other constraints have to be addressed. Although increasing quantities of chemical fertilizers and organic manure are being used in Kenya to maintain and improve yields, the high prices of inorganic fertilizers have been a major constraint to the use of fertilizers. Large scale use of fertilizers has been restricted to large scale farms and to cash crops such as coffee, sugarcane and tea. Very little fertilizer is being used by small holders except in coffee plantations. Recently, research into microbial nitrogen fixation has been intensified in Kenya in order to reduce dependence on chemical fertilizers.

Pesticides have been used and will continue to be used in future in Kenya to maintain production since pests destroy about one-third of food crops during growth, harvesting and storage. At present, much of the production cost of crops such as coffee, maize, cotton and vegetables is due to pest control. On small holdings, the level of pest control remains relatively low due to the lack of technical know-how and the high proces of pesticides. The crops which have suffered most as a result of low level of pest management are the food crops, notably maize, millet and sorghum and pulses while the major cash crops have not suffered as much.

In many parts of Kenya, a stable farming system does not exist and present land use practices are leading to a decline in productivity and are causing negative effects on the environment. There is evidence in Kenya today of accelerating decline of soil fertility in many areas where land is mismanaged. In some cases, loss of soil fertility as a result of soil erosion has not been accompanied by reduction in crop yields because this loss has been masked by increased application of fertilizers. The introduction of improved food crop varieties and of a great variety of cash crops has increased return from the land.

Temporarily, in some parts of Kenya, crop yields will continue to rise with improved crop varieties, increased application of fertilizers and pesticides together with improved cultural methods, though the nation's land resource will be shrinking.

Kenya has now a well-organized network of extension and research services which provide advice to farmers on modern and efficient methods of crop and animal production. The research being carried out has provided technical solutions to agricultural problems affecting farmers in the country. Emphasis is presently placed on training of both extension and research officers as well as the farmers under the training and visit programme. As part of Kenya's development policy, three regional development authorities- the Lake Basin, the Tana and Athi Rivers and the Kerio Valley Development Authorities- have been set up to step up food production and to conserve the environment, among other functions. These Authorities have already contributed significantly to food production. Also, in a bid to settle landless people and to distribute pressure on land, and to boost food production, settlement schemes have been set up in different parts of the country. However, it should be noted that food production has been hampered by low returns to farmers and fluctuations in international prices; crops like sisal, cashewnuts, cotton and pyrethrum have been affected.

Kenya has formulated a National Food Policy in 1981 which is presently being implemented. The objectives of the NFP are : to maintain a position of broad self-sufficiency in the main foodstuffs, in order to enable the nation to be fed without using scarce foreign exchange in food imports; to achieve a calculated degree of security of food supply for each area of the country, and to ensure that these foodstuffs are distributed in such a manner that every member of the population has a nutritionally adequate diet. However, since 1981, Kenya has been experiencing shortages of maize, wheat, rice, milk and sugar among other commodities and in some cases has had to import these commodities. Besides, certain sectors of the population remain under-nourished as a result of income inequalities, problems of distribution between geographical zones, seasonal fluctuations in supply and lack of nutritional education among certain groups.

In general, Kenya's potential in agriculture is still considerable and with the technological and research capability available and the institutional arrangements already in force, it will be possible to realise a higher and sustainable agricultural productivity.

V. FORESTRY

Forests cover about 3.9 % of the surface area of Kenya. An assessment of the forest cover in Kenya was carried out by FAO/UNEP in 1980, within the framework of the Global Environmental Monitoring System project on forest resources of tropical Africa. According to the GEMS assessment the forests of Kenya consist of the following.

1. Natural Woody Vegetation :

1.1 Closed broadleaved formations:

Only small remnants are left of the coastal forests on the wetter soils of the hills and along the rivers. Below 350 m, on sites with moisture, occurs a mixed evergreen forest with abundance of Afzelia and Trachylobium species. At higher altitudes (over 1,500 m), in the south-west, the Taita Hills are covered by an evergreen forest with camphor tree (Ocotea usumbarensis). Mt.Kasiagu has a small area of forest near its summit; Newtonia buchanani is predominant between 1,300 and 1,600 m. Mangroves are scattered along the coastal belt on the inter-tidal zones on estuaries and along creeks. The two principal species are nikoko (Rhizophora mucronata) and mkandaa (Ceriops tagal); four other (non-merchantable) species are also present.

The upland forest belt in the wetter zones begins with the plateau forests, between 1,300 and 2,000 m, and occurs in the central part of the country (neighbourhood of Nairobi, Ngong, Kiambo and Nyeri), with an annual rainfall of 850 to 1,000 mm and a cool and equatorial climate. These forests are evergreen or semi-deciduous. The evergreen type is dominated by Brachylaana hutchinsii (muhugu) and Croton megalocarpus. The semi-deciduous type is less rich in species. The largest area of upland forest occur on the main mountains between 2,000 m to above 3,500 m : Mt. Kenya, Mt.Elgon, the Aberdare range, the Laikipia escarpment and the Mau-Elgeyo-Cherangani mountain system. This evergreen forest can be subdivided in the following types : forests dominated by Ocotea spp. occurring on very dissected terrain; these forests present regeneration problems, as the seeds are threatened by predators and the suckers by elephants; and forests dominated by Aningeria adolfi-friederici occurring in the wet montane zone between 1,500 and 2,400 m.

On the south-west and north-east of Mt. Kenya and in the north-eastern Aberdares the pilar wood (Cassipourea malosana) forest occurs.

1.2 Open broadleaved forests :

The upper zone of the upland forest belt usually consists of woodland from 12 to 18 m high. The Hagenia Rapanea type is common

under wet conditions, and may be replaced by Afrocrania-Aguaria woodland in drier areas. Around 3,200 m, the Hagenia abyssinica woodland (up to 18 m) forms a belt which, under favourable conditions and minimum disturbance, might extend up to 3,500 m. In the southeast of Kenya some type of woodlands occur, dominated by Leguminosae : 80 % of trees are Julbernardia sp. and Brachystegia sp. Acacia woodlands occur in the highlands.

In the more open types of vegetation, the woody component is generally composed of small broadleaved trees, predominantly Combretum spp., often together with Terminalia spp. In drier areas Acacia and Commiphora become more and more prominent. In a broad belt around the Kenya highlands, between 1,200 and 1,500 m and within an annual rainfall range from 500 to 750 mm, the Acacia-Themeda wooded grassland with different Acacia species is the main vegetation type. Pure grasslands, without woody vegetation are confined to some highland areas.

1.3 Bamboo formations :

In the intermediate and wetter zone of the uplands, between 1,800 and 3,300 m, the mountain bamboo (Arundinaria alpina) covers large stretches on the Mau and the Aberdare ranges; and it also occurs in scattered patches on the eastern side of Mt. Elgon. In the bamboo thickets, shrubs can be found like those of Mimulopsis.

1.4 Coniferous forests :

Patches of a forest type dominated by Ocotea usumbarensis and Podocarpus spp. occur often in the belt between 1,700 and 2,400 m above sea level with a rainfall of about 2,200 mm on the eastern slopes of the Aberdares and of Mt. Kenya. In the drier highland areas, ranging from 1,000 to 2,900 m, with a major development between 1,800 and 2,900 m and an annual rainfall of around 1,100 mm, the Juniperus forest is widely distributed. An extensive population of big game damage these forests on the hills and mountains in northern Kenya.

1.5 Shrub formations :

Vast areas of the semi-arid eastern and northern parts of the country and of the Rift Valley are covered by so called bushland and thicket vegetation, characterized by small trees, branching from the base, and often thorny bushes, with a sparse growth of grasses. In the denser forms (thickets) there is no grass cover. Commiphore is the most widespread genus with emergent baobab trees (Adansonia digitata) in places. Communities dominated by Euphorbia are found in very dry sites. In the most arid parts of northern Kenya large areas of semi-desert vegetation are characterized by widely spread dwarf shrubs and bushes, without any ground cover, except during the short rainy season.

Table 28 gives the areas of natural woody vegetation at the end of 1980, according to the FAO/UNEP assessment. At the end of 1984, the Forestry Department of the Ministry of Environment and Natural Resources estimated the area covered by forests at 1,973,000 ha (natural).

Table 28 Areas of Natural Woody Vegetation (ha)

Type of Forest Cover	Productive	Unproductive	Total	Fallows
I. CLOSED FORESTS				
Closed broadleaved	350,000	340,000	690,000	40,000
Coniferous	140,000	110,000	250,000	15,000
Bamboo	-	165,000	165,000	-
II. OPEN FORESTS				
Open broadleaved	565,000	690,000	1,255,000	550,000
TOTAL	1,055,000	1,305,000	2,360,000	605,000

Source : FAO/UNEP (1981). Total shrub formations has been estimated to cover about 37,500,000 ha. In other words, total woody formations and fallows cover about 40,465,000 ha.

2. Plantations :

Until about 1945, almost all planting was with Cupressus spp. but since then Pinus spp. became increasingly important. Present composition of industrial plantations is about 47 % Cupressus and 53 % Pinus. The majority of these plantations is found west of the Rift Valley and in most of the highland regions east of the Rift Valley, between 1,800 and 2,700 m above sea level. Up to 2,100 m P.patula is predominant, and is replaced higher up by P.radiata which has better growth on higher elevations. However, plantation of P.radiata has been restricted to absolutely "safe sites" with no danger of Dothistroma pinii attacks. The exotic softwood plantations have been established through a kind of taungya system, locally called " shamba" (garden) system.

Plantations for fuelwood and poles consist mainly of Eucalyptus spp. and Acacia spp. Acacia mearnsii (black wattle) is grown for tanbark (wattle extract). These plantations seem to provide also a fuel and charcoal production in the highlands.

Table 29 gives the areas of established plantations in Kenya, from which it appears that softwood species predominate.

Table 29 Areas of Established Plantations (1980)

Species	Area (ha)
I. Hardwood Species :	
Fast-growing species	27,900
Other species	3,000
II. Softwood Species	150,000
Total	180,900

Source : FAO/UNEP (1981)
According to the Forestry Department of the Ministry of Environment and Natural Resources, there were 160,000 ha of softwood and 25,000 ha of hardwood plantations in 1984

Table 30 gives the growing stock in the forests and Table 31 gives the volume of harvested wood compared to the annual growth.

Table 30 Growing Stock (1984)

Type	Total Volume (1000 m^3)	Exploitable Volume (1000 m^3)
Softwood	40,000	2,800
Hardwood	104,800	500
Total	144,800	3,300

- Exploitable : Physically accessible and economically exploitable.
- Softwood yield, 450 m^3/ha , hardwood yield, 70 m^3/ha on a sustained basis assuming cutting cycle of 30 years for softwood and 120 years for hardwood.

Source : Forestry Department, Ministry of Environment and Natural Resources.

Table 31 Annual Volume of Wood Harvested (1984)

Type	Volume Harvested (1000 m^3)	Annual Growth (1000 m^3)	Net Growth (1000 m^3)
Softwood	1,793	3,500	1,707
Hardwood	100	5,000	4,900
Total	1,893	8,500	6,607

-Assuming annual growth rate of softwood of 22 m^3/ha/y and of hardwood of 5 m^3/ha/y.
Source : Forestry Department, Ministry of Environment & Natural Resources

The main commercial species from natural forests are podo (Podocarpus gracilior, P.milanjianus), east african pencil cedar (Juniperus procera), camphor tree (Ocotea spp) and Elgon olive or oliondo (Olea spp.). The proportion of timber extracted from plantations is increasing regularly. Wood for fuel (fuelwood and charcoal) constitutes about 95 % of total wood consumption in Kenya (about 26.7 million m^3 are consumed annually).

3. Deforestation :

Forests in Kenya are threatened in several ways, the most important of which are outlined in the following :

1. Uncontrollable depletion as a result of cultivation in private forests.
2. Over-exploitation of commercial species in some areas and particularly in private forests bordering the gazetted forests.
3. Fires have been a menace in some forest areas and especially in the Aberdares, western Mt. Kenya slopes, Maralal and Mt. Elgon. In the period between 1980 and 1984, fires destroyed on the average 520 ha of plantations, 6,700 ha of natural forests and 15,500 ha of bush and grass annually.
4. Grazing of domestic animals has caused a number of problems. Goats, for example, directly damage trees by eating the shoots of the young trees and/or the bark. Other big animals like cattle and donkeys trample on the young trees. It is however not uncommon that these animals eat the shoot and/or the bark of trees during drought. The problem is magnified by the fact that during drought, the forests are the only places where people can graze their animals. Although in wet years, overgrazing of forests is not significant, it may be so in isolated marginal areas and/or in private forests.
5. With population growth, conflict between land use for agriculture and forestry has become increasingly acute. Squatters have invaded forests illegally and cleared the trees to cultivate the land and/or to meet their fuel need.

It has been estimated that the annual rate of deforestation in Kenya is about 19,000 ha (FAO, 1985). The Government is therefore according high priority to afforestation programmes and the environmentally-sound management of forests. The annual rate of afforestation is about 10,000 ha

A Rural Afforestation Extension Programme is being implemented and a Presidential Commission for Soil Conservation and Afforestation has been set up. As a result of the activities of this Commission, tree planting is now an annual event of great significance. Besides, the Government, several non-governmental organizations (e.g. Kenya Energy Non-Governmental Organization (KENGO), the National Council of Women of Kenya (NCWK), Maendeleo Ya Wanawake Organization of Kenya, CARE-Kenya, etc) are also active in afforestation.

4. Forest Genetic Resources :

The Kenya Government attaches considerable importance to the conservation of plant germplasm. At present there are 16 Reserves covering about 50,000 ha within gazetted forests. In addition, large areas of conservation stands occur in the National Parks.

Steps have also been taken to protect endangered plant species from exploitation. At present, there is a ban on the cutting of certain indigenous species which are threatened with extinction. The Forest Reserve Branch has also embarked on the raising in plantations of some of the endangered species, such as Vepris glandulosa. Other examples of endangered tree species include : Grevea madagascariensis, G.Keniensis, Uvariodendron gorgonis, Dalbergio melanoxylon(Black ebony) and Trachylabium verrucosum. The Euphorbia wakefieldii and Gigosiphon macrosiphon have been included in the IUCN Plant Red Data Book.

VI. WILDLIFE

1. The State of Fauna and Flora :

The number of potentially valuable plant and animal species in Kenya is very large of which only some have been identified and classified. Butterflies are the only group of invertebrates studied in sufficient detail; these are severely affected by vegetation degradation due to overgrazing, deforestation, agriculture and exotic plantation. Data available on marine molluscs show that they are greatly threatened by increasing scouring, siltation, turbidity and changes in water quality. In general, there are four known threatened amphibians which are dependent on forest for their survival. Two of them are from the Kakamega Forest and two from the Shimba Hills National Reserve. Out of these four, only two are known to be endangered. As for flora, the number of threatened species is difficult to ascertain.

According to the Wildlife Planning Unit of the Ministry of Tourism and Wildlife, Kenya has about 19 biotic communities. These communities represent the synthesis of a variety of ecological factors such as soil, rainfall, altitude, and temperature which result in the development of a distinctive community of fauna and flora. These communities incorporate the major plant and animal species in the country and thus are a significant factor in developing a rational basis for the long-term growth of Kenya's national park and reserve system. The 19 biotic communities are :

1. Afro-Alpine Glacier and Moorland
2. Highland Moist Forest
3. Guineo-Congolean Rain Forest
4. Highland Dry Forest
5. Evergreen and Semi-Evergreen Bushland
6. Grassland
7. Semi-arid Wooded and Bush Grassland
8. Arid Thorn Bushland and Woodland
9. Semi-Desert
10. Coastal Forest and Woodland
11. Groundwater and Riverine Forest
12. Coastal Evergreen Bushland
13. Coastal Palm Stands
14. Permanent Swamps
15. Fresh water Lakes
16. Alkaline Lakes
17. Marine Beaches and Dunes
18. Mangroves
19. Coral Reefs and Islands

Table 32 and Table 33 give the representation of the major biotic communities and the natural regions in the existing National Parks and Reserves System, respectively. Table 34 summarizes the state of fauna and flora in Kenya.

Table 32

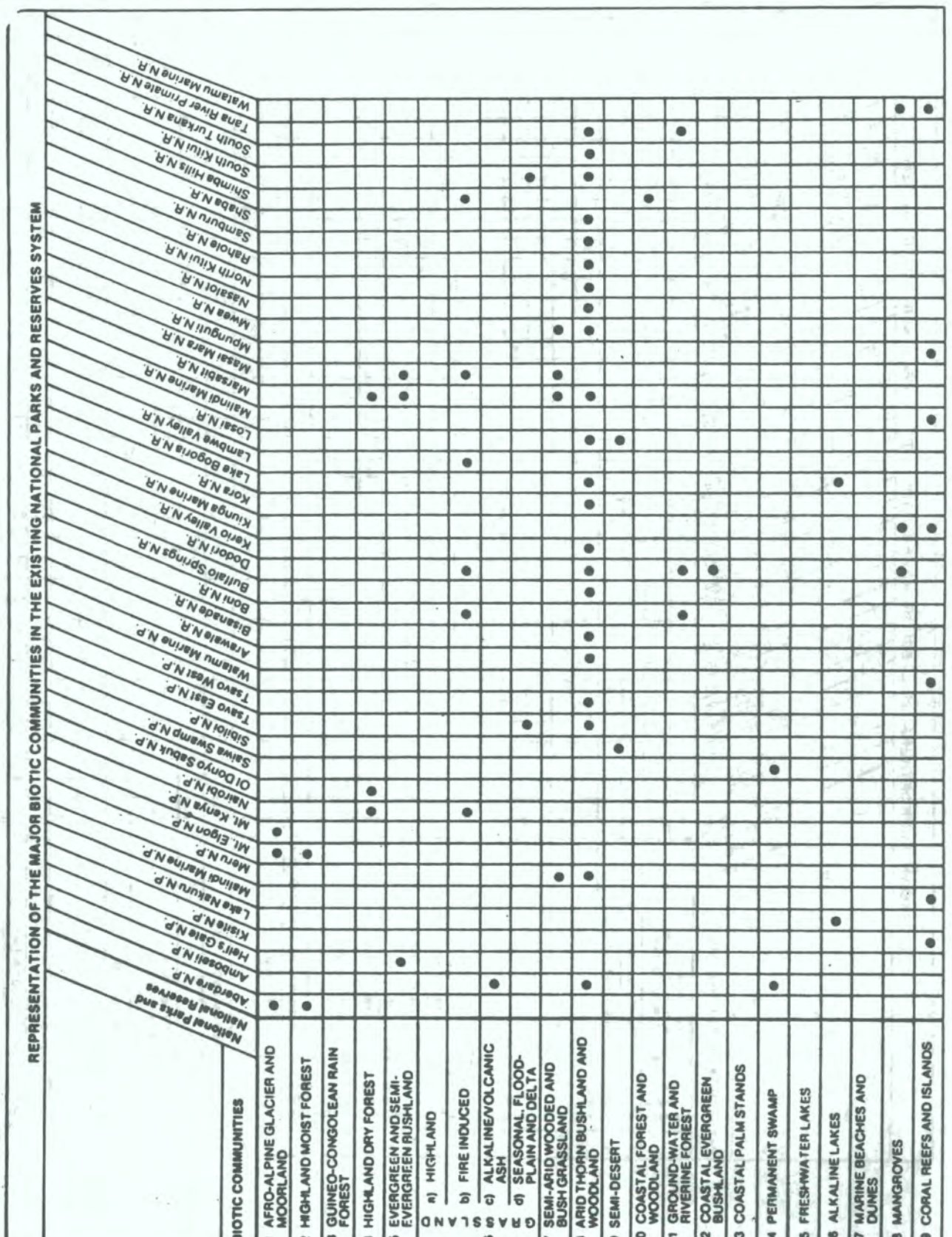
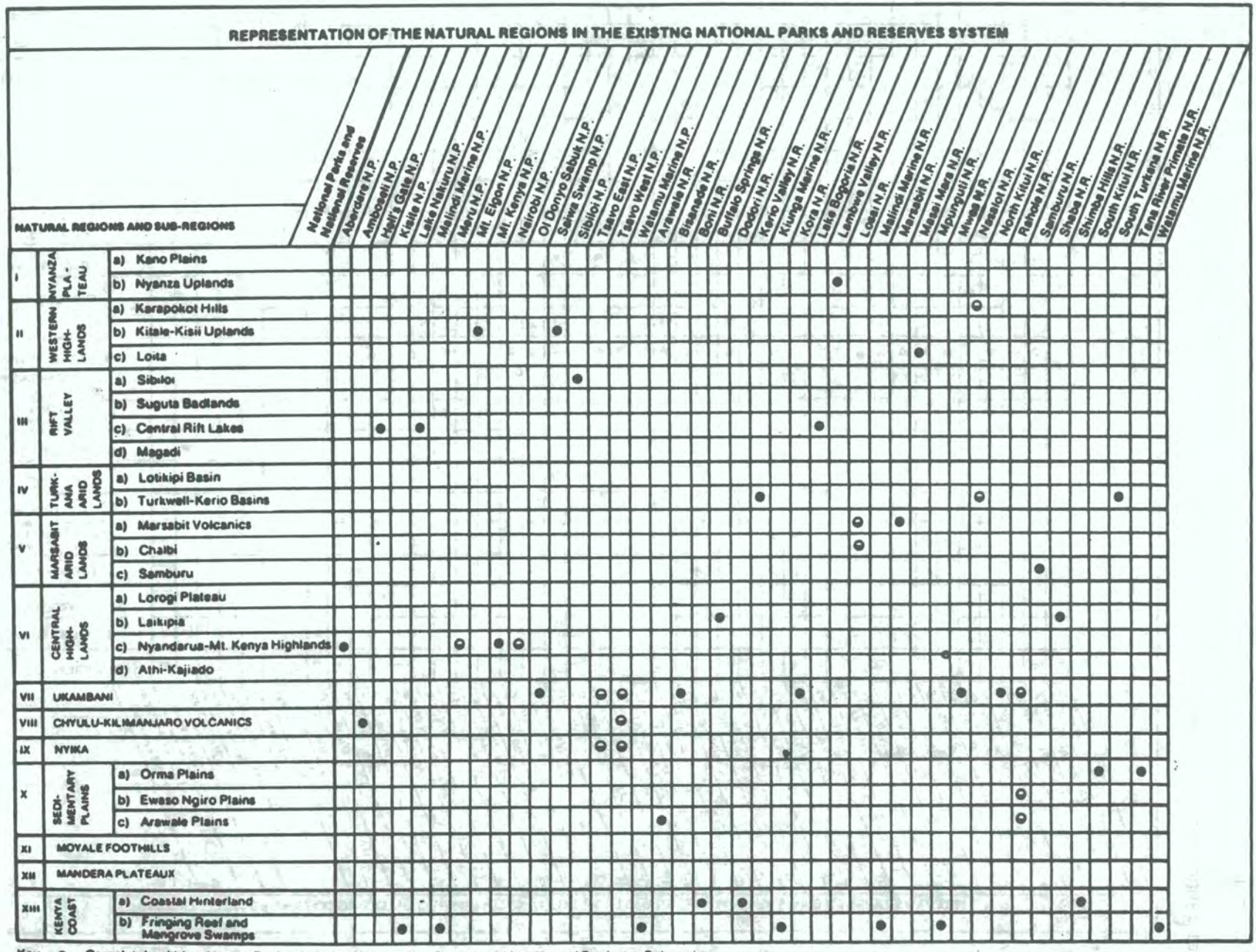


Table 33

REPRESENTATION OF THE NATURAL REGIONS IN THE EXISTNG NATIONAL PARKS AND RESERVES SYSTEM



Key. ● — Completely within a Natural Region or Sub-region. ⊖ — Partially within a Natural Region or Sub-region.

Table 34 State of Fauna and Flora

Groups of Species	Total Number of Known Species	Threatened Species			
		Endangered	Vulnerable	Rare	Care Demanding
Fauna :					
Mammals	314	10	6	5	4
Birds	1067	3	2	6	-
Reptiles	191	-	1	-	9
Amphibians	88	2	-	-	2
Invertebrates		4	40	300	
Molluscs	81	10	-	-	-
Flora :					
Trees & Shrubs	2000	100	-	160	

Source : National Museum, Kenya, 1985

Threatened Mammals : Ader's Duicker, Colobus angolensis, Black Rhino, Dugong, Cheetah, Serval cat, Hammer-head fruit bat, Tree Pangolin, Sitatunga, Grevy Zebra, Rotschild's Giraffe, Bongo, Elephant, Roan antelope, Sable antelope, Greater Kudu, Klipspringer, Otter Shrew, Tana River Mangabey, Tana colobus, Surdisorex polulus, S. norae, Golden mole, Brush tailed porcupine.

Threatened Birds : Endangered (Sokoke scope owl- Otus ireneae, Taita thrush- Turdus helleri, Clark's waaver- Polceus golandi); Vulnerable (Sokoke pipit- Anthus sokokensis, Hinde's Pied babbler-Turdoides hindei); Rare (East Coast akalat- Sheppardia gunningi, Spotted ground thrush- Turdus fischeri, Papyrus Yellow warbler- Chloropeta gracilirostris, Turner's eremomela- Eremomela turneri, Chapin's flycatcher- Muscicapa lendu, Amani sunbird- Anthreptas pallidigaster)

Threatened Reptiles : Malacocherus tornieri, Eretmochelys imbricata, Bitis gbenica, Causus lichtensteini, Boiga blandingi, B. pulourulenta, Hasipdophys lineata, Hormonotus modestud, Thrasop aethiopissa, Pseudohaje goldii

Threatened Amphibians : Leptopelis modestus, Hyperolius lateralis, Afrixalus sylvaticus, Hyperolius rubrovermisculatus

Threatened Invertebrates : Taita charaxes, Taita glider, Bebearia dealbata kitovo, Alaena johanna tsavea.

Threatened Molluscs : Laniatus ciliatus, Gabbiella parvipila, G.verdcourti, G. rosea, Incertihydrobia teesdalei, Euscoia inopina, Cleopatra exarata, C. athiensis, Bionupia crassistriata, Ceratophallus pelicystana.

According to the understanding of wildlife conservation and management, all fauna are protected under the Wildlife Act and only when distinctions are required that full and/or partial protection come into play. Partially-protected species may be cropped from time to time especially when their numbers exceed the carrying capacity of their habitat. Under partial protection are fauna for which licences may be obtained to hunt. Classes of fauna that are fully protected are :

- Any game animal which is immature.
- Any female that appears pregnant.
- Any animal accompanied by a young one.
- All birds other than game birds.
- All melanic (albino) animals.

Table 35 gives a list of wildlife species which are fully and partially protected in Kenya at present. Table 36 gives the number of protected areas.

Table 35 Protected Species of Wildlife

Fully Protected		Partially Protected	
Game	Others	Game	Others
Leopard*	Aardvark	Elephant	Bat eared fox
Rhino*	Aardwolf	Lion**	Abbotts Duicker
Bongo*	Caracal	Retic.Giraffe	Patas monkey
Rotchild's Giraffe	Cheetah*	Colobus monkey**	Yellow duiker
Grevy Zebra*	Dugong**	Crocodile	
	Golden cat	Wild dog	
	Hartebeeste		
	Hinter's antelope		
	Thomas kob		
	De brazza monkey		
	Mangabey monkey **		
	Serval cat		
	Potto**		
	Pangolins***		
	Roan antelope**		
	Sable antelope**		
	Sitatunga		
	Green turtle*		
	Hawksbill turtle*		

Source : Ministry of Tourism and Wildlife, Kenya

Notes : All species are also protected by CITES

* covers endangered species, trade in which is tightly controlled.

** covers species that may become endangered unless trade is regulated.

*** covers any species that any party wishes to regulate and requires international co-operation to control trade.

In 1970 the Rhino population numbered over 20,000 but presently there are only 425 recorded Rhinos. If this trend continues into the future, the Rhino would become extinct in Kenya in two decades or so.

Table 36 Nature Conservation and Protected Areas

Protected Area	No. of Places	Examples	Area (km^2)
National Parks	21	Tsavo, Amboseli, Saiwa Swamp, Mt. Elgon	26,712
Nature Reserves	14	Arabuko-Sokoke, Langata, South West Mau, Kisero, Kaimosi Forest	461
Game Reserves (miltiple use management areas)	30	Masai Mara, Shimba Hills, Kakamega Forest, Buffalo Springs	19,344
Anthropological Reserves	11	Turkana, Kariandusi-Nakuru, Thimlich-S.Nyanza, Gedi-Coast, Olergassaine	
Biosphere Reserves	4	Mt.Kulal (7000), Mt.Kenya Malindi-Watamu,Kiunga-Marine	8,513
Natural World Heritage sites	-	Proposed : Taita Hills Forest	2
Others	1	Mutomo Plant Reserve	0.17

Source : Adapted from Ministry of Tourism and Wildlife and National Museums of Kenya.
Note : Four of the nature reserves have not yet been surveyed. These are Baden Powel Walk, Arabuke-Sokoke, Mbololo Hill (Taita Hills) and Kaptaget Forest.

In Kenya, the Taita Hills Forest contains many endemic flora and fauna not found elsewhere in the world. This montane forest has been in existence for thousands of years but is being severely reduced in size to make way for plantations and exotic trees. The following are fauna which have had their population greatly reduced in the last decade :

Legless amphibian	- Affrocaecilia teitana
Frog	- Bufo teitensis
Backfanged snake	- Amblyodipsas teitana
Taita thrush	- Turdus helleri (endangered)
Orange ground thrush	- Turdus gurneyi otemitra

White starred forest robin	- Pogonocichia stellata helleri
Yellow-throat warbler	- Phylloscopus ruficapilla minula
Bar throated apalis	- Apalis thoracica fuscigularis
Yellow breased apalis	- A. flavida golzii
Taita montane white eye	- Zosterous poliogastra silvana
Shrew	- Sincus lixus naquatoridis
Elephant shrew	- Petrodroms tetradactylus sangi
Taita swallow tail	- Papilio demondi teita
Taita charaxes	- Charaxes xiphares desmondi
Taita glider	- Cymothoe teita

Butterflies are especially in a critical stage due to the destruction of the vegetation the caterpillars feed on.

Threatened flora include tree species such as Podocarpus usambarensis, Myphaena coriacea, Polyscias stuhlmanii; Phy-Uanthus mittoneansus, Albizia zimmermannii, Ficus kirkii, Cordyla africana. Other flora include the African violet Saitpaulia taitensis and the giant orchid Angraecum girianae.

2. Wildlife Protection Measures :

Kenya has signed a number of international treaties to protect and conserve fauna and flora. One of these treaties is CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna), which has played an active role in the protection of the Nile crocodile, Crocodylus nilotica.

The major problems encountered in wildlife protection in Kenya are summarized in the following :

1. More attention should be paid to isolated protected areas, e.g. the Taita Hills Forest, to monitor closely the replacement of indigenous flora for exotic species.
2. Most National Parks and Game Reserves have no inventory of species of flora and fauna, especially in the protected areas.
3. Although some Parks and Reserves have been thoroughly studied (e.g. Masai Mara, Nairobi, Amboseli) others are less adequately known.
4. Although some sites are not protected under the Antiquity and Monuments Act of 1983, these sites are of archeological importance. The protection of such sites poses, however, some problems and although some are already gazetted, they are vulnerable to vandalism due to their isolation (e.g. Muhanda Fort, Bungoma District).
5. In some areas in Kenya, the high rate at which forests and other natural vegetation are being destroyed poses a threat to wildlife. The ongoing afforestation programme is not commensurate with the high rate at which trees are cut down; in the past, the programme has excluded a lot of indigenous plant species on which the wildlife has adapted over years.

6. Illegal hunting has been a major problem especially with animal species that have some valuable commercial parts (e.g. elephant tasks and rhino horn). Through the hunting ban, Kenya has aimed to legally protect the wildlife from both sport hunting and poachers. However, migratory specied pose a significant problem as most of the neighbouring countries have not yet enforced similar hunting bans.
7. A great deal of conflict exists between wildlife and agriculture whereby animals destroy crops, or people clear up vegetation on which the fauna's existence depends. The wildlife-ranching conflict has been brought about by large herds of livestock kept by man. The livestock normally move into the protected area and compete with the wildlife herbivorous. Wild animals are then forced to seek food elsewhere and usually end up destroying agricultural crops. There are of course cases where due to shortages of food during drought, wild fauna move into pasture land outside gazetted areas but when rains return and vegetation grows the domestic livestock is not allowed into the protected area.

VII. HUMAN SETTLEMENTS

1. TYPES OF HUMAN SETTLEMENTS :

One of the major demographic and social features which affect planning of human settlements is the geographic distribution and growth of the population. This in most cases setermines the shape the settlements will take. Kenya's pattern of population distribution is directly correlated with that of the amount of mean annual rainfall. Redistribution of population has occurred in the process of land resettlement programmes (rural-rural migration) and the emergence of urban areas (rural-urban migration).

Table 37 gives the growth of urban population in Kenya. In 1979, 15.1 % of Kenya's population resided in towns, 12.6 % of them living in towns of more than 10,000 people. At the time of the 1979 Census, Nairobi had a population of 835,000; Mombasa, 342,000; and Kisumu, 150,000. Twenty-one other towns has populations exceeding 10,000.

Table 37 The Growth of Urban Population in Kenya

Year	Population (in 1000s)	Percentage Urban	No.of Towns
1948	236	5.1	17
1962	748	7.8	34
1969	1,080	9.9	47
1979	2,309	15.1	90

Source : Central Bureau of Statistics; Kenya Population Census.

Table 38 gives the distribution of urban centres by size of population. The Table underlines the phenomenal rate of urbanization. While the total urban population increased by 44 % during the 1962-1969 period, it more than doubled during the 1969-1979 period. This increase in urbanization is due to natural increase in population in urban areas, rural-urban migration and boundary changes. Of these factors, influx into towns in the major cause of high rate of growth as the rate of natural increase is lower in towns than in rural areas because of the predominance of males in the urban population. The rate of this rural-urban migration is so large that the growth rate of urban areas is over 7 % per year, almost double the rural rate.

Table 38 Urban Centres by Size of Population

Size of Urban Population	No. of Urban Centres			
	1948	1962	1969	1979
> 100,000	1	2	2	3
20,000-99,000	1	2	2	13
10,000-19,999	2	3	7	11
5,000-9,999	3	11	11	22
2,000-4,999	10	16	25	41
Total Urban Population (1000s)	276	671	1,080	2,309

Source : 1979 Population Census, Vol. III, Analytical Report, CBS.
The census definition adopted in Kenya for purposes of urban classification defines an urban centre as having 2000 or more inhabitants.

Projections of urban population in Kenya by 2000 show that urban population will be about 7.9 million people, or about 21 % of the total population. Nairobi alone is expected to accommodate over 3 million people by 2000.

The fast growth of urban population has brought with it some major problems which have affected the quality of life in some ways. For example, acute shortages have been felt in the provision of shelter, infrastructure and services. In many of the urban areas there is over-crowding and unauthorized construction of unplanned dwellings (slums, squatter settlements) made of unsuitable material. In such squatter settlements, there is a lack of water supply and sanitation and this has created an unacceptable standard of living with a danger of spread of epidemic diseases and repeated outbreaks of fire.

The Kenya Government has recognized the need for improving the quality of life in human settlements and is undertaking a number of programmes which include upgrading of slums and squatter areas, provision of infrastructure in urban slums and squatter areas and provision of infrastructure in rural settlements. The philosophy behind these actions is based on the assumption that most developing countries cannot keep up with the provision of new housing to meet the growth of housing requirements. This makes it essential to conserve and improve existing housing stock, even if at a sub-standard level. In the context of scarce development resources, the need for the maximization of available resources makes it necessary to regard the existing housing stock as an asset to be conserved and improved. The Government, through the First and Second Urban Projects has tried to increase the number of improved housing available through the Site and Service Scheme, and also by issuing title deeds to individuals in areas like Mathare, etc., thereby allowing people to develop their own houses. In the rural

areas there is no shortage of shelter as such because most people are capable of building their own traditional dwellings at a price they can afford. The major problem, however, is the lack of standards that can guide the people to build environmentally-acceptable household units.

2. INFRASTRUCTURE OF HUMAN SETTLEMENTS *

The state of water supply and sanitation in Kenya has already been referred to in Chapter II of the present report.

Solid wastes (domestic, commercial and industrial) are generated in different settlements. Domestic wastes consist mainly of organic components (food and residues of agricultural products). The composition of such wastes varies from one area to another depending on the residents' economic levels; the quantity of wastes increases with increasing wealth. Commercial and industrial wastes consist of various components from paper, plastics, glass and cloth to residues of food processing industries and those of other industries. Some of these wastes have been classified as "toxic"; these include heavy metals, pesticides, pharmaceutical products, flammable compounds, explosives, irritants, corrosives, radioactive wastes and out-dated chemical solvents and other compounds.

Table 39 gives the daily amounts of solid wastes generated in Nairobi.

Table 39 Solid Wastes Generated in Nairobi

Type of Waste	1972(tonnes/day)	1975 (t/d)	1980 (t/d)	1985 (t/d)
Domestic	300	560	1,100	2,630
Industrial	70	120	550	620
Earth	100	110	160	210
Total	470	790	1,810	3,460

Source : Nairobi City Council

On a per capita basis, the amount of domestic solid wastes generated in Nairobi varied from 0.65 kg/capita/day in 1972 to 1.0 kg/capita/day in 1980 to 1.7 kg/capita/day in 1985.

Solid wastes are normally collected by specialized lorries, tractor-trailers and ordinary tippers. Recycling of some components of solid wastes is partially carried out by the informal sector. Items such as paper, bottles and metallic constituents are recycled into useful products such as tissue paper, bottles, charcoal kilns (jikos), containers, etc.

Composting is mainly carried out in rural areas and the product is used as manure. Land filling and/or dumping in old quarries, murram pits, creeks etc are the most commonly used methods to manage the solid wastes collected from urban areas. Burning of waste is also common in both the rural and urban areas (some estates resort to burning of domestic wastes if the collection of such wastes is delayed).

The indiscriminate dumping of solid wastes has created pollution in some areas. For example, some groundwaters and parts of rivers in Thika, Nakuru and Karatina have been polluted from such wastes. Refuse dumps constitute also breeding grounds for different insects which are major carriers of diseases such as malaria, typhoid, etc.

Transport :

Road transport is the major mode of transport between different human settlements. The length of paved roads in Kenya increased from about 1,800 km in the 1960s to over 6,600 km at present. In addition, there are about 47,000 km of gravel/earth roads.

The number of vehicles in use in Kenya increased from 113,900 in 1970 to about 220,000 in 1980; about 60 % of these are commercial vehicles. New registrations remained more or less constant between 1980 and 1984. In the latter year there were 2,879 passenger cars and 5,868 commercial vehicles newly registered (Kenya Economic Survey, 1985, Table 14.4).

The Kenya Railway System has a network stretching over 2,650 km with a main line which extends from Mombasa on the Kenyan Coast to the border with Uganda. In general, there was a drop in the journeys of passengers by trains from 2,401,000 in 1980 to 1,803,000 in 1984 (the passenger-km dropped from 704 million in 1980 to 520 million in 1984). As for freight there was only a slight drop from 2,277 million tonne-km in 1980 to 2,246 million tonne-km in 1984 (Kenya's Economic Survey, 1985, Table 14.5).

Domestic air traffic accounted for 87 million passenger-km in 1984 and 7.4 million kg-km of freight in the same year.

Kenya has only one oil pipeline which runs from Mombasa to Nairobi. The pipeline is used to transport white petroleum products (e.g. petrol, kerosene, light diesel oil and jet fuel) from the Mombasa refineries to Nairobi.

3. AIR QUALITY :

There is no systematic air quality monitoring in urban areas in Kenya and, therefore, trends in air quality cannot be established at present. However, some scattered measurements were carried out; these give some indication about the concentration of some pollutants in the air, especially in Nairobi.

According to measurements carried out within the framework of the GEMS project on Air Quality in Selected Urban Areas, 1977-1978, the concentration of sulphur dioxide in air in Nairobi was found to range from 36 $\mu g/m^3$ in suburban areas to 57 $\mu g/m^3$ in industrial areas. The concentration of suspended particulate matter was found to vary from 51 $\mu g/m^3$ in suburban sites to about 80 $\mu g/m^3$ in industrial areas. However, measurements carried out in 1982 revealed higher concentrations of suspended particulate matter in Nairobi : industrial area, 252 $\mu g/m^3$; Burburu, 80 $\mu g/m^3$; South C, 103 $\mu g/m^3$; Shauri Moyo, 92 $\mu g/m^3$ and Woodley, 83 $\mu g/m^3$.

Measurements of the acidity of rain at various stations have revealed that rain falling on the Nairobi area is more acidic than that falling on other districts. The pH of rain was found to be : Nairobi area, 5.52; Kericho, 6.1; Meru, 6.3; Garissa, 7.1. The acidity of rain in the area of Nairobi is due to higher emissions of acidic gases (sulphur and nitrogen oxides)from industries.

4. ENVIRONMENTAL HEALTH :

Table 40 gives the number of reported cases and rate of incidence per 100,000 population of three major environmental diseases caused mainly by lack of safe drinking water and sanitation.

Table 40 Reported Cases of Major Environmental Diseases

Disease	1983		1984	
	Reported cases	Incidence	Reported cases	Incidence
Diarrhoea	1,492,993	9,240	1,927,423	9,873
Malaria	6,077,181	32,335	7,284,992	37,318
Schistosomiasis	86,013	506	116,176	595

Source : Ministry of Health
Incidence : cases per 100,000 population

VIII. ENERGY

Kenya's proven energy resources are relatively small. Hydroelectricity is currently the major supplier of primary electricity for the grid and the geothermal resources of the Rift Valley are being developed for electricity generation. Fossil fuel resources have not so far been proven; interest in oil exploration is increasing in prospective onshore and offshore sedimentary basins. No coal reserves have been discovered and so Kenya's major coal consumer, the Bamburi Portland Cement Company, imports all of its coal (60,000 tonnes/year) from Swaziland. As to wood, recent reports indicate that its consumption is exceeding annual regrowth, and in certain areas deforestation is becoming serious.

Hydroelectric and geothermal resources which can be considered as proven and capable of development amount in total to 1,075 MW, or about twice the current installed capacity. Between 1978 and 1981, hydropower stations in Kenya provided between 60 % and 83 % of the electricity generated. The potential theoretical generation available from rivers in Kenya has been estimated to be 30,000 GWh per year, with 15,000 GWh accounted for by the Tana River, though not all of this will be economically exploitable. Several dams have been constructed along the Tana River; the largest are Kindaruma (44 MW), Gitaru (145 MW), Kamburu (84 MW) and Masinga (40 MW). A fifth plant, Kiambere, with a generation capacity of 140 MW is under construction. In future, the Lake Basin Authority and the Kerio Valley Development Authority plan to construct plants with capacities of 48.6 MW and 120 MW respectively.

Geothermal areas in Kenya are located in the Rift Valley. There are three major areas of geothermal activity : Olkaria, which is under development (a 30 MW power station was commissioned in 1981 and by the year 2000, it is expected that generation from Olkaria field will reach 150 MW), and Eburru and Lake Bogoria, which are being explored.

Table 41 gives the electricity production in Kenya since 1980. Production has increased from 1,490 GWh in 1980 to 1,940 GWh in 1984; an increase of about 30 %. Table 42 gives the electricity consumption in Kenya; the increase in hydroelectricity imported from Uganda in 1984 was due to the drought that hit Kenya in that year.

The total consumption of fossil fuels in Kenya decreased from 1,774,000 tonnes of oil equivalent (t.o.e.) in 1980 to 1,672,000 t.o.e. in 1984 (Kenya Economic Survey, 1985). In fact, the average annual rate of commercial energy consumption fell from 7.1 % in the period 1965-73 to 1.0 % in the period 1973-84 (World Bank, 1986). The per capita commercial energy consumption was 135 kg.o.e. in 1980 and 107 kg.o.e. in 1984.

Table 41 Electricity Production in Kenya (GWh)

Year	Hydro	Thermal	Geothermal	Total
1980	1,060	430	-	1,490
1981	1,381	334	39	1,754
1982	1,397	311	96	1,804
1983	1,478	164	262	1,904
1984	1,491	255	233	1,940

Source : Kenya Economic Survey, 1985

Table 42 Electricity Consumption in Kenya

	1980	1981	1982	1983	1984
Total consumption (GWh)	1,538	1,553	1,701	1,747	1,845
Import (Uganda)	315	194	212	179	215
Per Capita (kWh)	92.2	95.8	94.2	93.0	94.4

Source : Kenya Economic Survey, 1985

The transport sector is the largest commercial energy consumer, accounting for 40 per cent of demand; the second largest is industry, at 38 percent. These are followed by residential/commercial energy demand (12 per cent of the total) and agriculture (10 percent). Since transport has been growing rapidly and since there have been moves to replace heavy diesel and fuel oil used in power generation and industry by hydro, geothermal and coal, the mix of petroleum products in demand has changed significantly. The share of demand of heavy diesel and fuel oil declined from 37 per cent in 1969 to 26 per cent in 1980, while the share of gasoline and gasoil increased from 37 per cent to 44 per cent and the share of jet fuel increased from 19 per cent to 23 per cent.

If non-commercial sources of energy (fuelwood and agricultural residues) are taken into account, the annual consumption of energy in Kenya is about 7 million t.o.e. (About 75 per cent fuelwood and agricultural residues). The per capita energy consumption is about 444 kg.o.e. Table 43 shows the distribution of consumption of different sources of energy between urban and rural areas in Kenya.

Table 43 Distribution of Energy Consumption

	Urban		Rural		Total	
	Total (1000 toe)	% of Total	Total (1000 toe)	% ofTotal	Total (1000 toe)	% of Total
Coal	40.2	1.7	-	-	40.2	0.6
Fuelwood	-	-	3,768.8	86.2	3,768.8	55.4
Charcoal	644.7	26.5	429.8	9.8	1,074.5	15.8
Petroleum	1,388.2	57.0	171.6	3.9	1,559.7	22.9
Hydro	362.0	14.9	-	-	362.0	5.3
Total	2,435.1	100.0	4,370.2	100.0	6,805.2	100.0

Source : UNDP/World Bank Report 3800-KE (1982)

The Kenya Government has set the following objectives for energy development :

1. Increasing the supply of energy to meet the requirements of development.
2. Rationalizing the use of imported petroleum
3. Developing indigenous energy resources
4. Reducing the dependence on imported oil

Special concern has been voiced on the situation of fuelwood in the country. Projections carried out show that with the current rate of consumption and population growth, there will be a national fuelwood shortfall of 30 % by 1990. A number of projects are now being undertaken to promote the development of renewable sources of energy and increase the efficiency of utilization of biomass (see Chapter 5 for afforestation programmes).

IX INDUSTRY

At present there is no systematic monitoring of different effluents resulting from various industries. Some industries have installed plants to partially treate industrial wastewater before discharging effluents into surface water bodies. The following is a description of the environmental impacts associated with some industries in Kenya, on the basis of available information.

1. The Coffee Industry :

Coffee processing is a major industry in Kenya. There are about 100,000 hectares under coffee in Kenya of which 30,888 hectares are estates and the rest under co-operatives. All estates have their own factories while co-operatives have joint factories. In total there are about 1,200 coffee factories, located near streams and rivers.

Wastewater from coffee factories is normally discharged into water courses after pre-treatment, or directly through seepage pits; in some cases wastewater is used for irrigation. It is now required that all coffee factories should recycle their water, achieving thereby zero discharge (they are required to use about 20,000 litres of water per tonne of coffee processed). The discharge of wastewater from coffee factories caused an increase in the BOD of some water courses to more than 100 mg/l in addition to lowering the dissolved oxygen which resulted in fish kills in some instances.

Solid wastes from coffee factories are used as mulch for grass, coffee and soil conditioning. Charcoal brickets are made from pulp and parchment.

2. The Sugar Industry :

Sugar industries in Kenya are mostly located in the Lake Victoria Basin and the Coast Province. They are all located near permanent rivers. Water withdrawn from these rivers is returned after treatment. The Mumias Sugar Factory, for example, is currently withdrawing 8,640 m^3 water per day; the wastewater is discharged at the rate of 603 m^3/day and has a BOD of about 40 mg/l (the BOD allowed for industrial wastewater discharges into surface waters in Kenya is 40 mg/l). Other factories, however, discharge wastewater with higher BODs (for example, in 1985, the East African Sugar Industries' wastewater had a BOD of 195 mg/l; the Nzoia Sugar Factory, 320 mg/l; the Sony Sugar Factory, 195 mg/l).

All sugar factories are currently required to use facultative ponds for the oxidation of their wastewaters.

Excess molasses are sold to farmers as animal feed, while the rest is converted to power alcohol. Caked mud is used as a land fill.

3. Slaughter Houses :

Nearly all slaughterhouses cause a number of environmental problems, through the disposal of their wastewaters and/or solid wastes. Reported impacts are pollution of rivers and streams, creation of condition that encourage congregation of various carnivorous birds, unsightly landscape and odours. In the more established meat processing industries such as Kenya Meat Commission, Athi River and Uplands Bacon Factory, there are conventional wastewater treatment plants. However, there is not sufficent information available about the performance of these treatment plants. The Kenya Meat Commission Factory in Mombasa discharges its effluents directly into the sea; this has reportedly made marine products like oysters unfit for human consumption.

At present, there are some proposals to establish a gelatin factory to recycle hooves, horns and skins; other residues from the meat industry might also be recycles as animal feed and/or manure to be used as fertilizer.

4. Leather Industries :

Leather industries process raw hide to the blue stage except for Bata Shoe Factory and the Kenya Leather Industries (to be commissioned shortly). To date no tannery in Kenya can be said to be operating properly in terms of environmental pollution. Except for one or two, most are located on the periphery of urban centres and discharge treated effluent into water courses. A tannery in Nairobi industrial area is known to discharge its effluents into the sewer system. Wastewater treatment at the Leather Industries involves screening, grit removal and treatment in aeration lagoons. The quality of the treated effluents varies from factory to another, according to the degree of treatment. Effluents from the Bata Shoe Factory in Limuru have a BOD of 39 mg/l and contain some chromium (37 mg/l), sulphides (5.3 mg/l) and oil/grease (0.34 mg/l). On the other hand, effluents from Kamiti Tanners (Nairobi) have a BOD of 1913 mg/l.

Odour from tanneries has been a major cause of complaints from residents near such factories.

5. Other Industries :

Fruit canning industries (e.g. Kenya Orchards at Machakos and Kenya Canners at Thika) discharge their organic-rich effluents without or without partial treatment into surface waters.

The mining of fluorspar in Kerio Valley has been the cause of documented environmental impacts on livestock and on fish and crocodiles in the Kimwarer River. The effluents from the fluorspar industry contain sand, suspended colloidal clay matter and dissolved and residual fluorides. It is not clear what component of these has actually caused the damage.

The steel industry at Kikuyu causes serious air pollution; it is claimed that air pollution from the steel mills has increased the acidy of rain locally. The major impact of this acid rain is mainly manifested on metal structures which have been seriously corroded to a point of rendering some homes unhabitable. No health data are available, but major complaints include chronic flu, intestinal problems and respiratory ailments.

Other industries that create some environmental problems include textile, paper, chemical and pharmaceutical products and the sisal industry.

X. INSTITUTIONAL ARRANGEMENTS AND LEGISLATIONS

1. ENVIRONMENTAL MACHINERY :

The Kenya Government policies with respect to preservation and improvement of the environment are based on the premise that the prevention of harmful effects is less costly than their subsequent correction. Hence environmental considerations are entertained at all levels of planning in order to ensure that the pattern and style of development is consistent with a healthy natural environment, which is essential to the well-being of the present and future generations.

These policies are designed to ensure that development proceeds in an environmentally-sound manner. They are continually refined as they relate to environmental education, resource use, environmental impact assessment reports, monitoring of environmental hazards, human settlements, environmental law and the co-ordination of environmental protection programmes.

Specific policies for environmental control have been designed by the Government for the current Development Plan (1984-1988). For example :

1. The Forestry Policy; whose main objectives include reservation of land for forestry purposes, protection of forest resources and conservation and management of forests, etc.
2. The Mineral Resources Policy ; whose main objective is to maximize the benefit accruing from the exploration of mineral resources through careful and systematic exploration and exploitation.
3. Fisheries Policy ; whose main objective is to develop and exploit fish resources effectively.
4. Energy Policy ; whose main objective is to generally improve energy efficiency and discourage wasteful consumption and thereby stimulate conservation.
5. Water Policy ; whose main objective is to manage and develop water resources to achieve multipurpose development goals such as flood mitigation, hydro-power development, irrigation and drainage, recreation and wildlife conservation whilst minimizing deleterious environmental effects.

Generally, policies with respect to the use of resources and material focus on identification of natural resource supplies and local materials which can be used to promote economic development without depletion to avoid premature exhaustion.

In trying to achieve the stated policy objective goals the Government has given the responsibilities of implementation of the different sectors to different Ministries. To co-ordinate between these activities, an

Interministerial Committee on Environment has been established under the auspices of the National Environment Secretariat. The members of the Committee are drawn from most of the Government Ministries which have activities with strong environmental implications; the University of Nairobi, Kenyatta University, Kenya Science Teachers College and several non-governmental organizations. The Committee has established task forces which deal with specific environmental matters and reports to the main Committee which then takes the necessary steps.

Non-governmental organizations have also played a very important role in the conservation of the environment. Their activities have been mainly supplementary to the Government efforts in this area.

The main bodies dealing with environmental matters in Kenya are:

1. Office of the President:
The Office of the President is responsible for the co-ordination and policy guidance on development programmes. The Office is in charge of the Permanent Presidential Commission on Soil/Water Conservation and Afforestation- a national body which co-ordinates all the activities related to soil/water conservation and afforestation programmes and the Government Chemist. The Office of the President also promotes conservation efforts at the grassroots (through the District Development Committees, the Chiefs' Tree Nurseries). The President has established the Presidential Tree Fund for raising tree nurseries at every local level and in all schools. The President personally leads the nation in tree planting and construction of gabions in eroded areas and has directed that every Chief must have locational tree nurseries.

2. Ministry of Agriculture and Livestock Development :
The Ministry is responsible for the administration of the Agricultural Act and District Conservation Committees. It also administers the National Soil Laboratories, the Pest Control Board, and works closely with national and international organizations. The Ministry determines the use of agro-chemicals, land use planning, co-ordination of arid and semi-arid lands rehabilitation, rangeland development and livestock development and marketing.

3. Ministry of Education, Science and Technology :
The Ministry is responsible for the development of environmental education programmes and teaching materials for all institutions of learning. Higher education institutions promote environmental awareness and trail personnel in the field of environmental science (e.g. Kenyatta University, Nairobi University, Diploma Teacher Training colleges such as Kenya Science Teachers College, etc). The Ministry has working ties with the UNEP/UNESCO International Environmental Education Programme.

4.Ministry of Environment and Natural Resources :

The Ministry undertakes work which is central to the national policy on environmental management, initiates environmental policies for the Government through three departments: the Forest Department, which is responsible for National Forestry Policy; the Mines and Geology Department, which is responsible for mineral exploration, regulation of the mining industry and the administration and enforcement of the Mining Act; and the National Environment Secretariat, which co-ordinates environmental matters in the country, provides advice and information on national environmental matters, initiates and enhances environmental education programmes and works closely with national and international organizations to enhance environmental awareness. The NES produces several publications such as "Our Environment" and "District Environment Assessment Reports". The Ministry also co-ordinates the activities of the National Tree Planting Day and World Environment Day.

5.Ministry of Health :

The Ministry deals with all matters affecting public health- disease control, preventive and curative medical services, control of dangerous drugs, health education, food and food handling, sanitary services and family planning.

6. Office of the Vice-President and Ministry of Home Affairs :

Formulates population policy guidelines for the Government in relation to natural resources.

7. Ministry of Energy and Regional Development :

Formulates the National Energy Policy Guidelines, the Energy Conservation Strategy and projects aimed at achieving the goals of the stated policy objectives such as the Kenya Renewable Energy Development Project. The Ministry also directs the operations of regional development authorities, e.g., the Kerio Valley, Tana and Athi Rivers and the Lake Basin Authorities.

7. Ministry of Transport and Communication :

The Ministry focuses on transport and communications network in relation to the environment. The Ministry is in charge of the Meteorological Service. Its agency, the Kenya Ports Authority abates and controls oil spills at the Coast. The Road Safety Unit promotes road safety campaigns to all Kenyans.

9. Ministry of Tourism and Wildlife :

The Ministry is in charge of wildlife conservation and management and the management of fisheries. The Ministry participates in activities such as protection of habitats and species threatened with extinction, anti-poaching regulations ; the Wildlife Education Unit creates awareness on wildlife conservation to school children and other groups.

10. Ministry of Planning and National Development :

The Ministry carries out general monitoring of all natural resources in relation to the total environment through its agency "The Kenya Rangeland Ecological Monitoring Unit (KREMU)".

11. Ministry of Labour :

The Ministry examines the general working conditions (environment) of all workers, through its Agency " the Factories Inspectorate".

12. Ministry of Water Development :

The Ministry is responsible for water development and supply of clean water to people. It is also concerned with conservation of water catchment areas, water quality and pollution control.

13. Ministry of Works, Housing and Physical Planning :

The Ministry prepares plans for urban development in relation to environment. Its plans take into account the potential for each area and the type of development which is compatible with most rational utilization of the resources of the area.

14. Kenya African National Union (KANU) :

The Party promotes environmental awareness in addition to supporting the policies and programmes of the Government aimed at environmental conservation. At present, the Party is establishing District tree nurseries to supplement Government efforts in afforestation.

In addition to the above-mentioned governmental bodies, several non-governmental organizations (both international and national) are involved in environmental matters in Kenya. Their activities range from the promotion of environmental awareness to actual practical involvement in some environmental conservation projects. NGOs play a vital role in supplementing Government activities in the area of protection of the environment. The following is a description of the activities of some NGOs :

1. Environment Liaison Centre (ELC) :

This international NGO provides environmental awareness amongst local NGOs through its publication "ECOFORUM", workshops,etc. The ELC helps in energy and afforestation programmes through grants (ELC Small Grants Fund) to local NGOs.

2. African Wildlife Foundation (AWF):

The AWF assists and supports Government institutions and individuals in the management and conservation of wildlife, Parks and Game Reserves and the rehabilitation of threatened areas. It also promotes environmental awareness through the production of conservation education material such as the "Wildlife News" and "Pied Crow's Environment Magazine".

3. International Council for Research in Agro-Forestry (ICRAF) :

ICRAF has established a field research station in Machakos aimed at developing diagnostic methodology to evaluate and compare land use systems. ICRAF also provides technical inputs into projects and documentation services to those working in agroforestry.

4. Kenya Energy Non-Governmental Organization (KENGO)*

KENGO is mainly involved in afforestation projects, fuelwood conservation and promotion of environmental awareness through the publication of educational material such as the "Kengo News" and training workshops on renewable sources of energy.

5. Kenya Freedom From Hunger Council :

The Council is involved in tree planting programmes through village groups and local schools.

6. Mazingira Institute :

The Institute promotes the development of renewable sources of energy through tree planting and promotion of environmental awareness among school children via magazines and competitions.

7. Men of Trees (K) :

Promotes conservation of existing forests, tree planting and promotion of environmental awareness to the public.

8. Youth Groups :

Several youth groups, especially Church-Organized Groups, are involved in promotion of environmental awareness and practical activities aimed at conservation, such as terraces/gabion construction and tree planting. For example, the Wildlife Clubs of Kenya organizes conservation education programmes for youth and tree planting, travels around the schools giving ideas and practical demonstrations aimed at environmental conservation. The Kenya Girl Guides Association and the Boys Scouts Association carry out programmes for the preservation of nature and natural resources.

9. Women Groups :

The activities of these groups are diversified. Some are involved in energy conservation-building of energy efficient jiko stoves such as the Kenya Ceramic Jiko (KCJ), while others are involved in afforestation programmes- establishment of tree nurseries and planting of tree seedlings, e.g. the National Council of Women of Kenya (Green Belt Movement)- tree planting, tree nurseries and seedling distribution and Maendeleo Ya Wanawake- building of energy efficient wood-characoal jiko stoves,etc.

10. Religious Institutions :

Such institutions, for example the National Christian Council of Kenya (NCCK), the Kenya Catholic Secretariat and the Kenya Bahai Community, are involved in renewable energy projects, establishment of tree nurseries, tree planting and promotion of environmental awareness.

Although the Government of Kenya has not developed a National Conservation Strategy, the individual Government Ministries and Departments have designed specific strategies for vaious respective natural resources. These strategies are based mainly on the principle of "Development without Destruction" and calls upon all Kenyans to address themselves to the idea of protection, conservation as well as enhancement of the environment. These strategies and policies (see page 71 of this report)

are embodied in the National Development Plan for 1984-88.

The Government of Kenya has charged the National Environment Secretariat with the responsibility of collecting, collating and disseminating relevant environmental information to all sectors of the Kenyan society. It is meant to develop a national population that is aware of and concerned about the environment and its associated problems. Environmental education is expected to provide the recipients with the necessary knowledge, values, attitudes and commitment to participate both individually and collectively to solve or look for solutions to environmental problems. To achieve these broad goals, the NES works closely with relevant Ministries, NGOs, Kenyatta University, Moi University, Nairobi University and the media.

2. ENVIRONMENTAL LEGISLATION :

Under the Laws of Kenya, there is not any one composite or specific legislation on environment (i.e. an environmental law). However, different Acts of Parliament touch on environmental issues, for example there are Acts providing for conservation of natural resources, pollution control and standards. The statutes are fairly adequate, compartmentalized (if not professionalized) but are not co-ordinated. The most important legislations dealing with environment in Kenya are :

1. Conservation Legislation :

The Water Act-Chapter 372 of the Laws of Kenya
The Agriculture Act- Cap 318
The Forests Act- Cap 385
The Land Planning Act- Cap 303
The Fish Industry Act- Cap 378
The Plant Protection Act- Cap 324
The Local Government Act- Cap 265
The Town Planning Act- Cap 134
The Lakes and Rivers Act- Cap 409
The Government Fisheries Protection Act- Cap 379
The Kerio Valley Development Authority Act- Cap 441
The Lake Basin Development Authority Act- Cap 442
The Tana and Athi Rivers Development Authority Act- Cap 443
The Wildlife Conservation and Management Act- Cap 376
The Grass Fires Act- Cap 327

2. Pollution Control Legislation :

The Water Act- Cap 372
The Public Health Act- Cap 242
The Factories Act- Cap 514

The Food, Drugs and Chemical Substances Act- Cap 254
The Pharmacy and Poisons Act- Cap 244
The Use of Poisonous Substances Act- Cap 247
The Cattle Cleansing Act- Cap 319
The Fertilizers and Animal Foodstuffs Act- Cap 345
The Agricultural Produce (Export) Act- Cap 319
The Pests Control Products Act No.4 of 1982- Cap 346
THe Radiation Act (The Radiation Protection Bill 1982)- Cap 245
The Traffic Act- Cap 403
The Penal Code- Cap 63
The Merchant Shipping Act- Cap 389
The Kenya Bureau of Standards Act- Cap 496

Each of the above-mentioned legislation deals with and operates for specific purposes for which it was enacted- either for conservation, pollution control and/or establishment of limits of emissions for harmful substances. Some Acts, for example the Water Act, provides for conservation as well as for pollution control. The following highlights the provisions of some of these environmental legislation:

The Water Act- Cap 372

The Act makes provisions for the conservation, control,apportionment and use of water resources in Kenya. Sec.19 of the Act provides for the establishment of a Water Resources Authority to carry out investigations on water resources and advise and make recommendations to the Minister in regard to the improvement, preservation, conservation, utilization and apportionment and any other findings they may deem necessary.

The Water Act has control devises for all use of water by providing for permits for such use to be granted through Local Water Apportionment Boards. These Boards deal with the questions of efficient utilization of water, and issue permits for abstraction of groundwater and licence contractors. The water permits are required for all uses, domestic, public, irrigation, industrial, power or any other purposes approved by the Board. The Act also provides for appointment of water undertakings- for the purpose of distribution of water supplies.

Besides addressing itself to issues of conservation, the Act also prohibits water pollution and gives control devises by giving such conditions in the permit as will ensure that pollutant substances are not left in any water supply. Thus, before a licence for use of water is issued one has to show steps proposed to render the effluent and the residue innocous and pure. Conditions are then given acceptable to the degree as the Board sets and if not met, the licence will be cancelled; and thereby laying down maximum standard of available concentration in the effluent as part of the agreement to issue of a water permit.

A Water Quality and Pollution Control Section has been set to undertake scientific and technical laboratory work on standardization of water quality. However, the setting of standards has been made difficult by laboratory costs, multiplicity of discharged effluents to a given body of water and the lack of full understanding of the different pathways and interactions between different effluents and between effluents and receiving waters. These difficulties constitute a constraint on the effectiveness of implementation of the Water Act's legislative measures.

Agriculture Act- Cap 318

The Act is for promoting agricultural development and it stresses the need for conservation of soil and its fertility and the development of agricultural land in accordance with sound practices of good land management and good husbandry. In other words, the Act emphasizes the prevention of soil erosion and in such a way it prevents land degradation and, indirectly, the deterioration of the quality of surface waters (through increasing loads of clay and silt resulting from soil erosion).

The Forest Act- Cap 385

This Act provides for the establishment, control and regulation of central forests, other forests and forest areas in Nairobi area and on unalienated Government land. The main objective is to encourage conservation and maintenance of vegetative cover in all lands. However, the administration of the Act faces some problems created by economic reasons, rapid growth of population and increasing demand for fuelwood; all these factors have accelerated encroachment on forest areas.

The Government Fisheries Protection Act- Cap 379

The purpose of this Act is to protect the depletion of certain species, for example, pearls or mother of pearl shells, or shellfish containing or believed to contain pearls or mother of pearl; beche-de-mer; and ambergris.

The Merchant Shipping Act- Cap 389

This Act provides for control of pollution of the sea by oil from ships.

The Wildlife Conservation and Management Act- Cap 376

This Act makes provisions for the preservation and control of wild animal life and wild vegetation so that these are allowed to flourish in their natural habitat.

The Lakes and Rivers Act- Cap 409

The Act controls the process of dredging of lakes and rivers.

The Radiation Protection Bill 1982

The Bill seeks to repeal the old Act which was simply named "The Radiation Act" Cap 245 Laws of Kenya. The Act does not allow for the control of radioactive substances; it deals more with administrative issues of licensing the use of radioactive material. The Bill provides for a Chief Radiation Protection Officer for the effective enforcement of the provisions of the Act.

The Public Health Act- Cap 242

The Act makes provisions for maintaining and securing health. It addresses itself to what is nuisance with a view to stopping interference with the rights of the public by acts that cause discomfort or injury.

The Local Authority Government Act- Cap 265

This Act provides that each local council (municipality,etc) may establish and maintain sewerage and drainage systems, water supply systems, etc. According to Sec. 129 of the Public Health Act, the local authority is responsible for taking the necessary measures to prevent any pollution dangerous to health of any supply of water which the public within its district has the right to use.

The Penal Code

The Penal Code- Cap 63 has provisions for abatement of noise and air pollution (intentional actions which might cause nuisance or affect the health of people).

The Traffic Act

Under the Traffic Rule 27 (1) every motor vehicle shall be constructed, maintained and used that no avoidable smoke or visible vapour is emitted therefrom.

Civil Procedure Code- Cap 21

A further way to curb pollution of the environment is where action by civil proceedings can be taken (where pollution amounts to public nuisance) and reliefs will be granted by courts. One area where individuals or local authorities can, for example, file civil proceedings is in the case of water pollution. While private action can be taken against pollution of water by persons who have a right to the water (or land), public nuisance can be brought by any person whether he (or she) depends on such water. All civil proceedings with regard to public nuisance

have to be brought with the Attorney-General's consent as provided for in Sec. 61.

Common Law and Pollution

The Common Law of Kenya provides for environmental protection. The public can demand the enforcement not only of the laws and regulations already in force bu also of their constitutional rights. Private citizens can sue for nuisance or seek injunctions where use or enjoyment of land or some right over it or in connection with it is interfered with. Thus, for example, under the Registered Land Act- Cap 300, a registered owner of land has overiding interests to natural rights of light, air, water and support and rights of way, rights of water,etc. Sec.48(1) of the Water Act also gives the right of water. A natural stream of water belongs to the propreitor of the adjoining land as a natural incident to the right of soil itself. Thus if one establishes the ownership of land which might be affected by polluted water, he can sue for damages and/or call for injunctions. In this way offensive acts such as dumping of sewage and other wastes which may create harmful consequences can be stopped.

Law on Chemical Substances

This Law is contained in multiple legislations, all are aimed at the protection of human, animal and plant life. The Law deals with the use and disposal of chemical substances. For example, the Food, Drugs and Chemical Substances Act- Cap 254, regulates the use, manufacture, export or import oc chemical substances (including germicides, isecticides, pesticides). The Public Health Standards Board is empowered to determine the effect of any chemical substance on the environment. If any chemical has adverse effects, the Board may require its removal from the market or lay down regulations for its manufacture, sale, import or export.

Kenya has ratified a number of international agreements in the field of environment (see Register of International Treaties and other Agreements in the Field of the Environment published periodically by the United Nations Environment Programme). However, some remains to be assessed with a view to their ratification.

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