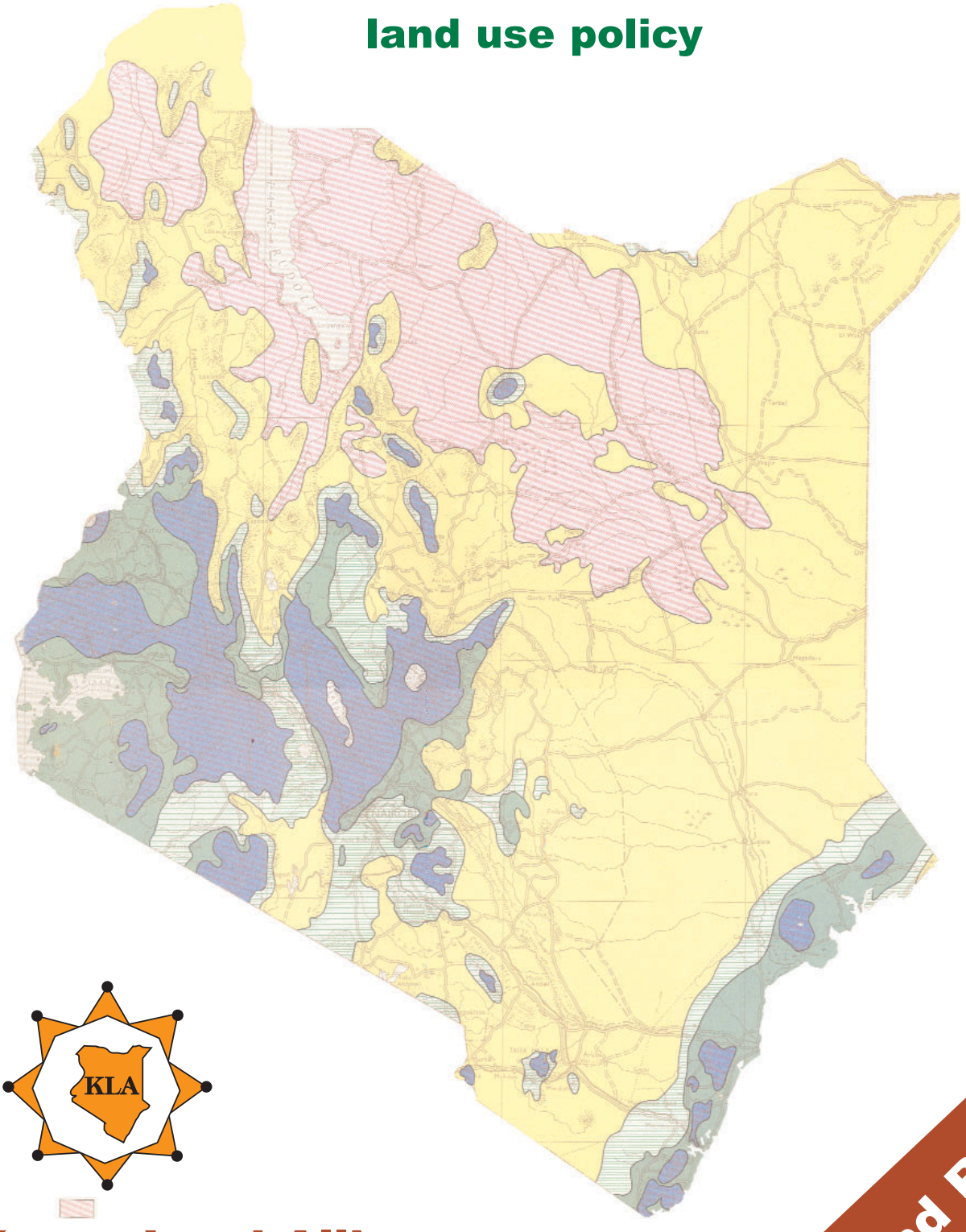
LAND USE IN KENYA

The case for a national land use policy



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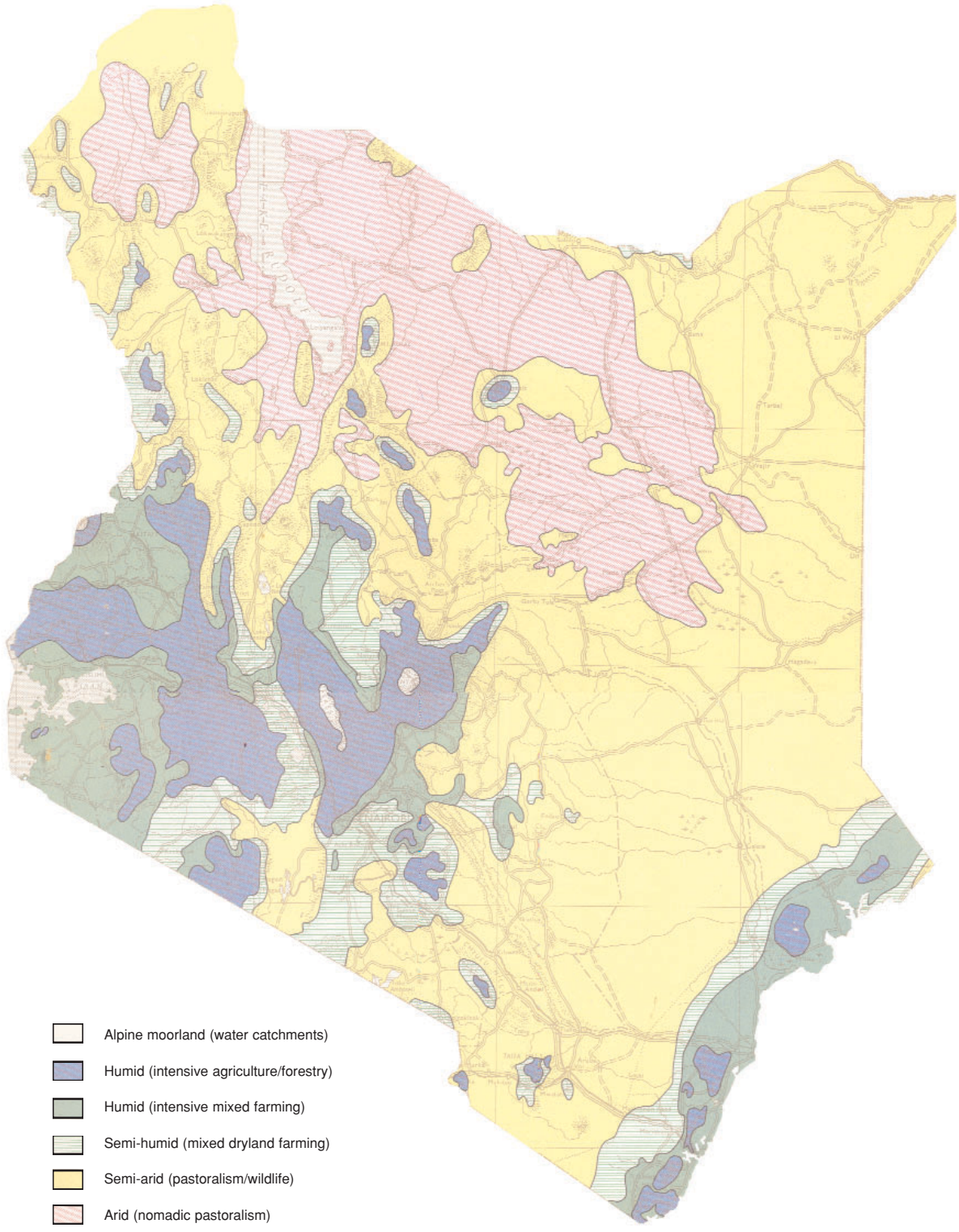
Alpine moorland (water catchments)
Humid (intensive agriculture/forestry)
Humid (intensive mixed farming)
Semi-humid (mixed dryland farming)
Semi-arid (pastoralism/wildlife)
Arid (nomadic pastoralism)

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There are many who contributed in different ways but whom we have not named, we express our heartfelt appreciation to them all.

The large body of the text is based on information arising from a social audit by Mwichabe and Wafukho in 1999 on the natural resources in Kenya. The audit was carried out in the context of providing a picture of now; and how this picture can enable us foresee the future of natural resource management in Kenya. The information has been a building block to the Kenya scenarios project by the institute of Economic Affairs.

The information in this book has been collected mainly through sieving data analysis of published data in the public domain, international organisations and authoritative articles as well as local publications. Of particular importance were the data sets maintained by the Central Bureau of Statistics, Kenya Wildlife Service, Department of Remote Sensing and Resource Imaging, the Ministry of Agriculture and rural Development and the Department of Forestry. Other useful materials were sourced from IUCN and UNEP.

Preface

Since its formation in 1999, the Kenya Land Alliance (KLA) has participated actively in land reform issues at the local, national and global levels.

In response to invitations to the stakeholders' consultancy meetings held in the Ministry of Lands and Settlement on the preparation of a national land-use policy for Kenya, KLA took up the challenge to undertake a social audit of our natural resources with a view to put up the case for a national land-use policy. Although the initiative within the Ministry of Lands and Settlement was subsequently suspended, KLA decided to proceed with the audit to completion.

This book argues the case for a national land policy, which spells out in broad terms how land and other natural resources should be used and managed in a sustainable manner. Kenya has a population of over 28 million people who derive their livelihood from land-based resources. If the full benefits of these resources are to be realized then a land-use policy must be put in place urgently. KLA notes that in the past issues of land use have been taken into account in various circles but there have been no tangible results. This is partly because whenever matters concerning land are raised, they evoke emotions and sensitivity among Kenyans.

KLA further appreciates that there has been confusion between land-use policy and land policy. Land policy is a broader concept, touching mainly on tenure/ownership and may also include aspects of law. A land-use policy is concerned with the way land and natural resources are used and managed, and issues of ownership/tenure are secondary.

It is hoped that this book will serve as a resource for government, policy makers, planners, researchers, academics, scholars and communities in Kenya and elsewhere to pressure for a policy framework to be put in place to govern land use.

Summary

This book exposes the key land use and environmental problems facing Kenya today due to lack of an appropriate national land use policy. The publication details how the air is increasingly being polluted, the water systems are diminishing in quantity and deteriorating in quality. The desertification process threatens the land and its cover. The soils are being eroded leading to siltation of the ocean and lakes. The forests are being depleted with impunity thus destroying the water catchments. The savannas and grasslands are undergoing de-vegetation through overgrazing, charcoal burning and other poor land use practices leading to desertification.

The book also reveals the underlying causes of the deterioration of the life support systems (air, water and land) through poor land use practices notably de-forestation, inappropriate irrigation techniques, overgrazing, fuel wood harvesting and charcoal burning. Others are pollution from industries, harmful agricultural practices and improper management of solid and liquid urban wastes. The ever-increasing population exerts pressure on the natural resources and drives the mis-use of the resources, the situation is exacerbated by the cyclic occurrence of disasters such as droughts and floods.

The publication further exposes the emerging conflicts and the consequences of un-sustainable land use. For example the scarcity of pastures and water fuels conflicts among pastoralists and between small and large-scale irrigation farmers. Poor air and water quality increases health hazards in human beings and loss of biodiversity. Destruction of water catchments diminishes stream flow and hence electricity supply necessitating rationing. Desertificaton reduces the productivity of land leading to food insecurity, reduced income and non-accumulation of economic assets. Eventually millions of families end up living below the poverty line. Currently, over 5 million households are unable to access basic human needs such as food, medical care, and education or meet other social obligations.

The book further demonstrates that the current trend of deterioration will lead to a gloomy future for the populace if the status quo is maintained. As an alternative future scenario, the publication exhorts the government of Kenya, industrialists, urban dwellers, farmers, fishermen, pastoralists, nomads, hunter/gatherers and other resource users to opt for a rational land use programme - practising wise management of natural resources and protection of the environment. Striking a balance between satisfying the human livelihood needs and wise usage of resources to ensure sustainability of the natural resource base is the biggest challenge. The book has identified the key elements that are needed in order to put in place a comprehensive and rational national Land use policy that will enable the emergence of sustainable land use practices in Kenya.

The information in this publication is an analysis of published data in the public domain of Government of Kenya, international organizations and local institutions. Field data analyses and interviews with a cross-section of professionals, ordinary farmers, pastoralists, fishmongers, hunter gatherers among other respondents in some parts of Kenya provided valuable testimonies that have enriched the text.

Acronyms

AEZ	-	agro-ecological zone
ASAL	-	arid and semi-arid lands
CFCs	-	ChloroFluoride Compounds
DDT	-	DichloroDimythyleToluene
EMCA	-	The National Environmental Management and Coordination Act
FAO	-	Food and Agricullture Organization of the United Nations
GHG	-	Green House Gases
GDP	-	Gross Domestic Product
IGAD	-	InterGovernmental Authority on Development
IUCN	-	International Union for Conservation of Nature
JICA	-	Japan International Cooperation Agency
KLA	-	Kenya Land Alliance
KWS	-	Kenya Wildlife Service
KFMP	-	Kenya Forestry Master Plan
MRDASW	-	Ministry of Reclamation and Development of Arid, Semi-Arid Areas and Wastelands.
NEAP	-	Natural Environment Action Plan
NEMA	-	The National Environmental Management Authority
P&D	-	Peris and Day
POPs	-	persistent organic pollutants
UNEP	-	United Nations Environment Programme
UNCHE	-	United Nations Conference on Human Environment
UNCED	-	United Nations Conference on Environment and Development
TLU	-	Tropical Livestock Unit

Introduction

Land use in Kenya—perceptions, types and trends

CNRM

A small scale farmer in Kieni, Nyeri

Land in Kenya means different things to different people. To farmers and pastoralists land is property to be owned and a source of livelihood, and access to land and controlling it are key concerns. The elite consider land as a marketable commodity from which to make windfall profits through market speculation mechanisms. As a nation, the public, politicians and administrators view land as a sovereign entity whose boundaries reflect a social, cultural and political identity.

To development agencies land provides goods and services required for people's welfare and prosperity. Conservationists technically define land as a fragile, ecological entity resulting from the mutual working of living and non-living things on the earth's surface. These perceptions roughly translate into different, and often competing, interests in land in Kenya. No single definition can adequately reflect the divergent perceptions. Some common features in the definitions indirectly suggest that land is an area of the earth's surface embracing the biosphere, the atmosphere and the lithosphere.

The different perceptions and varied interests in land translate into interest groups which influence land policy in the country. Ultimately, interest groups with political and economic power determine the shape of the land-use policy. For example, the colonial government reserved prime land throughout the country for British settlers and confined Africans to marginal reserves. Later, political agitation brought the elite, peasants and the landless into the white highlands through settlement schemes. After independence, the African elite took over the powerful roles of the settlers. The groups that included peasant farmers, the urban poor, pastoralists especially the nomads, the landless and squatters—especially those at the Coast Province—lost out in this game.

Land is currently the most important resource from which the country generates goods and services for the people. The national economy is primarily agro-based. Ninety percent of the population living in rural areas derives its livelihood directly from land. To these people, land resources are the means to a livelihood determining the levels of prosperity or poverty, fulfilling social obligations, and also conferring social status and political power. Sustaining the livelihoods of such a high population with limited land resources places a high demand for access to resources, making use and ownership of land fundamental issues in the socio-political and economic landscape of the country.

Natural resources change in quality and quantity over time. The Arabian Peninsula was poor in natural resources in the 19th Century until vast reserves of crude oil were discovered in the Middle East. Similarly raw materials like jute, once highly prized, are less valued today as they compete with synthetic products. Sustainable use of natural resources ensures that the use of renewable resources does not exceed their regenerative rates. Also, the use of non-renewable resources should not exceed the rate at which their renewable substitutes are created.

Land and its cover is currently the most important base from which the country generates goods and services for the populace.

The major land-cover types in Kenya are forests, savannahs, grasslands, wetlands, fresh and saline water bodies, and deserts. These are used for agriculture, pastoralism, water catchments, nature reserves, urban and rural settlements, industry, mining, transport and communications, tourism, recreation. Other uses include cultural sites, fishing, forestry, energy.

Of the total land cover, about 2.4% is under indigenous and exotic forests.

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Railway line, Webuye.

About 12% of the land has high rainfall supporting production of tea, coffee, pyrethrum, horticulture and floriculture, and food crops such as maize, wheat, potatoes, pulses, and dairy farming. The semi-arid area covering about 32% of total land has average rainfall and supports mixed crop and livestock rearing. Irrigated flower farming has in the recent past emerged as a major type of land use alongside agropastoralism. Over 50% of the total land cover is arid with extremely low and erratic rainfall. The expansive land is used for extensive livestock production under nomadic systems.

Specific sites along mountains, river valleys, and the unique savannah and grassland ecosystems have been set-aside for conservation of indigenous forests, wildlife sanctuaries, water catchments, marine life, monuments and cultural sites. Most of these protected areas are tourist attraction points.

Interspersed within the diverse agriculturally potential areas are settlements in rural and urban areas. Some parts of the country have limited mineral potential. Others have been set aside for urbanization and industrialization. Fresh and saline water bodies support the fishing industry. Regrettably, they are also used as disposal sites for urban and industrial waste. Rivers are the largest source of hydropower upstream while the lower parts of the large rivers have made irrigated farming possible. The expansive savannahs and grasslands are home to livestock production and wildlife conservation. They are now a major focus for innovations in dry-land farming.

Chapter One
The land resource endowment in Kenya

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A small scale farmer in Nanyuki, Laikipia

1.1 Agriculture

Land is the most important resource in Kenya. However, of the total area of 582,646 km^2, only 17% is suitable for rainfed agriculture. About 2.2% of the arable land is covered by forest reserves. Arid and semi-arid lands (ASALs) comprising grassland and savannah rangelands cover the remaining 82%. The rangelands are home to 85% of total wildlife population, and 14 million people practising dry-land farming and pastoralism (Mwichabe in Kengo, 1996).

Agriculture remains the backbone of the national economy. The sector contributed 24.5% of real Gross Domestic Product (GDP) in 1990–95, 24.4% in 1998 and a projected 26.0% in 2001. The growth rate declined from 1.5% in 1998 to 1.2% in 1999 and further dropped to 0.8% in 2000 (GoK/UNEP, 2001).

Agriculture supports over 80% of the population. It employs 70% of the country's labour force of over 10 million compared to only 3 million employed in the

formal sector. It also generates 80% of the export earnings and supplies over 70% of raw materials for the agro-industry. Overall the sector contributes to more than 45% of the government revenue (Ogendo and Kosura, 1995).

a) The agro-ecological potential

Kenya's agriculture is determined by factors such as climate, hydrology and terrain. Such agro-ecological factors also determine the suitability of an area for a particular land use. Agricultural potential can be classified into high, medium and low. Intensive cultivation is prevalent in the high-potential highlands where rainfall is high and soils rich. The high to medium potential land is estimated at 5.3 million ha (20% of total land in Kenya) and receives consistent rainfall of above 1200 mm annually. Common crops include tea, coffee, sugarcane, maize and wheat. A lot of pressure from the fast growing population is exerted on high- and medium-potential areas (table 1).

Approximately 59% of the soils in Kenya have moderate to high natural fertility making them suitable for growing a large variety of crops. Productivity is curtailed because only 17% of the country receives average rainfall of more than 800 mm per annum—the minimum requirement for rainfed agriculture.

The ASAL area comprising agro-ecological zones IV to VII is approximately 49 million hectares (ha). It covers most parts of the northern, eastern, and southern margins of the central Kenya highlands. In some areas there are true desert conditions. The semi-arid area covers about 20% of the entire land area and is inhabited by 20% of the population. The arid area covering 60% of the total land is inhabited by 10% of the population. In the ASAL, incidences of crop failure are common. The predominant land-use systems are ranching, wildlife conservation and pastoralism. Table 2 shows a comparison of the spatial extent of agriculture to other land uses (GoK, 1992).

Table 1. The distribution of the agro-ecological potential in Kenya

Agro-ecological zones	Potential land use	Area ('000' ha)	Percent of total land
I–III	Medium to high: agriculture, livestock (intensive), forestry and water catchment	8,600	15
IV–V	Marginal to medium: agriculture (drought-tolerant crops), forestry, livestock (ranching), and wildlife conservation	11,500	20
VI–VII	Marginal: livestock (extensive pastrolism) and wildlife conservation	37,400	65
Total		57,500	100

Source: GoK 1992: Development Policy for ASAL: MRDASW.

The changing land-use patterns affect food production. The dynamic marketing of agro-products is steadily changing land-use patterns with positive and negative results on cash and perennial cropland areas respectively.

b) Irrigation potential

The area of land with irrigation potential is estimated at 539,500 ha. Only 10% of this has been developed. Approximately 502 settlement schemes of about 65,000 ha exist in the country. 25,800 ha belong to private landholders, 27,200 ha to smallholders, and 12,000 ha is under schemes managed by the government (CBS, 1995). Irrigated agriculture on government land has since 1989 been declining at the rate of 7% annually. An additional 118,000 ha were proposed for development at the beginning of this decade. Unfortunately most of the schemes have faced problems relating to inadequate water supply, poor management, destruction of crops, collapse of irrigation infrastructure, and lack of maintenance rendering them moribund (Mwichabe and Wafukho, 1999).

The sharp decline in land under irrigation since 1989 may also be attributed to lack of incentives to farmers and poor marketing of their products. There are efforts to revamp the Ahero irrigation scheme as a slump in production in the Mwea irrigation scheme escalates over rice marketing problems.

Table 2. Estimated area under major land uses, 1995

Land-use category	Area ('000')	Percent of total
Crop (with intensive livestock) production	9,379.1	15.78
Livestock production	33,486.2	56.34
Forest and woodlands	3,082.7	5.19
National parks and reserves (protected areas)	4,389.9	7.31
Settlement and associated land uses	46.6	0.08
Others (water bodies, sparsely vegetated)	9,099.325	15.31
Total	59,450.8	100

Source: CBS Statistical Abstract, 1995

Table 3. Land under government irrigation schemes,1978–1995

Scheme	1978	1980	1982	1984	1989	1990	1991	1992	1993	1994	1995
Mwea	5648	5757	5782	5820	5818	5820	5802	5815	5846	5882	5878
Ahero	1369	1315	1236	1072	827	827	853	857	858	857	860
Tana River	872	872	804	831	878	867	0	0	0	0	0
Perkera	158	321	210	96	150	237	252	242	297	220	265
Bunyala	323	207	213	213	213	213	84	213	211	213	214
West Kano	237	1056	1172	450	449	475	734	895	585	898	900
Bura				739	2454	1600	1640	1845	840	0	0
Total	8535	9528	9417	9503	10789	10039	9365	9867	8637	8070	8117

Source: CBS Statistical Abstract, 1995

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Wheat production at Endebes, Kitale.

c) Under-utilization of the agricultural potential

Western Kenya, stretching from Kitale through to Kisumu, Kuria and Sotik, has the most ambient and stable tropical rainfall pattern in the country. Even the semi-arid zones along the lakeshores in Siaya, Busia and Suba with low rainfall have the least variability within seasons compared with ASALs in other parts of the country. The region has in fact witnessed fewer occurrences of drought since the 18th Century compared to central, eastern, northern, coastal and northeastern regions.

The reliability of the rainfall in selected districts is summarized in table 4.

In this region, there are 1.6 million ha with a potential of producing 8 t of grain per ha. However, the current production is 0.3 t per ha on average (45% less than the potential). In Kitale the current average production is 4 t per ha on both small- and large-scale farms (a field assessment by CNRM, 2001).

It is ironical that with such potential, the UNDP poverty (UNDP, 1998) indices place Siaya, Busia and Bungoma as areas with the largest number of people living below the poverty line in Kenya. There is little effort by the residents of this region to use technological innovations to grow high-value crops and rear animals to maximise use of the climatic conditions. The larger part of the region is either covered with maize or low-value cash crops such as sugarcane, tea and coffee. The attitude of the residents of this region towards embracing profitable land-use practices will remain a major challenge for a long time. The government's attempts to maximise production have been ineffective.

Table 4. The 60% reliability of first and second rains in western Kenya.

District	First rains (mm)	Second rains (mm)	Total annual rainfall (mm)
Siaya	350–900	50–800	800–2000
Busia	400–900	80–800	900–2000
Bungoma	500–800	430–800	1200–1800
Kakamega	500–1100	450–850	1200–2100
Kisii	550–600	800–1000	1200–2100
Homa Bay	250–1000	50–700	700–1800
Kisumu	500–700	450–600	1100–1500

Source: Calculations from Jaetzold et al: Farm management handbook 1982.

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Idle land on Uasin Gishu Plateau.

d) Land hoarding

In Kenya, the conditions for ownership of land have never included compulsory requirements to maximise production to attain food security nationally. As a result, the middle class and the elite are hoarding land which could have been used by people who do not own land but have adequate skills and resources to invest in such land and maximise production. The use of temporary leaseholds of both private, government and syndicate (long lease) lands is not commonly practiced and does not provide security of the temporary investments by the leasee.

From Kitale through Nakuru to Malindi one encounters small and large chunks of idle land in prime production areas. The land belongs to absentee land owners—middle and upper class Kenyans—who earn their living through white collar jobs or businesses, and only own land for prestige, political considerations or for idiosyncratic purposes.

Some of the larger tracts of land such as those held by the Agricultural Development Corporation or the National Irrigation Authority belong to the government. The list also includes land leased for long periods to multinational corporations. Some land belongs to special trusts like the Arab ownership along the Coast is by special arrangements. These individuals, corporations or syndicates do not need this land for their livelihood. They are unable to put it to maximum use either because it is not a priority or they own well beyond what they can manage.

From Kitale through Nakuru to Malindi one encounters small and large chunks of idle land in prime production areas which belong to absentee land owners.

1.2 Forest resources

The area under forests in Kenya is estimated at 2.4 million ha of which 1.64 million ha are gazetted. The area of land not gazetted (0.76 million ha) is fragmented into 273 forest units. Forty-three percent of the units stand on 100 hectares or less. The closed canopy of indigenous and exotic forest occupies about 1.22 million ha; plantations cover 0.16 million ha (GoK, 1999). Closed-canopy forests outside the gazetted reserves cover approximately 0.18 million ha. The government has proposed to add a further 0.5 million ha through afforestation and gazzettement.

Forest cover has been changing over time and space. In 1897 the only restricted forest area was the Akamba Wood Strip running 2 miles on each side of the then Uganda railway line. The wood strip was established under the Akamba Woods and Forests Regulations. By 1932, 43 forests had been designated government forest areas which rose to 1.05 million ha in 1940 (IUCN, 1998). At independence gazetted forests stood at 1.8 million ha representing 3.5% of the total land area. An aerial survey in 2000 shows that these forests have dwindled considerably (EAWS/KFWG, 2001).

Most indigenous and exotic forests are found in the central highlands where rainfall is high, soils are fertile and human settlement is limited. In the ASALs, forests are found in isolated mountain ranges and narrow bands along rivers. Table 5 summarizes the size and distribution of forests in Kenya.

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Kaya forest in Likoni, Kwale district.

Table 5. Forest size and distribution in Kenya.

Forest	Combination	Area (ha)
Mt. Kenya	With the protected area	199,500
Mt. Kenya	Lower/Upper Imenti & Thunguru Hills	213,000
Aberdares	Kikuyu, Kijabe, Kipipiri, Kirima, Nyamweru	103,000
Aberdares	Aberdares	148,000
South West Mau	Transmara, Londiani, Maji Mazuri, Tinderet, Timboroa, Nabkoi, Metkei, Lembus, Chemorogok	320,000
Kakamega Forest	Kakamega	45,000
Others	Small less than 100 ha size forests	1,475,250
Total		2,458,750

Source: IUCN, 1995.

a) Forest depletion

Though the area under open canopy is increasing as many Kenyans become aware of the environmental, aesthetic and commercial value of forests, closed-canopy forests have been destroyed.

By 1981 a complete forest inventory showed several gazetted and non-gazetted areas in danger of excision. Over a period of 20 years, some forest areas decreased by 16%. The list of threatened forests includes the Ngong and Karura Forests. Figure 1 shows trends in the rate of forest depletion between 1970s and 1990s.

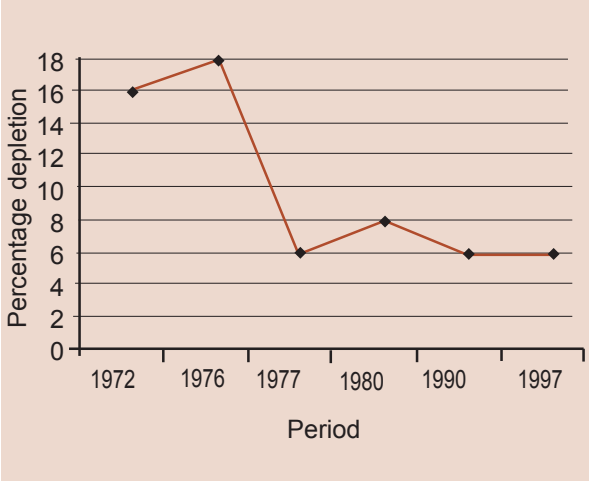


Figure 1. Trends in forest depletion, 1972–1997.
Source: Insitute of Economic Affairs, 2000.

Earlier forest depletion was an attempt by the first government to create room for crop agriculture and to settle landless people. A sharp decline in the rate of forest depletion in the 1970s from 18% to 6% annually was recorded following Kenya's efforts—supplemented by the international community—in conservation.

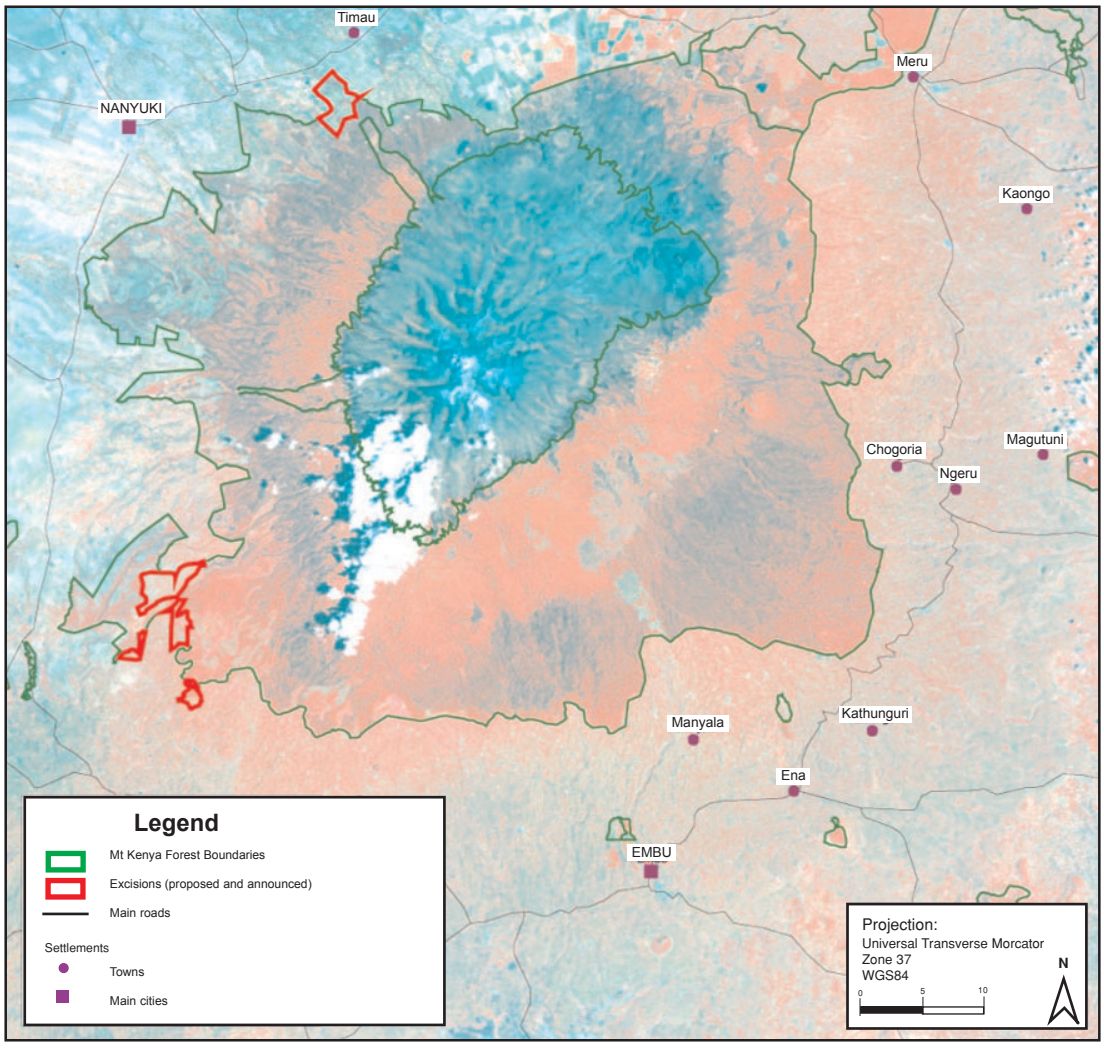
The depletion rate increased by about 2% in the late 1970s, stabilized at about 6% in the 1990s, but picked up again putting in jeopardy conservation measures done in the 1970s. Such deforestation has been a spatially and ecologically differentiated process varying over time and reflecting the relative power and ability of different groups to gain access into forest resources.

Between 1990 and 1995, forest cover changed by about 17% with an average loss of 3% per year largely because of settling the

landless. However a thorough scrutiny reveals that some of the forest blocks were acquired illegally by those who already owned land. The decline continues to threaten the existence of flora and fauna.

The forest area has been declining at an alarming rate. Loss of forests through excision, population pressures and climate change is estimated at close to 5,000 ha per year. Loss through excisions and forest fires is estimated at 15,000 hectares annually (GoK, 1999).

Out of 33 excisions since 1986 only two have resulted in improved protection. Legal excisions total 290,000 ha. These were Kakamega (46,944 ha) and Mrima (378 ha) Forest Reserves, among others (GoK, 1999). The area transferred to national parks and reserves was 115,000 ha. In 2000, the government excised 170,000 ha, with a further 35,000 ha to be excised in 2001/2002. The forests under threat are shown in table 6. Illegal excision around Mt Kenya are shown in figure 2.



Source: East African Wildlife Society/ Kenya Forests Working Group, 2001

Figure 2. Forest excisions around Mt Kenya.

Table 6: Kenya's endangered forests

Forest Name	Threat
North Nandi	Pressure for agricultural land
South Nandi	Pressure for agricultural land
Gwasi hills	Degrading forest use
Arabuko Sokoke	Degrading forest use
Kakamega	Poaching, encroachment, settlement
Endau	Overcutting
Mau	Pressure for settlement and agriculture
Siria Plateau	Encroachment
Kaya forests (all non gazetted)	Intense traditional activities

Source: Insitute of Economic Affairs, 2000.

b) The causes of deforestation

High-value forests found in the wetter zones are prone to excision more frequently as a result of high population pressure than the low-potential forests mainly distributed in the ASAL. For example, small areas of Karura, Mt. Kenya, the Aberdares and Ngong are continuously excised disregarding their significance for catchment protection, recreation and moderation of atmospheric conditions. The single large block of Mau Forest is rich in plant and animal biodiversity but this has not deterred the government from including it in the recently declared excision of forests.

Various parameters influence the above trends. In non-gazetted areas, reliance on shifting cultivation with long fallow periods preserved the natural fertility of the land and helped forests regenerate naturally. Also, communal custody of the forest resources ensured equal rights of access and use. Damage to the environment was limited. However, localized effects of population pressure and land degradation during drought or insect ravages could still be noticed. In the later years, land alienation for European use introduced forced settlements that had serious consequences. The alienation of more than 3 million ha of high-potential land by colonialists made a big impact on the quality and distribution of forest reserves. The slash-and-burn farming system was no longer feasible as regeneration of burned forests took long and more often gave room to clearing for agriculture and near-permanent settlement.

The increased commercial demand for forest products for construction, paper production and medicine among other uses led to a gradual decline in forest area. To date close to 6,000 ha of forestland have been extracted for timber, fuelwood, poles and paper manufacturing. Though the sustainable annual yield from indigenous forests is estimated at 1.6 million m^3, pressure on forestland is increasing.

People use large amounts of forest products. For instance, of the 2.9 million people in over 530,000 households living within 5 km of the edge of the forest, 71% use the forest for firewood, 32–44% for provision

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The shamba system at Burnt Forest, Uasin Gishu.

of other wood products, 55% for medicinal purposes, 33% for honey production, 25% for hunting, and 35% for livestock grazing. Some of these uses are destructive while others are not. Overall they led to a decline in the forest quality and eventually the area under forests (Meadows, 2001).

In areas such as the South West Mau Forest there is a permanent population settlement for 3,800 Dorobo households, while other areas such as Namanga Hill Forest have semi-permanent Maasai manyattas. The surrounding peoples temporarily or seasonally inhabit other areas. Illegal extraction of poles occurs in 40% of the forests, firewood in 23%, timber in 22% and charcoal in 20% of the indigenous forests (Meadows, 2001).

The average annual loss as a result of a combination of all these factors is approximately 1,350 ha. Invasion of forest for settlement and agricultural land is clearly the most destructive. People no longer wait for official allocation but invade forests for settlement (Meadows, 2001).

c) Consequences of deforestation

Forests store and release water to streams and rivers that supply water for domestic, livestock and irrigation. Water used for power generation originates from forested catchments. When forests disappear, so do these water catchment areas. Between 1999 and 2000, a severe water shortage was experienced leading to rationing of electricity supply in urban areas. The main cause was drought exacerbated by gradual destruction of the catchment areas that facilitated more water runoff and seasonal floods but less recharge of the river flow. Two hydropower generation plants closed down causing a reduction in the power supply. To address the short fall, a 305

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The savannah rangelands in Mwingi.

megawatt thermal generator that utilizes 20,000 litres of diesel a day was commissioned. This means an increased release of hydrocarbons into the atmosphere.

Large ungulates such as buffalo and elephant require woody vegetation as natural habitats. The declining vegetation cover partly explains the declining trends in large ungulates and other consequences such as soil erosion, pollution of water systems, gradual desertification and water-use conflicts following competition for the declining resource.

1.3 The savannahs and grasslands

The savannah and grassland ecosystems, collectively referred to as arid and semi-arid lands (ASAL), occupy approximately 80% (464,296 km^2) of the total land area. These ecosystems host all the group ranches and over 90% of the network of national parks and reserves. They are also home to about 50% of the total livestock population and nearly 80% of the total wildlife population in Kenya. Livestock production is the most extensive system in the rangelands (GoK, 1992).

Table 7 shows livestock trends in Kenyan rangelands. The information shows that all

types of livestock are declining. The greatest decline, 16%, was recorded for cattle and donkeys in the early 1990s to the late 1990s. Camels declined by only 11% thanks to their ability to withstand severe droughts while shoats (sheep and goats) fell by 14%.

The decline is partly attributed to the changes in ecology, weather conditions, socio-cultural and economic orientation and conservation approaches. The population of cattle, camels, sheep and goats (shoat) was stable in the late 1980s and early 1990s. Nevertheless, the ability of the savannah to hold vast populations of livestock is constantly threatened by the rapid expansion of croplands into these regions.

The ASAL ecosystems are currently used as sinks for population from the high potential areas. They are also the largest suppliers of fuelwood to the major urban centres in the country. Large-scale mining and oil prospecting also occurs in this zone.

In the process desertification occurs mainly within dryland ecosystems leading to the loss of its productivity. In Kenya desertification is extending at the rate of 18–40 km/year (GoK, 1992). The most affected areas are the arid and semi-arid lands where close to 50 million hectares are at risk.

An assessment of the land degradation hazard in Kenya in 1997 shows that 12.3% of the northern rangelands in Kenya are subjected to severe land degradation while 52% of the rangelands are vulnerable to "moderate" land degradation. Only 33% faces "slight" vulnerability to degradation (see figure 3) (GoK/UNEP, 1997).

a) The desertification process

Desertificaton can be slow or very rapid depending on the environment and socio-economic conditions. Climatic variations and inappropriate human activities are part of the cause. When desertification occurs, the land loses its biodiversity thus weakening the ecological linkages. The ability of the land to raise crops, pastures and wood is lost and the carrying capacity of the land is reduced due to loss of ecosystem functions. Economic activities decline or collapse. The risk of desertification in northern Kenya is shown in figure 3.

Recurrent droughts (see table 8), increased human and livestock populations, and inappropriate agricultural and settlement

Table 7. Livestock trends in the rangelands of Kenya

	Population estimates			Percentage change	
Species	Late 1980s	Early 1990sLate 1990s		80s– 90s	Early 90s–late 90s
Camel	566,828	579,933	517, 142	2%	-11%
Cattle (all)	2,898,749	3,074,174	2,595,515	6%	-16%
Donkey	100,171	80,923	68,062	-19%	-16%
Sheep & goats	6,385,846	6,211,961	5,315,685	-3%	14%
Total	9,951,594	9,946,991	8,496,403		

Source: Githaiga J. Wildlife Population Trends in Kenya, 1998.

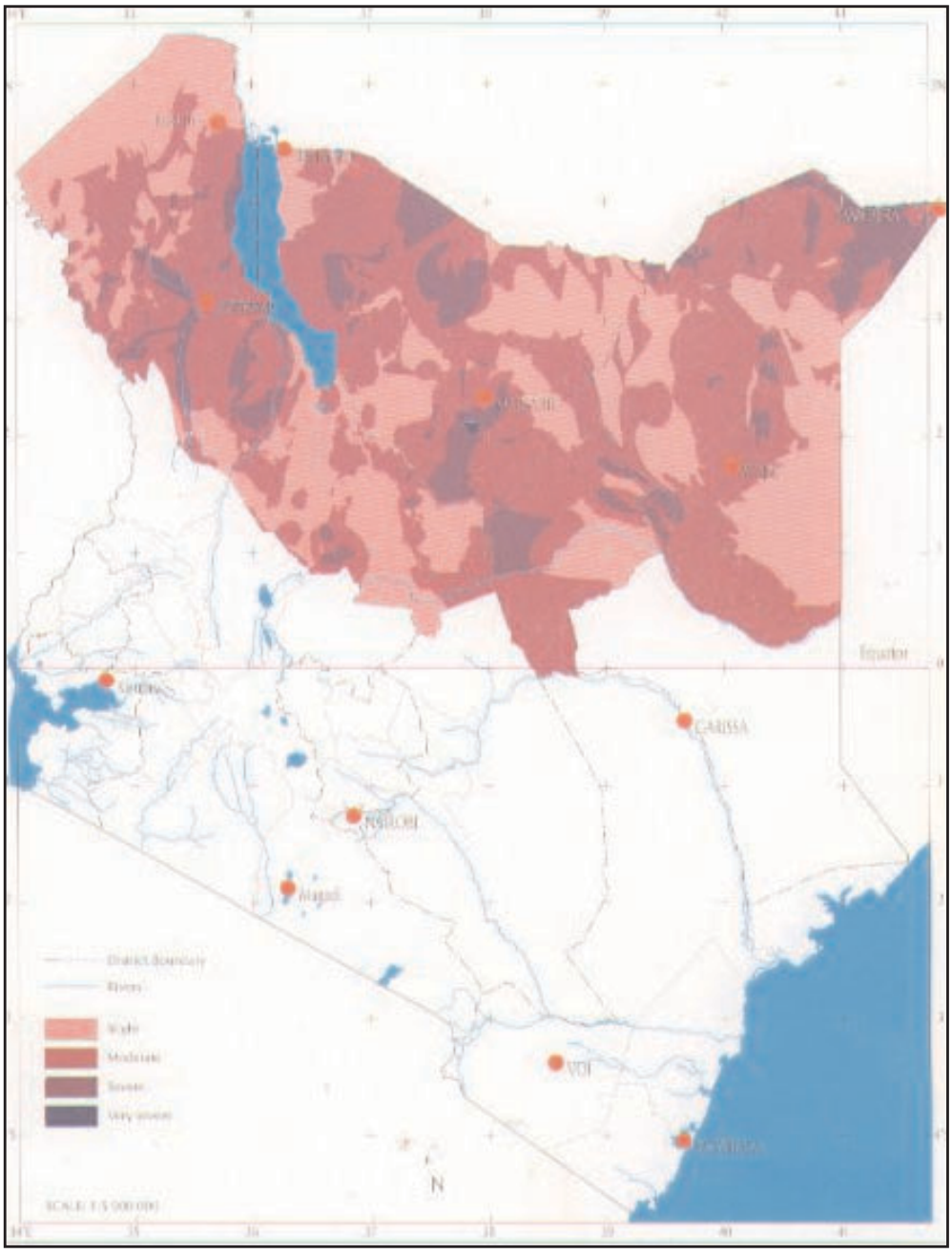


Figure 3. Land degradation hazards in northern rangelands of Kenya.
Source: GoK, 1997: National Land Degradation Assessment and Mapping

practices are the primary causes. The increased number of people searching for economic security in the ASAL has led to intensified cultivation, expansion of cultivated land, overgrazing, harvesting of trees for fuelwood leading to deforestation, acute water shortages, loss of biological diversity and soil erosion.

The ASAL has been singled out as an ecosystem whose imminent destruction may result in widespread desertification. As the bushes disappear, so do the animals, and the indigenous people who take away knowledge gained from centuries of intimate association with their environment.

The current agricultural land-use practices in the ASAL are attributed to the absence of a comprehensive land-use policy. Continued cultivation of very fragile and ecologically unsuitable land will degrade and render the land unproductive. A great threat to sustainable use of the ASAL is emerging through subdivisions of land into group and private ranches for settlement and agriculture, overgrazing and disposal of waste, especially municipal and industrial waste.

Table 8. Drought incidences in Kenya.

Date	Region affected	Effects
1883	Coast	Worst famine in 30 years
1889–1890	Coast	Year long famine
1894–1895	Coast	Countrywide
1896–1900	Countrywide	Failure of 3 consecutive rainy seasons, and human deaths
1913–1919	Eastern / Coast provinces	Impacts exacerbated by war
1921	Coast	Record dry year for Coast
1925	R. Valley, Coast, Central Provinces	Local food shortages, crop and livestock losses (50% in Baringo)
1938–1939	Northern, R. Valley and Central Provinces	Heavy loss of livestock. Lorian Swamp dried up. Human deaths reported
1942–1944	Countrywide	Food shortages. About 200 human deaths
1947–1950	Central and Coast provinces	Very severe in Coast
1952–1955	Eastern, Central, Coast and R. Valley Provinces	Driest period for Mombasa Water shortages in Nairobi
1960–1961	Eastern, Southern/North Rift	Droughts followed by floods. Cattle mortality 70–80% in Maasailand
1972	Countrywide	Rains reduced to 50% long term mean water shortages in Nairobi. Wildlife deaths in parks. Human deaths in northern districts
1974–1976	Eastern, Central and Northern provinces	Maasai cattle losses up to 80%
1980	Central, Eastern, Western and Coast	Crop production paralyzed. Water shortages in towns
1981	Eastern Province	Famine
1983	Countrywide	Water shortages, migration of people and livestock
1984	Central, R. Valley, Eastern and North Eastern Provinces	Large food deficits
1987	Eastern and Central Provinces	Severe food shortages in Eastern Province.
1992–1994	Northern Central, Eastern Provinces.	Relief food imported
1999–2000	Countrywide except for Western Province and coastal belt	4.7 million people dependent on food relief

Source: GoK / UNEP (2001).

b) The impacts of desertification

Loss of productivity

Crop and pasture failures

Nationally, there is evidence that crop production is on the decline. After the 2000 drought in central and eastern Kenya, maize yields dropped by 36%. Only 18 million bags were harvested against a demand for 32 million bags. Localized variations are even more worrying. In Kirinyaga, especially the lower drier part, maize production dropped from 15,000 t to 2,430 t in the same year. Fodder production decreased by 60%. Cattle numbers declined from 27,220 to 13,570 head between 1999 and 2000. Milk production fell from 60 million to 16 million litres. Livestock loses in Kajiado and Samburu were high (30–40%). Drier ecosystems like eastern Laikipia recorded total crop failure. Nationally, livestock deaths were high: 19.4% for cattle and 16% for sheep and goats between 1998 and 2000 (GoK/UNEP, 2001).

In addition Kenya experiences recurrent minor droughts every 2 to 3 years and major droughts after 8 to 10 years. Droughts decimate 30 to 40% of wildlife and livestock, 30 to 40% of crop yields, and destroys riparian and gallery forests. It decimates the natural germination capacity of range grassland by 50%. During drought, livestock and wildlife concentration around a few water points aggravates vegetation and soil degradation. Millions of hectares of forest are lost due to forest fires, often caused by lightning.

When the productivity of land declines, people are threatened with food shortages. Up to 16% (about 5 million) of the population in Kenya depends on food relief (see

Table 9. Relief food requirements in selected districts in 2001.

District	Total Population	Population in need of food relief	Percent of population
Turkana	500,000	331,000	66
Baringo	365,000	214,000	59
Samburu	150,000	130,000	87
Wajir	321,000	298,000	93
Machakos	915,000	460,000	50
Muranga	385,000	85,000	22
Nyeri	653,000	80,000	12
Meru South	205,252	33,000	16
Embu	276,011	90,000	33
Kirinyaga	455,000	100,000	22
Malindi	282,062	40,000	14
Kilifi	550,000	40,000	7
Kwale	497,000	90,000	18

Source: GoK / UNEP (2001)

table 9). Not only are they unable to get one meal a day but what is available is of very poor quality leading to severe malnutrition. In the drier districts of Kenya, malnutrition affects 25–30% of the population. In Baringo District 35% of the population, mainly children, are malnourished. Consequently relief food must be obtained primarily because of drought but desertification worsens the situation.

Drought also has ecological side effects. It decimates 50% of the savannah and grassland seeds affecting regeneration. Wind erosion is accelerated and on the onset of the rains, the de-vegetated surface loses soils due to increased surface runoff (GoK/UNEP, 2001).

1.4 Water resources

Water resources in Kenya consist of inland saline or fresh water lakes, the Indian Ocean, permanent and seasonal rivers, wetlands and ponds.

The water and wetlands resources are estimated at 15 million km^2; inland water surface 11,200 km^2; underground abstraction 3,115 million m^3 per year countrywide with a mean yield of 5–8 m^3/h depending on the rock type. The five permanent water basins have a total water flow of over 14,836 million m^3(IEA, 1999).

CNRM

Lake Victoria from Dunga Beach. Inset: The water hyacinth

Average annual rainfall is 567 mm which converts to 323 billion m^3 per year. It is distributed in the basins as follows: 7.30 billion m^3 in the Lake Victoria basin; 4.7 billion m^3 in the Tana River Basin; 1.39 billion m^3 in the Athi–Galana Basin; 0.81 billion m^3 in North Rift Valley; and 0.74 billion m^3 in Ewaso Nyiro South (see table 10) (GoK/UNEP, 2001).

Table 10. Aquifer and abstraction characteristics of the drainage basins in Kenya

Basin	Area (km^2)	Annual rainfall (mm^3/year)	Water Strike level (m)	Water level (m)	Rest yield (m^3/hr)	Abstraction (mm^3/year)
Lake Victoria	46,229	1,368	51	19	5	9.3
Rift Valley	130,452	562	87	55	7	11.7
Athi River	66,837	739	84	41	7	27.8
Tana River	126,026	697	75	39	7	4.8
Ewaso Nyiro	210,226	411	89	53	5	3.7

Source: GoK/UNEP, 1997

However, the water resources are unevenly distributed. According to the World Resources Institute report for the year 2000, the internal renewable water resource was estimated at 20 km^3 translating to per capita per annum of 673 m^3. The ranking effectively puts Kenya in the "chronic water shortage state" category. The 2.9% annual population growth, and over-dependence on a diminishing water resource, will push Kenya beyond the water barrier of less than 5 m^3 per capita per annum by the year 2025.

The use of the national water resources vary from place to place but is estimated to be distributed in use as follows: 65% agriculture, 18% domestic, 13% industrial and 4% other functions. In rural areas, an average of 49% of the population has access to safe drinking water compared to 67% in urban areas. Access to proper sanitation services is 81% in rural and 69% in urban areas (GoK/UNEP, 2001).

Water abuse

Water resources face threats from pollution, siltation, reclamation, pesticides, fertilizers, weed attack and human-related activities. The major threat is contamination from municipal and industrial effluent, and through leakage into the main water streams. Table 11 gives a summary of such problems.

Degradation of water resources is attributed to inappropriate farming methods that reduce the land cover, encourage soil erosion and permit heavy siltation of the rivers. The application of poor farming methods is a result of excess pressure on land resources arising from rapid population increase. Pesticide application also pollutes the water.

Secondly, the use of water bodies as dumping sites for domestic, urban, industrial and agricultural waste pollutes water resources. The absence of an effective legal policy and

Table 11. Current surface and aquifer water status in Kenya.

Type of water resources	Approximate area (km^2)	Current problems	Threat type
Lakes	17,500	Hyacinth attack	Pollution, siltation, chemicals, weed, population, eutrophication
Rivers	2,500	Varied	Pollution, siltation, irrigation
Swamps	120	floods	Flood water, pollution, siltation
Estuaries	20	Silt	Siltation
Mudflats	15		Mud flows
Lagoons	10	Silt	Siltation
Marshes	50	Floods	Floods
Ponds	40	Silt	Siltation
Bogs	12	Silt	Siltation
Flood plains	150	floods	Floods, pollution
Underground Aquifers			Uncontrolled exploitation
Total	20,400		

Source: GoK/UNEP, 1997

institutional framework to provide standards for water use, and a lack of incentives for good practices are other causes. However, with the enactment of the Environment Management and Coordination act in 1999, there is a promising future.

Consequences of water abuse

The volume of water in permanent rivers like the Tana, Mara, Athi and Kerio has reduced by half. Over the last 7 years, the Ewaso Ngiro River has not been flowing continuously below Archers Post. Studies show that a substantial number of streams particularly in ASALs have ceased to flow. Even in high-potential areas previously permanent streams have now become seasonal (GoK, 1997).

Table 12. Water deficits in selected provinces in Kenya.

Province	Water deficit (m^3/day)
North-Eastern	86,020
Eastern	281,516
Coast	76,241
Rift Valley	197,544
Central	63,200

Source: GoK 1997.

Kenya had a water deficit of 704,522 m^3 in the year 2000 as shown in table 12.

Declining water volumes have also been witnessed on Lakes Turkana and Nakuru directly affecting the economic lifeline of the local people. Whereas tourism was affected around Lake Nakuru because of migration of flamingo, the fishing industry at Kalokol on Lake Turkana collapsed as the catch declined and the shoreline moved 6 km away from the only cooling and fish-processing plant.

Decline in quality

All the major rivers, lakes and the ocean face a constant danger of siltation following increased soil erosion especially during the rainy seasons. Tonnes of soil made loose during the dry season are washed into the streams decreasing water level and quality. Sub-basins with high sediment yield include Lusumu, Nyando, Luanda, Perkera, Karya, Ndarugu, Athi, Saigon Maragwa and upper Ewaso Ngiro. The overall trend is summarized in table 13.

Table 13. Water quality in Kenya, 1963–2000

		Actual level				
Parameter	Desired level	1963	1974	1984	1999	2000
Colour	colourless	colourless	colourless	slightly coloured	coloured turbid	highly coloured
Turbidity	clear	clear	clear	turbid		very turbid
Sediment Load	nil	nil	slight	moderate	heavy	heavy
Total Dissolved Solids	normal	normal	fair	moderate increase	moderate increase	very high increase
Bacteriological Contamination	no pathogenic bacteria	little contamin.	little contamin.	little contamin.	gross contamin.	gross contamin.
Biological oxygen demand	less than 5mg/l	5–20	10–20	20–40	40–60	60+

Source: GoK, 1999.

Water quality is further degraded by organic and inorganic liquid effluent, gaseous emissions and solid wastes. Sewage matter and garbage, sediment tailings from mines, from agriculture, urbanization and industry continuously pollute water resources in Kenya. Intrusion of saline water at the Coast, leachates from solid-waste dumps such as heavy metals, acids, dyes and oils and infiltration of fertilizer and pest residues threaten ground water sources. Rivers are heavily laden with pathogens and decomposed organic matter while lakes and reservoirs suffer from eutrophication and acidification. Ground water and some rivers have an additional problem of salinization.

The Nairobi, Ngong and Mathare Rivers that flow through the commercial and residential parts of Nairobi are examples of those most polluted. Nairobi River receives sewage discharge at Kariobangi, while Ngong River receives oily discharge from industrial area. The Rui Ruaka River receives alcoholic effluent. All urban rivers at the moment are incapable of dilution by self-purification. The current status of polution in Nairobi rivers is shown in figure 4.

Over-pumping of boreholes along the Coast introduces salt-water into the water. The surface water at Bomani and Ngoda dams in Kwale District changed from fresh to saline water.

A decline in the quality of water directly leads to loss of biodiversity through deaths of aquatic plants and animals. The aquatic environment deteriorates by way of deoxygenating,

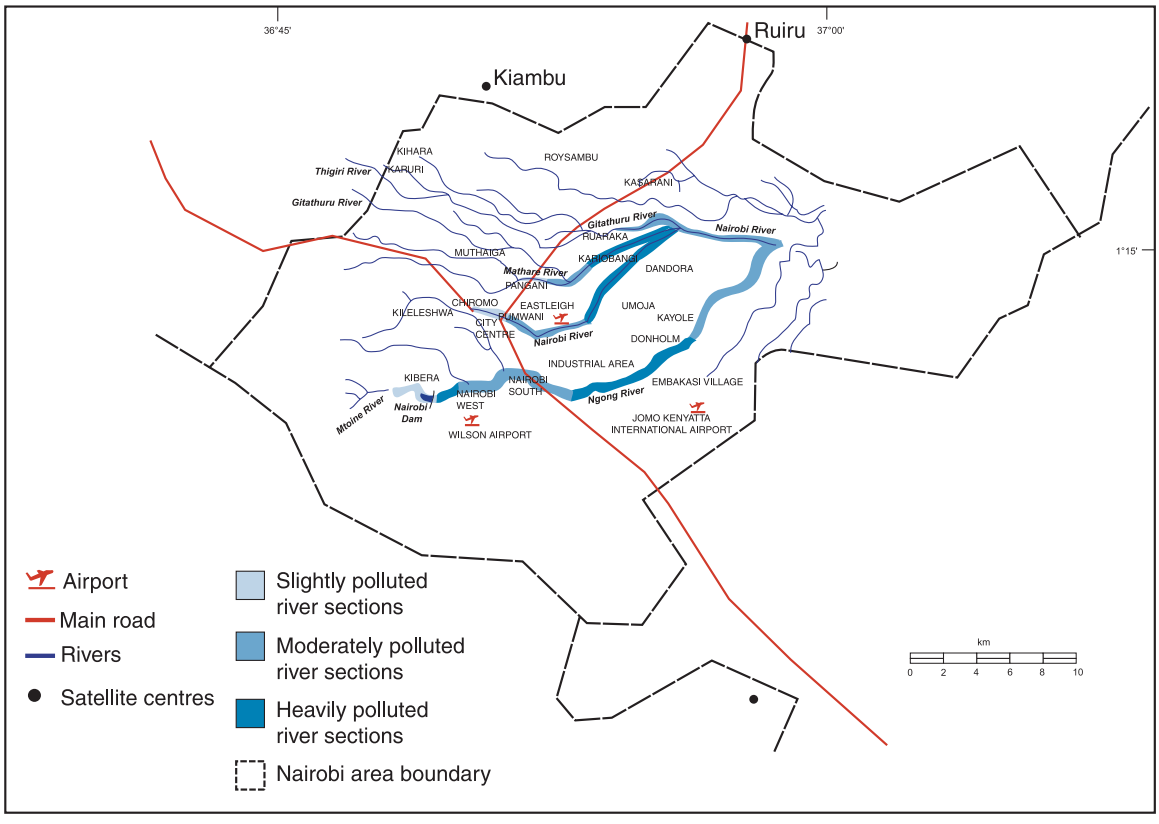


Figure 4. Polution status of Nairobi River.
Source: Research data by Masibo, 1993.

Water-use conflicts on Naro Moru River

In the Naro Moru area, large-scale farmers and saw millers caused immense economic losses to the farmers' downstream of Rivers Burguret and Naro Moru. In March 2001, the Tam Trout fish farms in Nyeri District—the only cold-water farming and breeding firm in Kenya that imports fish fingerlings from South Africa and Denmark—incurred massive losses of fish. Fresh trout thrives only under 15°C. The water diversion upstream by horticultural farmers and self-help projects increased temperatures as the level of river water dropped. Over 50% of trout fish died. According to Francis Mureithi, whereas fish trout farmers returned 100% of water into the river, other farmers upstream were using more than 190% of harvested water thus leading to rapid decline in water flowing downstream. The incident resulted in the loss of 26 jobs. He argued for the need to share the scarce resource through controlled irrigation activities upstream.

Pastoral-agrarian clashes on Tana River

In pastoral areas, clashes over water are common. The case in point is the Pokomo and Wardei fatal conflicts in July 2001 in the Tana River Delta. Conflicts over irrigation water are a growing threat in high-potential areas where farmers upstream abstract water leaving little for users downstream. The government had to ban irrigation in badly affected areas, especially in the upper Ewaso Ngiro Basin. However, large-scale farmers in Nyeri continued irrigating ready to pay the paltry fine of Kenya Shillings 5.00 stipulated in the Water Act. In 2000, water-related clashes left two people dead in Kirinyaga. In the same year, one farmer was prosecuted for over abstraction in the Yatta Canal. The tension between the big flower farmers and small irrigators, ranchers and pastoralists might soon explode in Laikipia District.

eutrophication, siltation, habitat modification and toxicity. Eutrophication leads to immediate overgrowth of invader life forms such as the water hyacinth on Lake Victoria and in Nairobi Dam.

Water-related economic activities like fishing declined or collapse. The scenic beauty is lost, as is the case for Nairobi Dam. The cost of supplying water rises due to expensive treatment of the polluted sources. There are also health problems with the emergence of water-borne diseases such as typhoid and cholera, as well as chemical poisoning in humans and animals.

Increase in conflicts

Water use conflicts arising from shortages of water for domestic, industrial and irrigation use abound in Kenya. For example the use of Lake Naivasha for watering Maasai livestock has been curtailed by irrigated flower farming. In the Ewaso Nyiro River Basin, conflicts arise from the expansion of irrigated horticulture upstream denying pastoralists and small-scale farmers downstream sufficient water.

Further, conflicts revolve around extraction and supply of water to urban areas at the

Water use conflicts along the Sirimon River

Samwel Kinyua of Wai Wai area near Nanyuki owns a 2.5-hectare farm on which he grows Snow peace, French beans, chillies and Baby corns using irrigation water from River Sirimon. Since 1991 water flow downstream has declined drastically due to forest destruction that has ruined the catchment area upstream and over abstraction.

According to Mr. Kinyua, large farms of over 3,000 hectares upstream use four-index systems for drawing water from Sirimon or the seasonal Nyarigino Rivers. Consequently, the smallholders down stream have been forced to invest in drip irrigation systems and will need a dam to harvest water to sustain their livelihoods. By 1998 farmers were using furrow irrigation but demand for water was higher than supply. The year 2000 was particularly dry yet the big farms diverted water to reservoirs (dams) upstream for irrigating flowers.

Early in 1994, water users in Laikipia and Nyeri trekked up the streams and located the farmer who was abstracting water from the stream using big 10-inch wide pipes. The district commissioners for Laikipia and Nyeri were involved in resolving the conflict.

expense of the rural people. The NoolTuresh pipeline from Loitokitok to Athi River is a case in point. Nairobi has exhausted the potential of the upper Athi and its next supply may be based on the inter-basin transfer from the Tana River with serious consequences. In the Tana case, critical issues are equity in extraction, supply of water and ecological balance. Damming for hydropower generation has flattened the flood amplitude and curtailed paddy rice-farming downstream.

Water use conflicts arising from shortages for domestic, industrial and irrigation use abound in Kenya.

1.5 Fisheries

Fishery in Kenya is a multi-billion shilling industry. Significant incomes are generated from fishing for local consumption and export, or as a recreational sport. Many people are dependent upon fisheries for employment. The national trends are shown in figure 5.

Countrywide around 1 million people depend on fisheries for their livelihood. Of these, 15,000 artisan fishermen are at the marine fishery and 450,000 persons are engaged directly or indirectly in fish processing or fish mongering at various levels. The level of marine resource use is summarized in table 14.

Fishing on Lake Victoria is a declining enterprise characterized by vicious conflicts among fishermen, fish processors and fishmongers.

a) Fishing on Lake Victoria

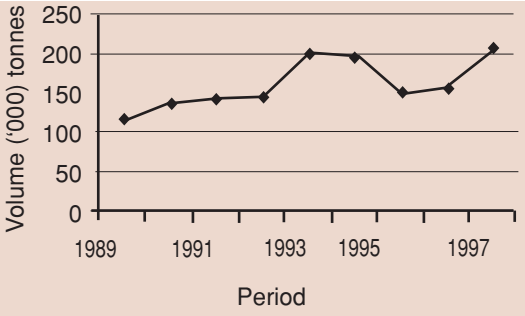
According to the United Nations Environment Programme (UNEP), the fishery of Lake Victoria faces at least three fundamental problems:

- uncontrolled and rapidly increasing fishing
- uncontrolled spread of the water hyacinth, and
- general degradation of the lake's environment

Fisheries management concerns fall under two broad categories. First, are those that appear to be generated within the fishery sector itself. The majority of fish species in Lake Victoria are restricted in their movement by habitat-type. With localized over-fishing, recoloni-zation by the nearest neighbour stocks can be a slow process. Secondly, many fish species are over-fished at or near breeding grounds during the breeding season. Furthermore, beach seines and nets of small mesh sizes (some as small as 20 mm) are widely used around the lake.

Uncontrolled exploitation of the Nile perch is a major problem. Data show that past

Figure 5. Trends in fish exploitation in Kenya, 1989–1997.



Source: GoK/UNEP, 1997

Table 14. Marine counts of selected animals.

Species	Number counted	Total population estimate	Main use
Sea turtle	500–600	800–1,000	Hunted for food, ornamental and medicinal (asthma) value
Dudong	8–16	25–30	Food, medicine, lamp fuel, charms, Ornaments and aphrodisiac properties
Whale	0	Humpback group sighted in deep seas October 1994	Oil, meat, gelatine, aphrodisiac properties
Dolphin	3,000–4,000	12,000–15,000	Oil, meat, gelatine, aphrodisiac properties
Shark	25–30	60–80	Oil, meat, gelatine, aphrodisiac properties
Whale shark	60–80	130–230	Oil, meat, gelatine, aphrodisiac properties
Ray	60–100	140–200	Not known

Source: GoK/UNEP, 1997.

CNRM

A dealer in "mgongo wazi" fish remains from processing factories in Kisumu.

high fishing rates cannot be sustained. It should be appreciated that problems arise because the three East African countries have difficulties in enforcing existing legislation owing to lack of a regional approach. It should also be recognized that the lake's fishery which was multispecies prior to the 1970's has since the 1980's been dominated by three species *Lates niloticus, Rasstrineobola argentea* and *Oreochromis niloticus.*

"With the revival of the East African Community there is now an opportunity for the development of a regional approach to the management of such shared resources, as the fisheries of Lake Victoria. The Community has recognized this as a major area for cooperation and one of the major regional organizations created so far has responsibility over Lake Victoria."

Within the framework of regional cooperation, the three countries of East Africa are implementing a joint program funded by the World Bank and known as the Lake Victoria Environmental Management Program (LVEMP). This program also provides an opportunity for a regional approach to the management of Lake Victoria and its fisheries.

The water hyacinth, a problematic aquatic weed, invaded the lake and has been spreading at an alarming rate choking bays, inlets and channels that are breeding areas for fish. The water hyacinth uses up most of the oxygen in the water making the area below its mats anaerobic. Fish cannot survive under such conditions. The weed also physically interferes with fishing activities, transport and recreation. Related to the water hyacinth problem are mounting levels of planktonic algae in many parts of the lake. If blooms of such algae

CNRM

Wetland (swamp) on Uasin Gishu Plateau.

occur, the result would be anoxic conditions in the bottom waters of the lake, which endangering marine diversity.

Some sound fishery management instruments exist. The main challenge is for the regional countries to enhance their use.

1.6 Wetlands

Wetlands are areas of marsh, fen, peat land or water. They could be natural or artificial and the water permanent or temporary, static or flowing, fresh, brackish or saline. Wetlands include areas of marine water whose depth during low tide must not exceed 6 m.

In Kenya, wetlands cover marine, coastal and inland habitats that consist of deltas, estuaries, mangrove swamps, marine mudflats and marshes, swamps, bogs, floodplains, shallow lakes and edges of deep lakes and rivers. Marine wetlands include sea grass beds and coral reefs as long as they are not deeper than 6 m.

The most important wetlands in Kenya are swamps, estuaries, floodplains and mangroves. Notable swamps include the papyrus areas around lakes Naivasha and Victoria and on major rivers like Ewaso Ngiro River. Others are confined to bottomlands within areas like the Kisii highlands and the Uasin Gishu plateaus. Estuarine wetlands occur at the mouth of the Sabaki River that has mangrove forests. The Tana Delta also forms inland ox-bow lakes and marshes besides the mangrove forest. Riverbanks that are frequently flooded form the commonest floodplain wetlands.

The benefits and functions of wetlands include ground-water recharge, flood control, shoreline stabilization, erosion control, sediment and toxicant retention, nutrient retention, biomass export, windbreaks as well as recreation and tourism spots. They are also habitats for fish spawning, forage reserves for livestock, provide agricultural land, supply water and are biodiversity reserves.

The major threats to wetlands is reclamation into farmland (Bunyala, Yala, Tana River) and pollution (Nakuru, Naivasha, Winam Gulf).

1.7 Wildlife resources

Kenya has diverse and abundant wildlife resources. They include national parks, reserves and other protected areas that cover close to 44,564 km^2 or 7.5% of the national area. Table 15 shows the various conservation sites by regions (KWS, 1998).

Most of the parks and reserves are small with complete ecosystems. The two Tsavo National Parks form 48% of the total protected wildlife conservation areas, 90% of which are located in the ASAL regions where, unfortunately, crop production is expanding (GoK, 1992).

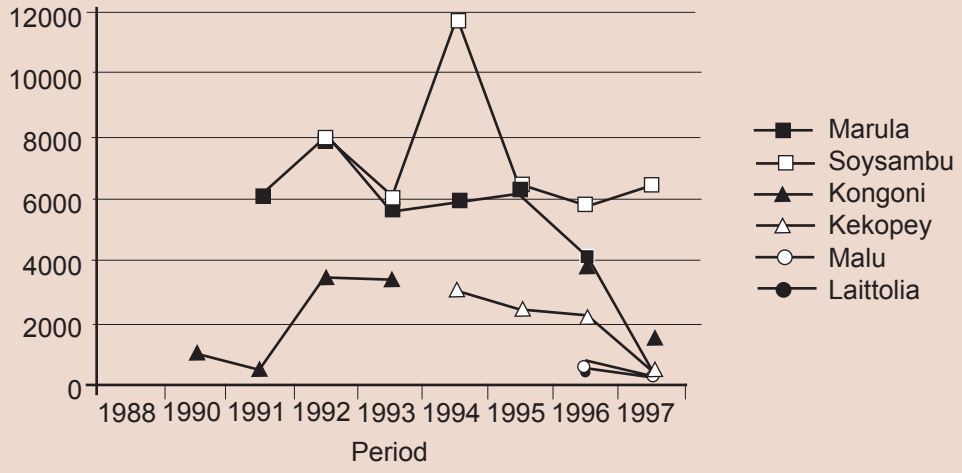
The resurgence of community-based privately owned parks is likely to change the wildlife resources scenario. Private group ranches where wildlife are raised for various reasons increased to 25 in 1999. Owing to diverse conservation strategies animal density in different group ranches varies. The number of wildlife conserved is however increasing but in diminishing proportions (figure 6).

Between late 1980s and the early 1990s, trends in wildlife showed a decline of 1.14%. A subsequent decline of 6.2% was recorded between the early 1990s and the late 1990s. A report by the Department of Resource Surveys and Remote Sensing shows that wildlife populations between 1977 and 1990 declined at the rate of 3.2% annually. A 1998 report suggested that the decline was 0.7% annually.

Table 15. Wildlife conservation sites in Kenya.

Region	Conservation site
Coast	Diani/Chale, Kisite, Malindi, Mombasa, Mpunguti, Watamu, Arabuko Sokoke, Boni, Dodori, Kiunga, Shimba Hills, Tana River
Western	Impala, Mt. Elgon, Nasalot, Ndere Island, Ruma, Saiwa Swamp, South Turkana, Kakamega Forest
Northern	Central Island, Malkamari Sibiloi, South Island, Losai, Marsabit
Eastern	Meru, Bisaanadi Bufallo Springs, Kora, Mwingi Rahole, Sambu, Shaba
Central Rift	Hells Gate, Lake Nakuru, Mt. Longonot, Keio Valley, Lake Bogoria, Lake Kamnarok, Masai Mara
Mountain	Aberdare, Mt. Kenya, Mwea
Tsavo	Tsavo East, Tsavo West, Chyulu Hills, South Kitui
Southern	Amboseli, Nairobi, Ol Donyo Sabuk, Namanga Forest, Ngong Forest

Source: KWS, 1998.



Source: KWS, 1998.

Figure 6. Wildlife trends in selected ranches in Nakuru District.

a) Human–wildlife conflicts

The human–wildlife conflict is intense where croplands border national parks such as in Imenti, Nyeri, Trans Mara, Kwale, Kimana, Leroghi and Taita Taveta (see table 16). Most wildlife–human conflicts occur in areas where land uses are not compatible with wildlife conservation.

The broad categories of conflicts involve damage by wildlife on human beings, crops and livestock on one hand, while on the other hand, humans causing damage to wildlife through poaching and destroying the habitat. For example between 1989 and 1994 poaching for ivory caused 40% of elephant mortality. Human settlement leads to conflicts when wildlife invade farmlands, destroy crops and kill people. In addition, conflicts in the management and ownership of wildlife resources may lead to loss of property, life and also interest in wildlife conservation.

Table 16. Areas prone to human–wildlife conflicts

Region	Area
Coast	Shimba hills (Kwale District), Arabuko-Sokoke Forest (Kilifi District)
Amboseli/Tsavo	Voi, Mbololo, Bura, Mjukini (Taita Taveta District), Rombo and Kimana (Kajiado District)
Mt. Kenya	Abedares, Mt Kenya, Nyeri, Muiga, Imenti, and parts of Laikipia
	Narok/Trans Mara entire district but minimal in Mau

Source: KWS, 1998.

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Burchel's Zebra in Tsavo National Park.

Human-wildlife conflict in Mweiga

In Mweiga area, John Njoroge grew Tuber Rose flowers, drawing water from River Honi 5 kilometres away. Wildlife have invaded his farms destroying cabbages, flowers and beans. He cited Kamatongu and Solio areas as notorious spots for destruction of crops by elephants. He claims that farmers were never compensated for loss of crops but when they reacted against the destructive animals, the Kenya Wildlife Services personnel rushed to punish the members of the community. To compound the problem farm produce such as onions and milk do not fetch good prices. The major market outlet, which was the main milk organization in the country, collapsed.

1.8 Mineral resources

The first records of geology and mineral resources in Kenya were kept towards the end of the 19th Century. Between 1914 and 1915 a temporary colonial office was established specifically to investigate a portion of the Northern Frontier District. In 1932 a permanent geological survey was incorporated in the mines department. It still functions to date.

The geological survey and assessment of minerals revealed that the mining industry in Kenya is small. The endowment of minerals is varied. It includes metallic minerals such as gold, copper, lead, silver and zinc. Non-metallic minerals include diamonds, gemstone, ruby, sapphire, garnet and other hydrocarbons that occur in trace amounts. Though petroleum energy is not extracted anywhere, geothermal potential is enormous. Industrial minerals such as talc, flouspar, limestone, soda ash, gypsum and dolomite exist. However, mining is hampered by poor accessibility to deposits, legal setups, financial and technical requirements, lack of markets and lack of large, mineral deposits to warrant major capital investments.

Currently, non-metallic minerals dominate the mining industry. The government does nearly all the exploratory work. Silica sand for glass is mined in southern Kenya. Titanium has been discovered at the Coast but exploitation has generated legal controversy over compensation to the local land users. Table 17 summarises the minerals found in different parts of Kenya.

Table 17: Geological succession and economic minerals in Kenya

Geological Age	Representatives	Type	Approximate age in million of years	Associated economic minerals
	Bedded rocks sands, Magadi soda lake, hot spring deposits	Intrusive rocks	Up to 1/40	Recent soils, alluvial, beach tona, salt, kaolin, brickearth, clay, sand, manganese, gypsum, guano, mineral pigments, meerschaum, cacum, diamonds, sapphires, ilmenite, monazite, rutile, zircon, nitre
Pleistocene	Raise coral reef and sand stone at the Coast, Rift Valley, & other inland sediments, some volcanic rocks of the highlands & Nort-Eastern & Eastern Provinces		Up to 2	Limestone, Diatomite, Gypsum, Pumice, Pozzolana, Bentonitic clays, Manganese, Kaolin (sulphur, cement-stones)
Tertiary	Coastral sediments and sediments of Noth-Eastern Kenya	Alkaline syenites, ijolites etc. of volcanic centers such as Mt. Kenya, rural etc. Carbonalities of South-western Kenya	2–25	Limestone, Carbon dioxide, building stone, road stoned ballast, bentonitic clays, pazzolana, lead, barytes, fluorite, (zinc, cinnaber, nepheline, apatite, pyrochlore, monazite, wollastonite)
Cretaceous	Coastal sediments & sediments of North-Eastern Kenya	Ijolites & alkaline, syenites of jombo at the Coast & Eastern Kitui. Alkaline dykes at the Coast & in Eastern Kenya Carbonatite at Mirima (Coast)	60–120	Managanese, Pyrochlore, rare earth minerals
Jurassic	Coastal sediments & sediments of North Eastern Kenya		120–150	Limestone, shells, (for cement & ceramics) gypsum, ballast
Trassic Permian Carboniferous	Sediments of the coast hinterland. Sediments of North Eastern Kenya		150–250	Ballast
Precambrian	Kisii series (Bukoban system) sediments and volcanic of south Western Kenya. Embu series – metamorphosed sediments, central Kenya Ablun series, Metamorphosed sediments, North Eastern Kenya	Dolerites Pegmatites in the basement system, Gabbros of Western Kenya; dunites	500–600	Mica, piezo electric, quartz, samarskite, columbite, beryl, felspar, amblygonite bismuth, ilmenorutile, amazonite, zinc, spinel, flourspar, rare earth minerals chromie, gamierite, magnesite, ermicusite, corundum, sapphire, vcolivine.
Precambrian	Basement system – gneisses & schists	Norite & allied rocks, minor peridotites, pyroxenites & granites	600+	Limestone, marble, wollastonite, kyanite, asbestos, magnesite, dolomitic limestones, garnet, rutile, ilmentine
Precambrian	Kavirondian system, sediments & volcanics of South Western Kenya	Granite, syenitics & dolerites	2,2000	Gold, Silver, (Molybdenite)
Precambrian	Nyanzian system sediments & volcanics of South Western Kenya	Granites, epidorites	2,200+	Gold, copper, zinc, silver, pyrite, (cobalt, schelite, arsenic, fluorite)

Source: GoK, 1989; Mineral Development Policy in Kenya.

1.9 Energy

Kenya derives much of its energy resources from biomass which provides about 19% of the total energy required by the domestic and industrial sector. Electricity generated within the country contributes nearly 5.1%. Between 1992 and 1995, the average electricity production was 20,497 Terajoules, of these 403 were imported (UN World Energy, 1997). All petroleum products derived from crude petroleum are imported. On the other hand use of coal and lignite in industries has remained constant (see table 18).

Energy consumption varies between sectors (see figure 7). The household sector consumes the highest amount of biomass energy. Of the total energy imports, petroleum accounts for the highest percentage. All the imported coal is used in industry. Most of the electricity generated locally is used by industries, which account for 64% while households consume less than 36%. Light petroleum is mainly used by both the industrial and transport sectors.

Production of electricity has been increasing since 1987 following privatization and an increase of power generating plants by 25%. Despite the increase in electricity production, supply has constantly lagged behind demand. This in effect hinders the achievement of the desired industrialization goals. Power distribution is in favour of urban areas. The distribution in the rural areas is geographically biased and therefore likely to add to the existing tension and conflicts.

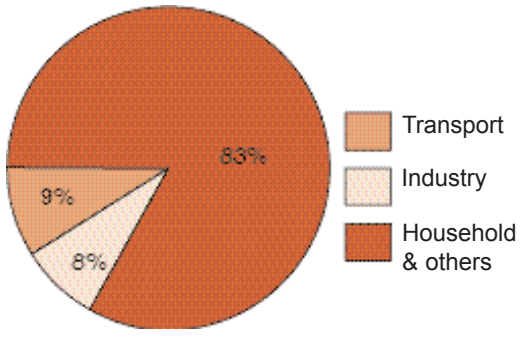

Figure 7. Average energy consumption by sectors, 1992–1995.
Source: Insitute of Economic Affairs, 1999.

Table 18. Average energy production and consumption, 1992–1995.

	Energy products (in Terajoules)							
Energy Production & use	Hardcoal & lignite	Crude petroleum	Light petroleum	Heavy petroleum	Other petroleum products	Electricity	Primary biomass	Total
Primary production	-	-	-	-	-	20,497	324,698	344,698
Imports	3,839	87,950	913	2,372	2,234	403	-	97,737
Exports	-	-	-8,319	-15,118	-926	-	-	
Total Energy Requirements	3,839	87,950	-9,998	-19,330	1,308	20,901	324,200	408,851

Source: UN World Energy, 1997.

The largest source of energy in Kenya is biomass particularly from fuelwood, obtained from forests, woodlands, shrubs and on-farm trees (see table 19). Indigenous forests have a potential sustainable supply of 0.9 m^3/ha annually. The Kenya Forestry Master Plan estimate the average growing stock of the woodlands, bushlands and wooded grasslands is about 15.9 m^3/ha of woody biomass, an annual increment of 0.115 m^3/ha. Fuelwood production from wood-lands and bushlands is 89%. The sustainable annual fuelwood production is only 2% .

In the rangelands, charcoal production is a major source of income and increases in intensity among subsistence farmers when other types of activities fail to provide sufficient household income, particularly during extended periods of drought.

At least 80% of urban fuel used by households is from charcoal. Charcoal use amounts to about 1.4 million t annually. The yields vary from 10% to 14% by weight thus requiring 10–14 million t of wood. Kenya's charcoal is mainly produced from trees, on semi-arid lands and cleared agricultural land. About 90% of Nairobi's charcoal supply comes from Eastern and Rift Valley Provinces. Kisumu's charcoal comes from Western and Rift Valley Provinces, while much of Mombasa's charcoal comes from the Northeastern and Coast Provinces.

a) Over-reliance on biomass energy

Table 20 shows the heavy reliance on fuelwood as a source of energy in Kenya. The majority of households and the small- and medium-scale processing industries heavily rely on wood fuel.

In 1988, fuelwood provided 63% of the nation's primary energy requirements. The total gross demand was 19.9 million t made up of 13.4 million t or 69% of fuelwood, 6.1 million t of charcoal (29%) and 0.4 million t of industrial feedstock (2%). By 2001, at least 80% of urban fuelwood demand by households is made up of charcoal (1.4 million t annually) which requires 10–14 million t of wood to produce (GoK/UNEP, 1997).

In urban areas charcoal is largely for domestic and industrial uses. Urban dwellers have a higher energy demand than rural households who consume about 50% of the charcoal supply. Kenya's industry sector—brewing, butcheries, bakeries, brick making,

Table 19. Sources of fuelwood in Kenya.

Source	Area (million ha)	Wood stock (m^3/ha)	Sustainable harvest (m^3/ha)	Product
Indigenous forest	1.2	176	1.76	fuelwood
Woodlands and shrublands	37.6	16	0.12	charcoal
Farmlands and settlements	9.5	8	0.46	charcoal
Forest plantations	0.17	347	69.4	timber

Source: Institute of Economic Affairs, 1997.

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Charcoal production in Kapsaret Forest, Uasin Gishu.

blacksmiths, fish smoking, tobacco curing, food drying—consumes about 20% of the country's fuelwood. Informal industries use about 11%. Overall, the commercial and institutional sector that includes schools, hospitals, hotels, prisons and offices account for about 1% of the total wood energy used in Kenya.

Table 20. Pattern of energy use in Kenya.

Product	Quantity (tonnes equivalent)	Percentage (%)
Coal and coke	79.0	0.9
Petroleum	1,809.1	21.7
Electricity	661.4	7.8
Fuelwood	5,957.8	70.0
Total	8,507.3	99.6

Source: GoK/UNEP 1992.

Traditional forest- and farm-based wood supplies are consumed faster than they are replaced. The consequence is severe environmental degradation. If more wood is harvested from the forests every year through gathering and cutting, charcoal making and pulpwood production, or through land clearing for agriculture, then forests will eventually disappear. Clearing of land for agricultural use, overgrazing and fuelwood collection have aggravated this process.

Fuelwood demand is expected to rise to 57.3 million t by the year 2005, while the supply of fuelwood from these areas will decline from 14.7 to 12 million t causing a deficit of 27.5 million t. The rise in demand is shown in table 21.

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Biogass in Kapsabet, Nandi.

Fuelwood consumption, is considered a major cause of de-vegetation and degradation of woody resources. Woody biomass continues to be the predominant source of fuel for households, rural industries, and urban commercial establishments. Even in drought-prone regions, with relatively small and scattered human populations, de-vegetation has outpaced the ability of the system to sufficiently renew wood. Cities in these regions are pressure points for land degradation. Very few institutions and households use biogass energy.

Table 21. Trends in fuelwood demand and supply (million t) in Kenya.

Year	1995	2000	2005	2010
Fuelwood demand	20,107	23,947	27,693	31,720
Accessible sustainable supply	1,665.5	1,143.0	1,120.5	1,098.0
Indigenous forest	10,585.4	10,507.6	10,429.8	10,353.0
Woodlands/bushlands	6,145.8	7,746.2	9,417.7	11,079.4
Farmlands/settlements	353.5	415.6	351.9	360.8
Forest plantations				
Total fuelwood supply	18,250.2	19,812.4	21,319.9	22,890.2
Deficit*	1,856.8	4,134.6	6,373.1	8,829.8

Source: GoK/UNEP 1992.

Chapter Two
Land abuse in Kenya

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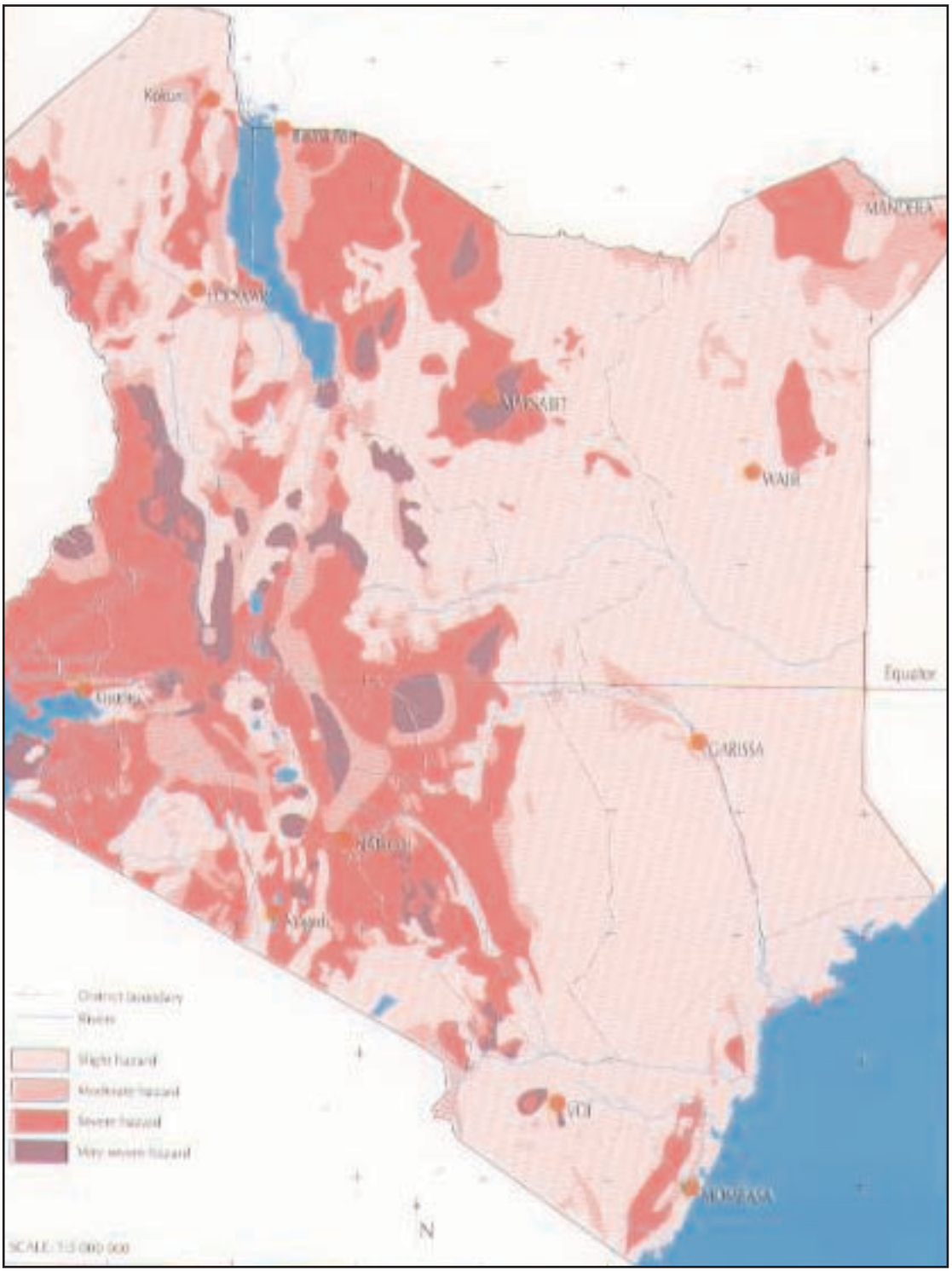
Soil erosion in Mwingi.

2.1 Soil erosion

Soil erosion is both an ecological and socio-economic problem. Erosion in cultivated land is closely related to rainfall, landform, soil type, land use and the level of conservation measures. The areas with the greatest risk include steep slopes, land usually bare before the onset of rains, soils with surface sealing problems that encourage runoff, bad tillage practices such as cultivating up and down slopes, exposure during periods of heavy rain or wind, and inappropriate land use and cultivation of marginal lands.

Erosion on pasturelands especially in ASAL is on the increase because of overgrazing. The major erosion types are rill, gully and riverbank. Areas prone to gullies include bare land, animal tracks, faulty road drainage structures and neglected rills and furrows. Up to 35% of the sediment load from 61 catchments in Kenya originates from roadside gullies. An equal amount is derived from footpaths and cattle tracks. The risk of stream bank and bed erosion is high where the streams and rivers flow through alluvial plains with little vegetation cover. Where vegetation is lush, there is minimal risk. Where streams and rivers flow over rocky beds and banks, the risk is similarly minimal. The hazards associated with water erosion are summarized in figure 8.

The areas with the greatest risk include steep slopes, bare land, bad tillage practices and cultivation of marginal lands.



Source: GoK/UNEP 1997.

Figure 8. The hazards of water erosion in Kenya.

a) Causes of erosion

Two processes drive water and soil erosion. The first is the loosening or detaching of the topsoil particles when large raindrops fall following splash erosion which occurs when vegetation cover is removed and the soil surface is directly exposed to raindrop impact. If this occurs on slopping ground, the splashed soil particles move downhill.

The scouring effect of surface runoff appears in the form of sheet erosion, which progresses unobserved because the whole surface of the field is gradually eroded uniformly. The only evidence is when the roots of trees or crops or bottoms of fence posts are exposed. At this stage the landowner has already lost tonnes of the top productive soil.

Secondly, the transportation of such detached particles by the flowing water is characterized by rill erosion, which begins when small, shallow surface flow starts to concentrate in low spots on the soil surface. As the flow changes from sheet to deeper flow in these low areas, the velocity and turbulence of the flow increases thus detaching and transporting soil particles. This action begins to cut tiny channels called rills that are usually a few centimeters deep. If uncontrolled it could lead to gully erosion when water runoff cuts rills deeper and wider, or when the flow from several rills come together and form a large channel. Also, large chunks of soil can fall from a gully headwall in a process called mass wasting.

Soil erosion occurs when farming practices provide a medium for the two processes to take place. De-vegetation through shifting cultivation, clearance for land, overstocking and overgrazing provide such a medium. Other malpractices that promote soil loss include deep ploughing of land, lack of crop rotation, as well as ploughing and planting down the contour. In such areas with deep soils and high rainfall, landslide erosion prevails because rainwater infiltrates vertically into the soil up to the bedrock and then moves laterally along the bedrock causing the soil at the outlet to slide. This phenomenon is common along the sides of gullies. It can happen without the intervention of human activity.

In the arid and semi-arid lands, another cause of water erosion arises from opening up saline and alkaline soils. These soil types are inherently of poor structural stability and when vegetation is cleared and soil is exposed to heavy raindrops, the particles detach faster accelerating soil loss and the land rapidly become gullies. The gullies in such soils are difficult to heal once they are developed. Similarly wind erosion is prevalent in such conditions. It occurs where the land has loose, dry and fine soil.

Such landscapes also have a smooth surface due to sparse or no vegetation. A study of the erosivity index in Kenya shows that the highest risk of wind erosion is to be found among some humid and sub-humid climates within the ASAL. In such places, there is a high load of sand suspended in the atmosphere. Table 22 shows that the highest incidences of wind erosion are most likely to occur in Marsabit, Moyale, Wajir and Garissa. The lowest risk is found around Makindu and Voi.

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Gully erosion in Nyando area, Kisumu.

The above scenario has a negative impact on productivity, causes pollution and reduces the economic value of land.

b) Consequences of soil erosion

Loss of productivity

The productivity of a piece of land is demonstrated by the capacity of the soil to produce crops. When the soil is eroded, there is a general decrease in the reservoir of exchangeable nutrients absorbed by the plants for their metabolism and growth. When this reservoir is truncated and washed away, so is the source of nutrients making the remaining sub-soil less fertile and less suitable to support optimal plant growth. Loss of topsoil is therefore directly a loss of the best reservoir of soil nutrients.

Similarly, when the topsoil is removed, it means loss of the soil moisture-storage capacity. The loss arises from changing the soil water-holding characteristics of the rooting zone (which is reduced in volume

Table 22. Sand movement potential in Kenya.

Station	Lodwar	Mandera	Moyale	Marsabit	Makindu	Voi	Wajir	Garissa
Annual potential sand movement (m/s)[3]	99.2	62.1	86.5	828.6	23.2	64.8	104.9	144.9
Risk rating	*mod.	mod.	mod.	high	low	low	mod.	mod.

*moderate

Source: GOK/UNEP 1997.

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Silt-laden Tana River in the lower course.

via truncation) limiting the water-holding capacity. This leads to reduced plant growth due to limited moisture. At the same time, a larger proportion of the precipitation is lost as runoff causing more erosion and destructive floods. Plants grown on such eroded soils wither due to lack of moisture and nutrients leading to significant drops in yields.

With the removal of the topsoil, the structure of the soil becomes poorer leading to the formation of soil clods. The clods then facilitate the development of surface sealing and crusting limiting plant germination. The crusts and seals also reduce water infiltration, promoting runoff and subsequent flooding.

Polluton of water systems

In 1965, the Tana River and Athi–Galana–Sabaki carried 250,000 and 150,000 t per year of sediment respectively. By 1986 Tana River carried 2.5 million t per year while Athi–Galana–Sabaki had risen to 2 million t per year (KSS, 1989). This sediment loads have destroyed inland water bodies and marine life.

Loss of economic value of land

Eroded soil is transported in the form of silt by rivers and deposited in the lakes and the ocean. Over the years, silt accumulates and changes the colour of water from clear blue to reddish brown. This is an unattractive colour for people who organize aesthetic activities such as tourism and exclusive settlements around water bodies. To the north of Sabaki River mouth, the village of Mambrui is being submerged in sand dunes and silt deposits from the river. The silt emptied in the ocean kills coral reefs and damages marine life. Homes also have been abandoned.

Some dams and pans have had their lifespan severely reduced due to the accelerated sediment deposits through erosion. The hydro-power dams along the Tana River have been silted on several occasions reducing their capacity to generate power, leading to power rationing and frequent blackouts.

Frequently, the silt is deposited on the white coral beaches turning them into mud beaches and damaging the scenic beauty. Some hotels in Malindi town have lost business as tourists moved to other white sandy beaches. Consequently jobs have been lost and social structures disrupted.

2.2 Pollution

a) Air pollution

Air pollution arises from gaseous emissions from domestic operations, power generation, agricultural practices, uncontrolled disposal of solid waste, industrial and vehicular emissions. The major sources of air pollution are industries manufacturing chemicals, rubber and plastics, paper mills, cement and excavations, ceramic tiles and glass factories, and leather industries.

Vehicle emissions contain carbon dioxide, greenhouse gase (GHG), that is a cause of global warming. Road and railway transport systems in Kenya rely on fossil fuels which are linked to high emissions of GHGs. Road transport accounts for 80–90% of the passenger and freight transport and accounts for 80% of Co_2 emissions.

Air pollution from agricultural practices include emissions of carbon dioxide, methane and nitrous oxide from cropping e.g. rice and sugarcane cultivation, and bagasse production. Methane emitted from flooded rice fields due to anaerobic decomposition of organic matter in the soil is the largest source of greenhouse gases in Kenya. Others are animal husbandry—due to enteric fermentation, manure management facilities and anaerobic decay; application of synthetic manure and organic fertilizer; and burning savannah grasslands and scrubland. Domestic sources include the use of biomass, pit latrines and waste.

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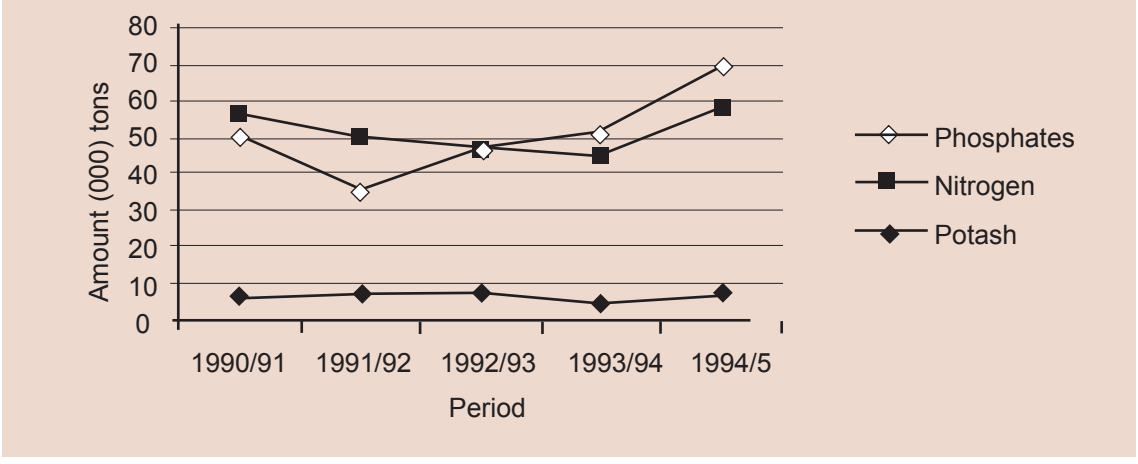
Gaseous emission from poorly maintained vehicle.

b) Land pollution

Chemical fertilizers, pesticides and fungicides are important in agriculture. However, their improper use has poisoned and compacted the soils. Fertilizer is the dominant farm input in Kenya averaging 275,270 metric tons/year. The use of industrial fertilizer is on the increase (see figure 9). The government, in cooperation with local non-government ogranisations and other stakeholders, is promoting the use of organic manure, which is easy to access and is environmentally friendly. There are success stories on the use of organic manure among smallholder farmers as exemplified by the Chanderema Women Group, Vihiga District.



Source: FAO, 1996.

Figure 9. Chemical fertilizer use in Kenya.

c) Water pollution

Water resources in Kenya are increasingly becoming polluted at point and non-point sources due to agriculture, urbanization, and industry. Intrusion of saline water in the coastal region, leachates from solid waste dumps and infiltration of fertilizer and pesticide residues threaten ground water. The five principal sources of water pollution in Kenya include sediments and agrochemical residues (biocides and fertilizers); industrial processing of agriculture and forestry products which produce liquid effluent, gaseous emissions and solid waste; industrial manufacturing—heavy metals, acids, dyes, oils; domestic/municipal effluents—sewage and garbage; sedimentation—soil erosion; and mining which produces tailings and effluents.

d) Noise pollution

Traffic generates noise. With increasing number of vehicles and aircraft, most urban areas are becoming increasingly noisy. Loud music in public service vehicles is a public nuisance. Other sources of noise pollution include noise form factories, ballasting at quarries and mining sites.

2.3 The polluting agents

a) Persistent organic pollutants

Persistant Organic Polutants (POPs) have become more concentrated as they move up the food chain and can travel for thousands of kilometers from the point of release. The most notorious chemicals in PoPs include Aldrin, Chlordane, DDT, Dieldrin, Endrin, Heptacle, Hexachlorobenzene, and Toxaphene. Despite their worldwide ban, they are illegally used in Kenya as fertilizer and or crop protection chemicals. These PoPs can persist in the environment for decades and accumulate in marine and land-based food chains posing health risks long after exposure (see table 23).

b) Heavy metals

Heavy metals include lead, copper, zinc and mercury among others. Industrial products made from these metals are used in all aspects of life. Lead is used in plumbing, and insecticide and battery manufacturing; mercury is used in the preparation of cosmetics and is a base in some painkillers. It is also used extensively in gold mining especially in South Nyanza and Lolgorien area of Trans Mara District.

Table 23. Reported levels of DDT residues in fish from Kenyan lakes

Species	Residue concentration (mg/kg) wet mass
Lake Baringo	
Tilapia nilotica	0.009
Clarius mosambicus	0.019
Burbus gregorii	0.028
Labeo cylindicus	0.400
Lake Naivasha	
Tilapia spirulus nigrax	0.001
Micropterus salmoids	0.003
Lake Nakuru	
Tilapia grahami	0.015
Latesilotica	0.004

Source: UNDP/UNEP 1996.

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Gaseous emission from the paper factory in Webuye.

c) Gaseous emissions

Air pollution especially from industries is a growing problem. The public outcry against KEL Chemicals in Thika in 1991 is symbolic of the problem. Large concentrations are evident at Webuye where the paper and pulp factory emits sulfur compounds into the air turning trees yellow in the region.

Mzee Moses Luyuku of Nabuyole village in Webuye says that the smoke from the paper factory causes rusting on iron sheets within a year of building the house. Local people around Webuye say they suffer from allergies and respiratory diseases due to gaseous emissions from the factory. Farmers have also complained that crop yields have dropped by over 80% due to chemical pollution from the factory.

Vehicle emissions contribute significant volumes of carbon dioxide, one of the greenhouse gases causing global warming. In 1991 there were 159,000 passenger and 150,000 commercial vehicles in Kenya (GoK, 1999). This figure has since increased adding to serious air pollution in urban areas. If these cars use leaded petrol, they contribute significantly to the accummulation of lead in the environment. Lead is added to petrol to boost the octane rating and hence increase power. Lead poisoning affects the brain, kidneys, the reproductive and cardiovascular systems. Also lead has residual effects in contaminating water and land resources in the long run.

d) Liquid effluent

Chemical discharges from industries and other urban waste have degraded the fresh water sources in rivers, lakes, and other water bodies. Such pollutants have interfered with the flora and fauna of these areas.

Sediment yield and discharge of industrial waste into the major river systems have reduced the volume of fresh water, interfered with fish species and wetland life forms such as riparian forests and marshlands. Pollution of inland fisheries has far-reaching implications. There is a possibility that some of the health disorders suffered by human beings could be linked to eating contaminated fish.

The marine resources are prone to not only land-based pollution, but also to pollution by ships, especially oil tankers. For example in 1993, a tanker at the port of Mombasa spilled approximately 80,000 metric t of oil. The impact on the natural resources of such oil spills is monumental. There is deliberate pollution from ships during de-ballasting and tank washing.

In 1930, scientists synthetically produced chlorofluorocarbon compounds to replace the use of ammonia and other coolants in refrigeration, air conditioning, aerosol propelling and fire depressants. At the time they were preferred due to their advantage over the leaks and explosions that were associated with ammonia products. These chemicals are unfortunately responsible for the depletion of the ozone layer in the stratosphere above the atmosphere. The direct impact of reducing the protective ozone layer has been the increase in ultraviolet radiation which raises surface temperatures (as a result of the greenhouse gas effect) causing changes in weather systems and bringing about extreme episodes of drought and floods

e) Pesticide and nitrate contamination

Pesticides are valuable agricultural inputs used for protecting crops to increase yields. However, they also have severe effects on health due to their toxicity. They can cause headaches, flues, skin diseases, blurred vision and many neurological disorders. The most notorious pesticides causing health problems

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Liquid waste disposal into Mtoine River from Kibera/Nyayo High Rise Estate, Nairobi

are organophosphates and carbamates. Most of them are banned or restricted in use worldwide.

Together with pesticides, nitrogen fertilizers increase yields tremendously and their application in Kenya has increased five-fold since the sixties. The dissolved nitrogen that is not taken up by plants contaminates surface and ground water because the excess nitrate is water-soluble and easily washed down the soil profile by rain or irrigation water. Water contaminated with nitrates can cause disorders in red blood cells leading to conditions of low oxygen commonly called "Blue-Baby"

2.4 Urban waste

Wastes are solid, liquid or gaseous materials that are discarded by people and industries. They are released carelessly into the air, water and land as though the latter have an infinite capacity to absorb these wastes.

a) Solid waste

Household and consumer waste are the major component of solid municipal waste. Per capita municipal waste produc-tion in Kenya is 1.2 t per annum. Solid waste consists of a mixture of organic materials, paper, plastics, textiles, glass, metals, ash and grit. Food remains are solid waste. The moisture content of household waste is generally high and is therefore not readily combustible.

Packaging material, glass and plastic bottles, cans, paper clips, paper and plastic wrappings are the major constituents of litter. The use of non-returnable containers has increased the volume of litter. Furthermore, the production and widespread use of non-biodegradable plastics in packaging materials has compounded the litter problem. Plastic litter in marine environments at the Coast arises from fishing gear such as nylon, buoys and nets; packaging bands straps and synthetic ropes; general litterbags, bottles and plastic sheering. The same litter is also found in large inland water bodies.

Treatment of domestic and industrial wastewater at the plants yields sewage sludge. This is a type of slurry made up of fine organic-rich particles with a high chemical composition. Such sludge will require a highly efficient system to treat and clean. Demolition of old buildings and construction sites also generate waste. Currently, contractors in Kenya seem to have a free hand in dumping their waste. Commercial mining sites (for instance rubies, gold, marble, cement, and soda ash) leave behind trailings and spoils. Such waste may include soil, rock and inert dirt or trailings from extraction that are contaminated with metals or chemicals used for mining separation.

Solid waste in most urban centres in Kenya is disposed of in open dumps or crude sanitary landfills, burned or left to decompose in open places. In low-income residential areas, collection is very poor and waste is disposed of by simply dumping it along streets, playing fields and in between houses. Burning is practiced in some estates leading

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Garbage dumping site in Dandora, Nairobi

to gaseous effluents like carbon dioxide, nitrogen oxide, methane and smoke.
The main method used by municipal authorities to dispose of solid waste is by crude and unsanitary land-filling mainly because it is cheap and there is scarcity of disposal sites in most municipalities. These grounds are left open and create dangerous health risks to both the public and animals. The collecting efficiency in most towns is very low leaving waste uncollected at the sites, or is dropped in the wrong place.

A study by the Japan International Cooperation Agency reveals that in Nairobi City only 20% of the generated waste is collected and disposed of. The rest lies along roadsides or riverbanks. The City Council has over time reneged on collecting industrial waste, which is now done by the individuals. Table 24 summarizes solid waste generation in Nairobi City.

Of the total solid waste generated in Nairobi, the largest quantities by weight are petricibles (65.5%) followed by paper and cardboard (23%), metals (2.6%), textiles (2.6%), unclassified (3.1%), glass (1.7%) and plastics (1.5%). The per capita solid waste production for Nairobi is 0.5 kg/day—a total of 1 million t per day for a population of 2.2 million (JICA, 1998).

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Uncollected and or collected and untreated solid waste releases methane gas in to the atmosphere. The gas raises temperatures that cause climatic change. The average methane production from solid wastes in Kenyan municipalities is shown in table 24.

Table 24. Estimated municipal solid waste generated in Nairobi.

Year	Population (million)	Annual municipal solid waste generated (tonnes)	Annual municipal waste disposed (tonnes)	Methane gas generated (tonnes)
1992	1.72	332,734	66,547	2,050
1993	1.79	346,276	69,255	2,133
1994	1.87	361,752	72,350	2,229
1995	1.92	377,228	75,446	2,324
1996	2.03	392,704	78,541	2,419
1997	2.11	408,179	81,636	2,514
1998	2.20	425,590	85,118	2,622

Source: JICA, 1998.

b) Liquid waste

Liquid waste is generated from industry, service premises and domestic areas. They contain a wide range of chemicals and physical components which when decomposed generate various amounts of greenhouse gases, such as methane.

The amount of methane emitted depends on the organic loading in the wastewater normally measured as the Biochemical Oxygen Demand, and the extent to which the material will decompose under anaerobic conditions. This is the condition under which sewage and industrial waste streams are maintained.

c) Hazardous waste

This is waste whose properties may be radioactive, toxic, explosive, corrosive, flammable or infectious. The waste is likely to harm people, livestock, crops or the environment either on its own or when mixed.

In Kenya, there are no facilities to store and move such harmful classified waste. Major towns such as Nairobi, Mombasa, Kisumu and Nakuru have facilities for storing and transporting clinical waste from the major medical institutions like hospitals and research centres, clinics, pharmaceuticals factories. Each medical institution is required by law to maintain an incineration plant for disposing clinical wastes.

Despite the presence of such facilities and guidelines cases of careless disposal of such clinical waste in Nairobi, like dumping it at Dandora dumping site, have been highlighted in the print media. Expired drugs and other waste from pharmaceuticals is not being incinerated but instead also dumped in Dandora.

d) The causes of inadequate waste management

The underlying causes for poor, urban waste management include:

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Mzee Lukuyu pointing at the damaged roof from contaminated rain next to Webuye paper factory.

- Weak enforcement of existing laws and regulations due to inadequate human resources and cumbersome procedures. The municipal councils and quality control organizations like the government departments in the Ministry of Environment and the Kenya Bureau of Standards are not able to fully implement the provisions of the existing statutes. Even where they may be able to do so, the penalties stipulated in the statutes are unrealistically low to be a deterrent.

- The policies and laws regulating waste management do not provide incentives for individuals or companies willing to adopt efficient waste management technologies. Such incentives may include tax reductions, awards, access to cheaper credit facilities as well as information and technology. The waste management and sanitation sector does not feature as a priority in the development agenda of the country. As such, it never receives adequate resources or consideration when articulating national development issues.

In Kenya, there are no facilities to store and move such harmful classified waste. Major towns such as Nairobi, Mombasa, Kisumu and Nakuru have facilities for storing and transporting clinical waste from the major medical institutions like hospitals and research centres, clinics, pharmaceuticals factories.

- The lack of comprehensive discharge standards and methods of measuring the quality and quantity of effluent makes it difficult for any authority to contain waste generation. This scenario has systematically led to a situation where industry and urban dwellers have become insensitive to legal regulations on the safety of the environment and health. The practice of following standards for health and safety of workers at the work place has long been ignored.

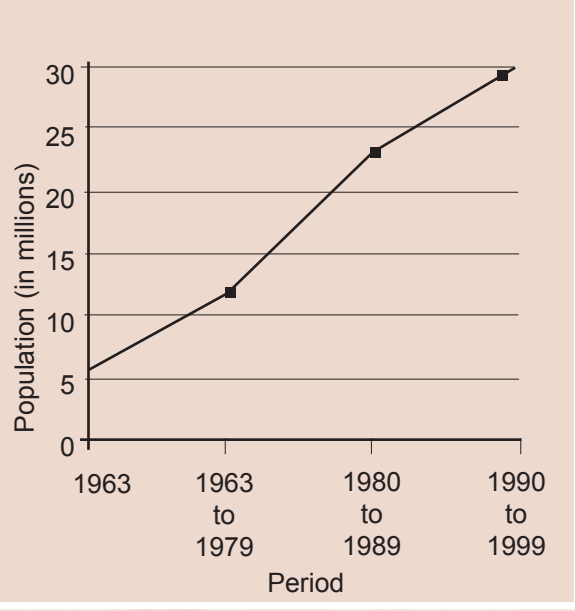
2.5 The driving forces behind unsustainable land use

a) Population increase

At independence, Kenya had a total population of about 7 million people. By 1979 the population had risen to 15.5 million people. In 1989, it shot to almost 21.5 million people. By 1999 the population had reached 29 million (see figure 9). Over the same period, the Kenyan economy performed poorly with no remarkable industrialization to cope with the demands of the population. The population trend has inevitably resulted in intense pressure on the available natural resources.

The pressure in many parts of Kenya has triggered the cycle of degradation of forests, wildlife, water and mineral resources. The increased number of people searching for economic security has led to intensification of cultivation, expansion of cultivated land, overgrazing of the range, and harvesting of trees for fuelwood leading to deforestation and an acute water crisis as well as loss of biological diversity and soil erosion.

Figure 10. Trend of population increase in Kenya, 1963–1999.



b) Misapplication of modern technological innovations

Technological innovations have had positive and negative impacts on the management of natural resources in Kenya. A good example is the National Soil and Water Conservation Programme that was started in 1974 to conserve soils in cultivated and grazing land within permanent settlements. By 1987, the project had 51 tree nurseries with an output of 200,000 fruit tree seedlings and 2.5 million forest and fodder tree seedlings annually. These conservation efforts raised crop yields by between 50% and 70%. In 1982, the programme had put in place 2,912 km of cut-off-drains, 3,090 km of bench terraces, 556 hectares of narrow-base terrace, 2000 km of grass strips, 283 km of stone terraces, 1,107 km of trash lines, 81 km of artificial waterways. In addition, 714 hectares of grass were planted, 1964 gullies rehabilitated and 1,247 gabbions constructed. These efforts are estimated to have conserved millions of tonnes of topsoil and soil moisture thereby expanding crop agriculture into areas then not utilized.

The second commendable effort in technological innovations has been the blending of modern and traditional practices—a practice called agroforestry—in the last 10–15 years. Within the humid

and semi-humid zones of Kenya, there has been tremendous increase of tree cover (open-canopy forest) in the cultivated lands through an extension campaign based on re-vegetation of lost forests with trees that have direct economic benefits to the household. Some areas in central Kenya, eastern (Machakos, Meru, Embu) and western Kenya (Maseno) have incorporated traditional knowledge and skills with new farming technologies propagated by the Kenya Forestry Research Institute, Kenya Agricultural Research Institute and the International Centre for Reseearch in Agroforestry, that have resulted in amazing increases in yields.

Cases of abuse of technology have also been reported. The irrigation technologies adopted in places like the Kimligo–Kamleza irrigation scheme have over time deposited salt materials on the surface rendering the soils unproductive. If not checked, the entire scheme will experience serious soil degradation and soon end up as a wasteland. A similar fate may befall the hundreds of hectares under small-scale and large-scale irrigation schemes especially in the dry areas at the Coast and along the Tana and Ewaso Nyiro Rivers.

c) Stifling indigenous skills, technologies, knowledge and practices

Indigenous knowledge and techniques abound in Kenya. The Turkana pastoralists protect and conserve trees through ownership of the trees by individuals and families. Pasture land near settlements is guarded by migrant herders who cannot use the pasture without prior permission from elders. Amongst the Suba of Nyanza, their traditional belief and respect for founder clan shrines has guarded against human activity. These shrines are now thick forests alternating with farms and homesteads. The Endo of Elgeyo Marakwet use an ancient irrigation technology that has helped them produce bumper fruit harvests over years.

The pressure in many parts of Kenya has triggered the cycle of degradation of forests, wildlife, water and mineral resources. The increased number of people searching for economic security has led to intensification of cultivation, expansion of cultivated land and overgrazing of the range

Experience shows that disregarding indigenous traditional skills has led to destruction of natural resources. When the government through the Ministry of Livestock Development introduced the "North America" model of range management by demarcating the drylands in Turkana, Marsabit, Isiolo, Garissa, Wajir and Mandera into "Grazing Blocks", the traditional transhumant system of seasonal migration in search of water, pasture and the opportunistic spread of grazing pressure was ignored. Age old systems developed by the Rendille, Borana, Somali and Turkana herdsmen were regulated into designated territories in which the government undertook to develop water sources and also develop social services such as schools to transform the nomads into sedentary populations that could be easy to govern and plan for. About 40 years down the line,

this model failed and cases of severe de-vegetation and soil loss were reported over the period. The centres for water and social services instead degenerated into epicentres of desertification and sanitation problems associated with urbanization.

By de-emphasizing the links and relationships between people, their culture and resources, previous and on-going development programmes have unwittingly contributed to the prevalent insensitivity and apathy of communities towards 'sound' environmental and natural resources management. Furthermore, they have exacerbated the colonial legacy of separating people from nature.

d) Natural and man-made disasters

Kenya experiences minor droughts every 2 to 3 years, and major droughts after 8 to 10 years. Drought decimates 30–40% of the wildlife and livestock, 30–40% of crop yields, destroys riparian and gallery forests. It decimates the natural germination capacity of grasslands by 50%. Livestock and wildlife concentration around a few water points leads to serious vegetation and soil degradation. Millions of hectares of forest are lost due to forest fires, which more often are caused by lightening. After fierce forest fires, as much as 20% of the plant and animal species are lost and never recur during the regeneration period that follows.

Lack of alternative sources of goods and services force people to exploit vulnerable environmental resources in order to meet livelihood needs as seen in the new settlements for conflict victims in Naivasha and Nakuru suburbs, and in refugee camps such as Kakuma. Poor people use natural resources in an unsustainable manner when survival strategies are necessary. Moreover, while many communities are aware of environmental concerns, they lack the capacity to practice sound management.

Subsistence farmers and pastoralists who rank among the poorest in the country are extremely vulnerable in times of prolonged drought and/or floods. For example, during the prolonged drought in 2000, hundreds of pastoralists invaded commercial ranches in Laikipia District and Mount Kenya forest in search of pasture, and a number of Maasai herdsmen from Kajiado moved their cattle into Nairobi also in search of pasture. Arguably the drought was the result of a natural disaster rather than human-induced environmental degradation. Nevertheless, it forced people into re-activating a long-standing tradition of moving into the drought escape areas that are now private ranches and urban centres forcing pastoralists to resort to unsustainable survival mechanisms.

e) Poor environment regulation

A concise policy framework from which to generate holistic and integrated strategies and actions does not exist. Sectoral policies—the technocrat's view of forests, soils, wildlife and water—have not been effective on the ground. The absence of a concise national land-use policy has had a direct impact on the way natural resources have been conserved.

The enactment of the Environmental Management and Coordination Act is an attempt to address the need for a framework legislation on the management of the environment. It is too early to judge the efficacy of this legislation. Indeed the institutional framework envisaged by the legislation is yet to be put in place even though the legislation is now in force. Nevertheless, the legislation has been passed in itself and the role of the government and other stakeholders is to ensure that the benefit of the legislation are realized for the sustainable management of the environment.

2.6 The impact of unsustainable land-use practices

a) Health hazard and diseases

Almost a quarter of all diseases in Kenya can be attributed to environmental factors. The poor, particularly women and children, are most affected. Water-related diseases, such as cholera and diarrhea arise from polluted water. Burning biomass fuels for cooking and heating causes indoor air pollution in turn contributing to acute respiratory infections and related illnesses. Malaria arises from poor management of water sources where malaria-carrying mosquitoes breed. Agrochemicals affect poor farmers who use pesticides without training on how to handle them or without protective clothing.

Water pollution leads to environmental health effects in the form of water-borne diseases, such as, cholera ad typhoid and chemical poisoning in human beings and animals. For example, in Mwea area, there is a higher than normal incidence of water-borne diseases among paddy rice farmers—31% of residents show signs of bilharzia, 15% of hookworms, and up to 50% of the sampled population regularly have malaria parasites in their bodies (GoK/UNEP, 2001).

A survey in major horticultural areas found that most farmers experience occasional poisoning symptoms after applying agrochemicals. It estimated that pesticides poison 7% of the people in Kenya's agricultural sector every year and that a quarter of the farmers in major horticultural areas regularly suffer from pesticide-related ill health. Organophosphates pose an acute danger because of their relative high toxicity.

About 80% of treated cases between 1987 and 1990 at Kiambu District Hospital had suffered agrochemical poisoning from organophosphates used in coffee, vegetables and flower production (GoK/UNEP, 2001). One tenth of all illnesses treated at Lake North Clinic near Lake Naivasha were attributed to pesticide poisoning of flower farm workers who complained mainly of rashes, sores and gastro-intestinal problems. High organo-chorine residues, especially DDT and Dieldrin, have been found in human milk samples taken from mothers in horticultural and coffee-growing areas.

Further, health risks arise from the ingestion of agrochemicals in contaminated containers used to carry water, or in airborne transfer. Infections can cause skin, eye, and gastro-intestinal and respiratory complications. Long-term health effects include pathogenesis of childhood anapestic anemia, chronic mercury poisoning and possibility of impotence. The impacts of pollution are shown in table 25.

Table 25. Impact of industries on air, water and land pollution in Kenya.

Type of industry	Air	Water	Land
Chemicals	Emissions of sulfur oxide, nitrogen and chlorofluoro-carbons	organic chemicals, heavy metals, suspended solids and PCBs	Sludge
Paper and pulp	Emissions of sulfur oxide, methane, carbon dioxide, hydrogen sulfides, mercapptans, dioxins	Suspended solids, organic matter, chlorinated organic substances, dioxins	
Cement, glass and ceramics	Dust containing nitrogen and carbon oxides, chromium and lead. Emission of lead, arsenic, carbon dioxide, hydrofluoric acid, silica and fluorine compounds	Oils and heavy metals contamination	Soils contaminated with metals and solid wastes
Mineral mining	Dust and heavy metals such as mercury	Discharge of acids (arsenic, lead and cadmium)	Degradation by slag heaps and soil erosion
Refineries/ petroleum products	Emission of sulfur, nitrogen and hydrogen fumes, toxic compounds and ordours. Risks of explosion high	HCs, mercaptans, caustics, effluent from gas scrubbers	Harzadous waste, sludges, spent catalysts.
Leather and tanning	Leather dust, hydrogen sulfide and chromium compounds	Toxic solutions containing suspended solids, sulphates and chromium	Chromium sludges

Source: GoK/UNDP 1997.

b) Biodiversity loss

Organic pollution, chemical discharges from industries and urban waste have degraded fresh water bodies and their biodiversity. Waste also impacts on water quality and are manifest through deterioration of the quality of the aquatic environment, deoxygenating, eutrophication, siltation, habitat modification and toxicity among others. In some places some plant and animal species introduced into some water bodies have caused disastrous environmental impacts. The hyacinth has interfered with the hydrological cycle of the lakes and the breeding points of the key lake fishes. The introduction of the Nile perch, a predator, has eliminated indigenous species.

Sediment deposited into the major river systems coupled with discharge of industrial waste has reduced the volume of sea water, interfered with fish species and the wetland life forms including riparian forests and marshlands. Pollution of inland fisheries has far reaching implications. There is a possibility that some of the health disorders suffered by humans could be linked to eating contaminated fish.

Where pesticides are reasonably safe for humans, they may be acutely toxic to fish, birds, bees and other beneficial non-target species. Uncontrolled development, existing pollution and sedimentation from agricultural areas upstream increasingly threaten marine life.

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De-vegetation of the semi arid savannah through charcoal burning in Mweiga, Nyeri.

Pollution reduces the capacity of soils to produce crops and leads to food insecurity as is the case around the Webuye paper factory. The liquid effluent has reduced the habitats of aquatic life forms such as fish. The fishermen's catch on Lake Victoria for instance has reduced tremendously in the last 10 years. According to the 1997–2001 National Development Plan, the "… current fish-catch levels in Lake Victoria are unsustainable and the potential collapse of the Nile perch fishery is imminent" (table 26). Some fish species have been reported to be now extinct as a result of pollution of the lake and river waters.

Sewage sludge is a concentration of heavy metals and water-soluble synthetic organic compounds. It also contains grease, oils and bacteria. When such sludge is mixed with irrigation water or agricultural manure, it leads to soil poisoning.

Table 26. Status of species of fish, reptiles and amphibians in Kenya

Category	Fish	Amphibians	Reptiles
Total species	683	101	24
Endemic in Kenya	54	13	17
Known extinction	7	-	-
Endangered	60	2	11
Vulnerable	7	-	-
Rare	16	1	3
Introduced	13	-	-

Source: GoK, 1992

c) Economic loss

In Kenya there are quantitative estimates of economic costs of environmental degradation but analysis of cross-sectoral, multi-resource or multi-species values of our natural resources are inadequate. However, R.F. Meadows (2001) has attempted an analysis of the relationship between the environment, incomes and livelihoods both at macro and micro levels with regard to economic costs of environmental degradation. The results indicate substantive losses shown in table 27 below.

d) Aesthetical/cultural site loss

Aesthetic losses include interfering with the scenic beauty that renders water and recreation sites unsuitable for recreation. For example, the water hyacinth at the Nairobi Dam has derived the sailing club use of the facility. This reflects an economic loss. Siltation, which changes vegetation for example, in the coastal areas of Malindi and Mambrui, has rendered settlements and beach plots for recreation unsuitable.

Litter is an eyesore and spoils the scenic and aesthetic quality of beaches and other tourist centres. The Nairobi Central Business District is one such eyesore as it is littered with waste from hawking activities of the previous night, so is litter from residential estates strewn all over exuding a pungent smell.

Table 27. Selected economic costs of environmental degradation in Kenya.

Service	Estimated loss annually (in US$ millions)
Loss of ecological services, including watershed catchment protection function alone	26
Loss of support to rural household livelihoods, including income and subsistence	94
Loss of the national economy income	4
Loss of foreign exchange earnings	0.22
Loss to commercial and industrial consumers earnings	2
Loss of global wildlife tourism values	350
Loss of total government earnings from wildlife tourism	29
Loss of global tourist consumer surpluses	450–700
Loss per forest adjacent to household;	100–350
Loss of tourism from Mount Kenya forests	0.3
Loss of farm income (agroforestry, livestock and soil conservation)	330 million/ha
loss of elephant populations	75–97
Loss of flamingos	3–6
Loss of Amboseli lions	30
Loss of Masai Mara gross revenue	31
Loss on Masai Mara wildebeest	187–225

Source: Data synthesized from Meadows (2001)

The Kaya forests form a natural habitat for fauna and flora, and are important for the traditional, cultural and medical requirements of the local communities (from the Digo's in the South Coast to the Giriama in the North Coast). The Kayas are used by the elders (Wanatsi) to lead the communities in search of their gods for forgiveness or thanksgiving after success. They are also used to appease or pacify gods when there is evidence of declining harvest, reduced rainfall, absence of peace and harmony, rampant diseases...

These cultural groves now face challenges including heavy encroachment due to declining respect for traditional values and customs, rising demand for agricultural land and wood fuel, mining to meet the needs of local and international markets. Demand for construction materials, sand, timber, and coral blocks and the occurrence of forest fires especially in dry seasons exacerbate the problem.

e) Land-use conflicts

The department of livestock production in Laikipia District estimates that on average, the grazing capacity varies from 5.2 ha per tropical livestock unit (TLU) in agro-ecological zone (AEZ) IV and 6.5 ha/TLU in AEZ V. Estimates by Flurry (1986) show more localized variations form 2.8 to 5.2 around Ngobit, 2.8 to 4.3 along the Naro Moru Nanyuki Sirimon area and 6.5 ha to the north of Timau. Central division consisting of most of the plateau was estimated to have an average grazing capacity of 4.2 ha /TLU (Mwichabe, 1997).

Studies by the department in West Laikipia show that the average household of 7 persons who are agro-pastoralists in AEZ IV need at least 2 cows, 1 heifer, 9 sheep and 5 goats to survive. This works out to about 3.5 TLU/household or a per capita demand of 0.5 TLU. If the grazing capacity is at best 4.3 ha/TLU then it follows that could be the minimum land holding size that can enable a family to survive above the food security line and probably market some surplus. In order to meet other cultural obligations for example dowry, fines, gifts, etc, the family in AEZ IV would require 14.5 ha/family (Mwichabe, 1997).

The optimal farm size based on its ability to provide self-sufficiency for the Central Division in Laikipia is an average of 13.2 ha per household for an average family to achieve food self-sufficiency—based on the assumption of substantial contribution from farm crop and livestock products.

It is therefore not surprising that on small scale ranches, the livestock population far exceeds the available grazing by a factor of 4.5–7. The problem is however mitigated by the high numbers of absentee landowners whose land is subject to pasture poaching. Were these absentees to settle, the current stocking rates will have to be destocked by 70–90%.

Irrigation schemes on smallholder farms upstream use over 90% of the river water reducing the flow to similar small irrigation schemes downstream resulting in conflicts in the recent past. This situation prevails particularly along the rivers Engare Ngobit,

Suguroi, Salama, Pesi, Lamuria and Kanagoi within the Kieni West area (Ngobit areas).

The pastoralist Maasai move with their livestock during dry spells over a large area without any regard to private property. This has resulted in conflicts with large-scale ranchers who despite fencing the ranches, the Maasai still move their cattle onto the ranches in search of pasture and water.

f) Increase in poverty

Degradation of the environment leads to lower fertility and productivity of a natural resource (such as soils) resulting in food insecurity. This leads to a decline in household nutritional status, with children particularly being affected. Shortages of food coupled with lack of access to water and poor sanitation are amongst the factors, which cause malnutrition.

One coping mechanism adopted by poor people when food is scarce is to find alternative land for grazing and cultivation. Often this involves the use of "unsuitable" or marginal land, such as wetlands or vulnerable forests, which, in the longer term, cannot sustain such usage. For many Kenyans, hopes of building or even accessing shelter are rapidly diminishing owing to the increasing cost of building materials and inappropriate shelter policies, technologies, standards and strategies.

Catchment destruction that resulted in lowered flow of water into streams led not only to water rationing in major towns in Kenya but also to rationing of electricity. Two hydropower generation plants closed reducing the power supply by over 70%. The country undertook expensive emergency measures to supply power that cost billions of shillings in importing equipment and personnel. Power consumption bills went up by at least 200%. Almost 40% of jobs were lost in this period. To address the shortfall, a 305 megawatt thermal generator that utilizes 20,000 litres of diesel a day was commissioned. The side effects of this generator included health threats to nearby residents and increased release of hydrocarbons into the atmosphere. This time, an ecological mistake nearly grounded the national economy as industries operated at less than half the capacity.

Households with few assets are most vulnerable to all kinds of shocks. Resilience of households is dependent on financial and social capital or rights to exploit natural capital. External shocks are an important cause of asset loss. Households and communities are often poor because crucial livelihood assets, such as livestock or land, have been affected by disease, floods, or conflicts/ethnic clashes. Natural and man-made disasters have a greater impact upon the poor who may have no choice but to live and work in locations that are unsuitable and at risk or more prone to disaster.

g) Disjointed policies, laws and institutions

There is no policy framework from which holistic and integrated strategies for wise use of land can be generated. Instead, there are numerous sectoral policies laden with

sectoral interests. The translation of the policies into practice has not been successful. The absence of a concise, national land-use policy has had a direct impact on the way natural resources are conserved.

Since the late 1970s, ad hoc reviews of the sectoral policies have attempted to graft an integrated national outlook. The reviews are usually parliamentary sessional papers, national development plans or sectoral action plans. The first effort at formulating a macro land-use policy was Sessional Paper No. 1 of 1986 on Economic Management for Renewed Growth, which targeted limiting misuse of land in the country. Through this, the government expressed the intention to establish a National Land Commission to review land tenure, land-use practices, and legislation to conform with current development needs.

The best attempt to put in place an integrated, national policy on land use was contained in the National Environmental Action plan (NEAP) which culminated in the enactment of the Environmental Management and Coordination Act of 1999 which has been operationalised, but its full institutional framework is yet to be put in place.

The development policies for towns in Kenya are still modeled along the colonial line, where conservation of natural resources within peri-urban areas is considered a temporary use of the land as opposed to urban activities associated with industrial activities. The main thrust of the policy on commerce and industry is the promotion of import substitution to attract external investors into the country. The policy encourages extractive use of natural resource base with minimal investment in its conservation and sustainable management.

As early as 1930, the colonial government in Kenya established laws and institutions such as the African Land Development Board to reduce soil erosion within the "native reserves". The post-independence government elaborated on these and established laws to stem land (natural resources) degradation mainly as sectoral efforts. The Kenya Constitution itself does not have direct provisions protecting the environment and natural resources other than under sections dealing with the broad issue of human rights. The laws have been entrusted within various ministries, parastatals and commissions that have been, and are still instrumental in the management of natural resources.

Fortunately an umbrella law was enacted in 1999 to rationalize the sectoral acts. These include more than 50 separate statutes that relate to the protection of natural resources and the environment in general. Those that regulate land-use activities include the Agricultural Act (CAP 318), Land Control (CAP 302), The Chief's Authority Act (CAP 128), the Mining Act (CAP 306), the Local Government Act (CAP 268), the Trust Land Act (CAP 208), the Land Planning Act (CAP 303) and the Government Lands Act (CAP 280).

There are separate ministries, departments, corporations, technical institutions, agencies and organizations for every known

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biophysical component of the environment. Each of these institutions has its own set of policies, regulations and even laws governing its operations. Quite often, these institutions have no relationship with one another. Hence the department dealing with soil and water conservation is in the Ministry of Agriculture but hardly has any links with the Ministry of Water nor that of Lands at the policy and technical levels. At the policy level the Ministry of Environment does not have any powers over how land is alienated and used in the country.

Despite the absence of policies and laws, and despite the conflicts, overlaps and overlooks in the sectoral policies, laws and institutions, there is some possibility that were the government and its agencies to implement the framework the way it is, some significant benefits would accrue in the area of natural resources management. Indeed, the period between 1963 and 1980 saw a show of goodwill on the part of civil servants who applied the same framework and went out of their way to implement programmes that did less damage to the natural resources. The political establishment was commited to conserving natural resources to the point where the world rewarded them by locating a key natural resources management institution—the United Nations Environment Programme (UNEP)—in Kenya!

The technocrats in government had well-placed zeal in internalizing the concerns and agreements from the global fraternity as were emerging from the various international protocols. When corruption took root and became some kind of national pastime, all the policies, laws and institutions were rendered irrelevant. Forests have been destroyed everywhere. Wildlife poaching and deforestation have reached alarming levels. Individuals can invade wetlands and water catchment areas without retribution despite the existing laws. Individuals who are "politically correct" will pollute the environment and damage the water and terrestrial resources without restraint.

Chapter Three
Emerging trends

CNRM

Fighting desertification in Migwani division of Mwingi district.

3.0 The emerging trends

Shifts in policy, legislation and institutional land-use practices have over the years brought about changes in the way land-based resources have been used in space and time. Such changes can roughly be grouped in three periods each with unique landmark changes.

3.1 The genesis of sectoral policies, laws and institutions

This period covers the decades between 1898 and 1963 when the country was under colonial rule. Generally the authorities made policies and laws that not only enhanced production but also preserved forests, wildlife and soils and enforced them without persuading the indigenous people. The colonial administration applied principles of conservation according to the letter. Settlers who had the habit of destroying natural resources in their bid to expand their agricultural activities ceased to do so.

Everybody feared the consequences of breaking the law and the destruction of forests, wildlife, wetlands, soil loss was at a minor scale. The indigenous Africans, were subjected to punitive laws. Indeed this was an era when the laws stated in the various statutes were applied and followed to the letter. It was an age of mechanical application of scientific principles without

regard to the needs, responsibilities and capacities of the local communities in managing natural resources.

This age could be called the "golden era" for natural resource conservation in Kenya because there was little destruction of the resources. Clearing of indigenous forests was minimal. Wildlife protection was probably at its best. There was no economic pressure to reclaim wetlands. But, soil loss within the areas reserved for Africans was significant.

3.2 The benevolence age

This period spans from 1963 to about 1983. These decades were the "competence test" for the new government after independence. The new government introduced a human face in the application/enforcement of the sectoral policies and laws on conservation of the natural resources, which had been put in place prior to independence. But the government did not attempt to improve on them. For instance the forced use of bench terracing for soil erosion was stopped. Forest reserves such as Marmanet, Mt. Elgon, Mt Kenya, Lamu were de-gazetted and converted into settlement schemes for the poor and landless who had been displaced by the white settlers. The punitive fines for fishing and poaching wildlife were discarded.

Although the politicians were reluctant to stress the colonial conservation policies for fear of being associated with the draconian conduct of the colonial government, the new government established a central policy position in Sessional Paper No. 10 of 1965, which recognized the need to conserve natural resources for future generations. The concern to balance conservation of the resources with the need to exploit was incorporated in the national development plan. Subsequently the government established the National Environment Secretariat which spurred this policy into development planning. Subsequently, the United Nations Conference on Human Environment (UNCHE) facilitated the location of the United Nations Environment Programme in Kenya in 1973.

In the 20-year period, natural resources management and environmental protection enjoyed unprecedented political goodwill and support form the highest office in the land. Resource conservation was part of the political agenda. This enabled technocrats to introduce some meaningful changes within the sectoral polices and international protocols. This was reflected in an upsurge in the development of environment and natural resources institutions, and schools of wildlife management and environmental studies. The question of appropriate technology took center stage in the development process.

Overall, excision of forests was slower. However, wildlife went through the most dramatic loss especially between 1975 and 1983 when 'politically correct poachers' nearly decimated the large herbivores in the country. The wildlife saga was actually the first impact of high-level corruption. Soil erosion worsened until about 1975 when economic realities and good extension packages in NSWCP reversed the trend.

3.3 The dark age

The period between 1983 and 2001 could be considered in this country as the age of ironies and contradictions. Sectoral policies, legal and institutional reforms were at an advanced stage. The application of appropriate technology was brought within the policy environment to influence sustainable utilization of the natural resources.

In addition, rational programmes emerged in response to international protocols and cooperation. In 1996, six East African countries decided to pool resources under the auspices of IGADD to fight natural resource degradation. In 1987 the government took practical steps to integrate development and environment on a sustainable basis following the provisions of the report "Our Common Future" by the Brutland Commission. In 1989, the government in response to the UNEP General Assembly and the United Nations Conference of Environment and Development (UNCED) placed high priority on integrating financial, scientific and technological resources in the national programmes to reduce the degradation of natural resources.

Despite all the gains at technical and policy level, there was no political will to support conservation of natural resources. Some individuals and private citizens destroyed forests, wildlife and wetland areas with impunity because of the short-term political survival interests, and high-level corruption in the power structures and government system. All the policies, laws and institutions charged with sustainable utilization of the natural resources were ignored. Forests were excised and converted into private land without regard of their role as a public good. The international community has pumped billions of shillings into the Kenya Wildlife Service (KWS) to protect wildlife resources. Although the Ramsar sites have been officially declared, there still are cases of individuals acquiring beach plots along Lake Naivasha as evidenced by the spirited resistance of the Naivasha Riparian Owners Association. The Export Promotion Zones in the industrial area of Nakuru also discharge waste into Lake Nakuru.

Water and wetland resources, however, have borne the brunt of decline during this period. Despite significant awareness creation in the development and conservation of water resources, pollution steadily increased.

Shifts in policy, legislation and institutional land-use practices have over the years brought about changes in the way land-based resources have been used in space and time. Such changes can roughly be grouped in three periods each with unique landmark changes. These periods include the age of hegemony during the colonial period; the benevolence age immediately after independence and the dark ages today.

Chapter Four
Towards a national land-use policy

4.1 Justification

It is clear from the above that the current trend of using land will lead to a gloomy future if the status quo is maintained. Pollution will continue; destruction of water catchments will increase leading to cessation of flow of major rivers and limiting water and power supplies; land-use conflicts over arable land; water and pastures will escalate; the savannahs and grasslands will be subjected to severe desertification due to expanding agricultural activity, overgrazing and the search for fuelwood. Loss of biodiversity will accelerate the collapse of the life-supporting ecosystems.

The Kenya Land Alliance (KLA) formed in 1999 is advocating for formulation and implementation of a National Land Policy and a review of land laws. The initiative to create an institutional framework for land laws and land policy advocacy in Kenya was necessitated by the realization that the policy, legal and institutional framework created in 1950s is inappropriate because of the many changes in the social, political, economic and cultural fronts in the country today. The increase in population has resulted into a heightened competition for access to land and natural resources. In addition the changes in the global environment have combined to create a significantly different reality. It is in the face of this reality that KLA has consolidated all efforts towards effective advocacy for land policy and land law reforms in Kenya, as a contribution to the constitutional review process.

4.2 The choices to be made

The possible future scenarios regarding the natural resources available for use in Kenya revolve around three key areas: i) The national land-use patterns; ii) the evolving policies and legislation with respect to natural resources in particular; iii) the related sectoral policies and how they affect the entire economy, and the effects of technological innovations and other global changes.

Scenario 1
Maintaining the status quo

This scenario involves maintaining the status quo characterized by an increasing population, and the projected trends of the current land-use practices worsening following the search for additional land. The situation could accelerate migration into ASAL areas as a large proportion of the growing labour force find affordable settlements but to the detriment of forests and rangelands. Pollution and technology abuse will continue unchecked. There will be little improvement in governance because of little political goodwill in enforcing

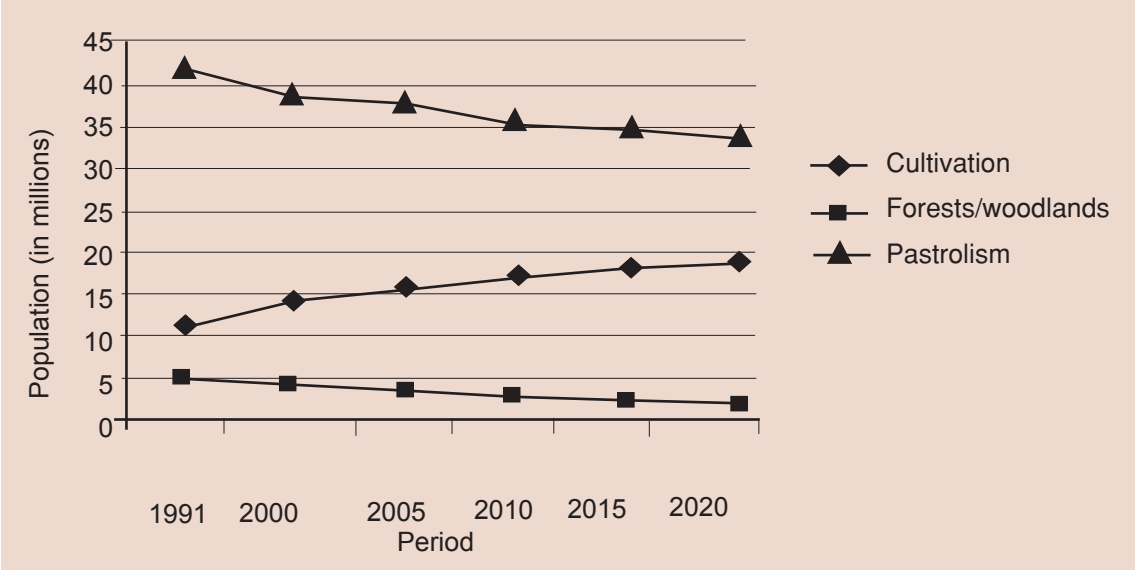
policies and legislation. Corruption in every sector of the economy continues.

The consequences of this scenario will be severe particularly in the area of wildlife conservation and the environmental protection. Continuation of the current trends in land use implies that the area under crop production is likely to increase to approximately 15.0 million ha by the year 2005, with a corresponding decrease in forest and woodlands. There will be more encroachment on forests and rangelands, increased settlements and cultivation in ASAL that would lead to environmental degradation and destruction of water catchments. Agricultural expansion into the ASAL will be uneconomic in the long run due to the ecologically fragile state of the region. Expansion of large scale agriculture into wildlife and pastoral areas and commercial ranching, and smallholder agriculture will increase. The expected land-use changes are shown in figure 11.

Continued land-use conflicts are expected among such activities as smallholder irrigated agriculture, rainfed agriculture, pastoralism and wildlife, coastal tourism and exploitation of the wetlands in districts such as Tana River.

There will continue to be less room for roaming wildlife. The stock of wildlife in both reserves and national parks will reduce leading to possible decline in the volume of both local and international tourists. There will be increased pressure on wildlife conservation and protected areas to be opened up for settlement and agriculture. The pressure to allow access to parks for dry-season grazing is already on the increase especially in Narok and Taita Taveta districts. The communities claim that the parks were their ancestral lands and therefore have grazing rights, as they never receive any tangible gains from tourism.

Figure 11. Projected land-use trends



Source: Institute of Economic Affairs, 1999

There will be increased loss of biodiversity to unplanned human activities leading to a breakdown in the life supporting systems. Destruction of catchment areas will lead to cessation of river flow and affect the water sources and supply systems, loss of scenic beauty and irrigation potential. Unchecked increase in pollution and destruction of the natural resources will inevitably occur without good political will, sound policies and laws.

Scenario 2
Instituting a rational national land-use program by chance

This scenario assumes that the goodwill of individual citizens and donors and sectoral reform will at some foreseeable future lead to rational use of land in the country.

Under this scenario the land resources may undergo positive gains. Such gains may be in the form of increased open-canopy forests on private lands and the reduced rate at which land is converted for cultivation. Land-use intensification will continue (as emphasized in Sessional Paper No. 2 of 1994 on National Food Policy). A draw back to this scenario is the high costs involved and lack of political will. This will slow down the implementation process. High capital investment for the development of agricultural innovations, building farmer capacity through training, and creating public awareness will remain a dream. There will be no strict land-use control system to ensure that proper land-use practices are established in all places in accordance with appropriate zoning ideals.

The best that one can expect from reliance on a goodwill scenario is the intensification in use which lessens the pressure on land. Forest destruction may be reduced by about 1.5% annually. It also implies that a total of 11.5 million ha will be saved from conversion to agriculture by the year 2020 (table 28).

If implemented, intensification of agricultural land will have tremendous positive effects on the overall status of natural resources particularly availing more land for other land uses such as pastoralism, water catchment, conservation, wildlife and settlement.

Table 28. Changes in land use and projected requirement

Land use	Land requirement (million ha)					
	1995	2000	2005	2010	2015	2020
Status quo (current agriculture)	10.6	11.8	13.1	14.3	15.5	16.7
Intensification of agriculture	10.6	11.8	10.5	11.5	12.4	13.4
Land made available by intensification	0		2.6	2.8	3.1	3.3
Remaining forest and rangelands						
i) Status quo	42.9	41.4	40.0	38.6	37.1	35.6
ii) With agriculture intensification	42.9	41.4	42.6	41.4	40.2	38.8

Source: Institute of Economic Affairs, 1999

To attain the scenario, high capital investment to develop appropriate technology and manpower will be necessary to sustain the changes. It will also require a strong government input, strategy reinforcement and goodwill for promotion of productive practices, especially the wider use of improved seeds, fertilizer and disease and pest control; promotion of increased intercropping and multicropping; provision of efficient support services including extension, research and storage and handling services in the agricultural sector; restructuring various institutions charged with the management of all the sets of natural resources in question; transformation of most of the policies and legislation related to sets of natural resources to levels that are compatible with the socio-economic, political, environmental and ecological realities.

The worst occurrence would be negative loss through de-gazzettment of the remaining important forest areas, grabbing of plots by some unscrupulous people, minor level of poaching, minor forest losses through fire and wood poaching, and loss of soils through soil erosion.

Scenario 3
Instituting rational land-use by choice

Scenario three will depend on the following assumptions.

- Population pressure is minimized as a result of the economic realities of the time. Policies and laws would have been strengthened and the institutions harmonized.
- That corruption will be eliminated when government embraces the principles of good governance and the entire population's ethics change against corruption. In addition, increased economic burden would rise to the level that people reject the status quo.
- It is further assumed that new economic opportunities would emerge alongside innovation and use of technologies that utilize natural resources at optimal levels.
- Introduction of multiple land use will depend on formulation of a national land-use policy enacted and enforced to guide and harmonize land-use planning activities. Though majority of the population will continue to depend on land for their economic welfare, they will be supported to practice the best economic and environmentally least harmful land-use practices based on land potential and local level land-use management plans with the active participation of local communities in setting out areas for specific and appropriate uses. The local people will be encouraged and supported to participate in land-use decisions and in the conservation of wildlife and biodiversity in the wider sense. Local communities would gain more from wildlife conservation than from alternative land uses.

The possible impacts of this scenario include more efficient use of the available natural resources, and an increase in the overall balance of natural resources. There will be an increase in biodiversity, wildlife population, rational use of ASAL and increased land equivalent ratio.

Introduction of multiple land-use systems alongside agricultural intensification therefore has tremendous impact on Kenya's natural resources conservation and environments. More land will be availed for use. There will be reduced destruction of natural resources and environment degradation. The welfare of landowners will be guaranteed through diversification of their economic base and production strategy especially in the ASAL where climatic conditions are unpredictable.

Two major conclusions can be drawn from the three scenarios.

The best option is Scenario 3: Instituting rational land-use by choice, where a deliberate effort is made by all sections of the Kenyan society to institute a rational land-use programme. This requires commitment, goodwill and a change in attitude amongst the peoples of Kenya. It will require a facilitative environment (technological innovations including use of traditional skills and indigenous knowledge, rational policy, legal and institutional framework as well as collective bargaining).

Scenario 1 is probably the worst option. Unfortunately it is the easiest to achieve since one ends there by doing nothing. Scenario 2 will introduce half-hearted measures through reforms driven by international protocols and donor pressure. The desired results will most likely happen by chance as the process relies on external initiatives and the goodwill of the populace. The current externally-driven reforms will perhaps lead to a rational land use by chance but over a long period of time. It is therefore reasonable to suppose that everybody, not government alone, is responsible for instituting a rational land-use plan nationally and each person should play their part in putting in place the transformation required for the realization of scenario 3.

4.3 The key elements of a national land-use policy

To review and put in place an appropriate national land-use policy, principles to guide the process should be enforced.

a) The guiding principles

The principles are aimed at guiding the manner and conditions under which appropriate use of land can be achieved. The appropriate land-use system must involve making decisions, choosing between options, accommodating diverse interests and presenting them as guidelines whose implementation must cater for the best interests of people individually, communally and as a nation. To achieve this, the system must be based on some mutually agreeable rationale that guides the decision-making process and the institutions in charge of the administration of land resources. The following are core guiding principles:

- The cultural integrity of the various peoples in Kenya relating to perceptions, rights, tenure systems, community institutions, conflict resolution among other value systems, must be respected and recognized as the basis for making decisions on land use and therefore superseding short-term

political interests. People resident in a given area should have first priority in determining access to land resources and providing time-tested conflict resolution mechanisms.

- Whereas it is important to meet the objectives of the people and those for national development when zoning land use, an equilibrium must be maintained for a suitable environment. Satisfying human needs should be balanced with the needs of other organisms in order to maintain the ecological linkages that sustain life.

- The State must ensure equity amongst the various categories of resource users, their production systems and ecosystem protection. The land-user rights and access by all citizens must be treated equally. The rights of access by future generations must not be compromised by the present generation.

- Access to, use and conservation of land resources must be based on a national system of resource allocation where various stakeholders, including the general public, participate in decision-making and administration through a forum where consensus is reached after compromises and concessions are voluntarily made.

- The 'Abuser Pays' principle needs to be embraced as a preventive measure. Liability for resource abuse should never be passed on but rather, the abuser of natural resources should be forced to meet the costs of rehabilitation.

b) The National Land-use Plan

For a national land-use plan to provide coherent, rational and coordinated guidance on the use of land resources in Kenya, it must be comprehensive and integrated and should aim to:

- Rationalize the use of land resources in line with the principles of appropriate use and sustainable development.

- Harmonize initiatives in the use of land resources so as to achieve an integrated and sustainable strategy for managing natural resources.

- Consolidate the inventory of land resources, and create a platform of strategic information for national land-use planning, resource allocation and resource management programmes.

- Provide a suitable institutional arrangement for a national early warning system that would alert the relevant policy and implementing agencies of the current and emerging threats to ecological and economic sustainability of the resources.

- Establish the guidelines that control and direct land-use and production systems, and technological choices for different ecological and social differences.

A national land-use plan can be developed using a national land-use planning process that entails the following.

c) Continuous land-use planning process

Since land is used for different purposes, it is important to select the appropriate purpose for a particular area that best serves the interests of all those involved. Different land uses such as pastoralism and sedentary farming in ASALs compete. The people living in a specific area usually consist of different groups with divergent interests in land and its resources.

Land-use planning therefore is a process of mitigating competing land uses and the diverse interests of people. The process balances three objectives:

- to maximize the use of scarce natural resources to meet socio-economic, political and cultural obligations of people.
- to ensure equity or fairness in the distribution of costs and benefits from the use of the resources among groups regardless of social background.
- to add value to natural resources. Land-use planning is therefore directed at the "best" use of the land.

The end result of the land-use planning process is a national land-use plan in which the country is zoned into areas suitable for various uses such as agriculture, conservation, cultural groves, industry etc. The development of the national land-use plan will spell out the responsibilities at the national, meso and local levels.

Land-use planning is a continuous process necessitated by the need for change; or arising from the development of national objectives. The process can also be triggered by national development plans such as the current focus on poverty eradication. Two processes should be undertaken simultaneously. Land evaluation to re-examine the suitability of land for the use and undertake what is commonly referred to as farming systems analysis to gauge the socio-economic constraints. In Kenya, such data exist in national institutes such as the Kenya Agricultural Research Institute and Kenya Forestry Research Institute, and with international non-government organizations such as The African Medical and Research Foundation and OXFAM.

Land evaluation is a critical step when carrying out a land-use planning process. It is the process of assessing the suitability of land for alternative uses. The process includes the identification, selection and description of land-use types relevant to the area. A suitability analysis is then conducted to determine the best use by matching the various land potentials and the positive as well as negative consequences of each land-use type. One of the key considerations is the level of current and future investment in terms of technology, which will alter the suitability ratings. The land evaluation process supplies the land-use planning process with alternatives for land resource use.

d) Environmental impact assessment

Environmental Impact Assessment (EIA) is the integration of the science of environmental analysis with the politics of resource management. It is a process of environmental planning and monitoring that ensures resource management is

sustainable. It is an action-oriented policy statement providing for a mandatory and public environmental impact statement over any development activity.

Environmental impact assessment focuses on the unpredicted costs of development programmes. For example water reservoirs may lead to diseases, weed problems, eutrophication and seismic effects. Health programmes may lead to drug resistance, water pollution or population increase. Irrigation projects may trigger diseases, water pollution, salinization or water logging. Increased agricultural production can pollute the soil, acidify it or lead to genetic loss.

It is therefore mandatory that land earmarked as suitable for one form of land use undergo thorough environmental impact assessment before implementing the programme and projects.

The newly enacted Environment Management and Coordination Act provides for Environment Impact Assessment before any major developments are undertaken that have a bearing on natural resources and the environment. Once the legislation is fully in force and the institutional framework for its enforcement is fully operational it should be possible for the environmental impact of major environment projects to be established and corrective and mitigation actions taken. However, as with every legislation, the greatest challenge is in the enforcement.

e) Incentives and penalties

Incentives and penalties need to be well defined to protect the natural resources and also the welfare of the people who depend on these resources for their livelihoods. Sanctions are best developed through a participatory process with stakeholders so that a compromise is reached between different parties.

Such sanctions will involve clearly defining the values to be protected. For example: human health safety and life support media such as water, soils, flora, fauna; use of a mixture of criminal, civic and administrative statutes to allow flexibility in administering incentives and penalties; a clear statement and an un-ambiguous list of crimes perceived as land resource abuse. They may include:

- Damage and permanent injury to the ecosystem
- Pollution which injures another human being
- Contributing to risk of injury to the environment
- Contributing to the risk of death or injury to human beings and other animals

The crime list would include:

- Released pollutant into the environment
- Operated a hazardous installation
- Handled toxic materials
- Contributed to damage of ecosystems
- Supplied false information on monitoring or
- Tampered with monitoring equipment

Incentives could involve a wide range of awards and tax exemptions for industrialists and other land users who use technology to preserve resources; the individuals who contribute immensely to knowledge on appropriate use of the land resources; clubs and groups who volunteer time, knowledge and resources to lobby for specific land-use issues need to be recognized by society and listed in the national heroes medal awards scheme.

f) A rational land-tenure system

Arable land in Kenya comprises 19.2% of total land, of which 2.2% is covered by forest. The remaining 82% is arid or semi-arid. About 24 million Kenyans live off 17% of the country's arable land majority of whom own tiny pieces of land or are landless. In Nyanza, Western and Central Provinces, the average land size dropped from 2 to 1.6 ha between 1982 and 1992 (Ogendo and Kosura, 1995). Over the same period 15–25% of the 5 million households in Kenya were virtually landless with no guaranteed access to land.

This situation has resulted from the suitable but scarce land being hoarded by the middle class in the high-value highlands and municipalities. There are also problems of gender where widows and youth have been dispossessed especially in trustlands inheritance process. This skewed access and distribution of land inevitably translates into sharp social differences leading to increased poverty, political marginalization of citizens because some are squatters.

The National Land-use Plan therefore needs to be supported by a national land-tenure policy which ensures fairness and equity in access and control of land and its resources; facilitates just and fast administration; has fair conflict-resolution mechanisms; spells out fair compensation mechanisms; and facilitates and protects informal leaseholds especially the landless who have farming skills but no purchasing power to own land.

g) Institutional re-arrangement

A national land-use policy with a well-articulated national land-use plan will require an apex, umbrella organization to integrate all the concerns in land resources and take the responsibility of implementing and enforcing the provisions of the policy.
A suitable institution would be a permanent national land-use commission. The commission would enforce the national land-use policy and implement the national land-use plan. It will stipulate the manner under which land resources can be accessed and used. The commission will take into account what cannot be compromised, the rights of the people, and the principles of conservation.

4.4 The assets to build on

a) The National Environment Action Plan (NEAP)

The NEAP was adopted in June 1994. The NEAP Report addresses environmental issues in an integrated cross-sectoral manner. The NEAP provides not only a strategy for achieving sustainable development in Kenya, but is a basis for translating

Agenda 21—the Global Programme of Action on Environment and Development—into an action plan. It shows the government's continued commitment to conservation and sustainable use of natural resources, as stated in the national development plans and policies. The enactment of an umbrella law for the management of environment (EMCA) in 1999, and the development of the National Poverty Reduction Strategy are key achievements of the NEAP.

b) The National Environmental Management and Coordination Act (EMCA) (1999)

This is an Act of Parliament that establishes an appropriate legal and institutional framework for the management of the environment in Kenya. The Act stipulates that there is need to improve the legal and administrative coordination of diverse initiatives in order to improve the national capacity for the management of the environment. The Act also provides that the environment constitutes the foundation in the national economic, social, cultural and spiritual advancement.

The general principle of the Act is that every person in Kenya is entitled to a clean and healthy environment and has a duty to safeguard and enhance the environment. The Act enforces the principles of sustainable development, namely;

- The principle of public participation
- The cultural and social principles traditionally applied by any community in Kenya for the management of the environment or natural resources
- The principle of international cooperation in the management of environmental resources shared by two or more States
- Intergenerational and intergenerational equity
- The polluter-pays principle
- The precautionary principle
- An effective administrative structure that consist of the following organs—

c) The National Environmental Management Authority (NEMA)

NEMA's main object and purpose is to exercise general supervision and coordination of all matters relating to the environment and to be the principle instrument of government in the implementation of all policies relating to the environment. The main responsibility is monitoring the state of the environment; advising the Government on issues of environment policy legislation; coordinating and harmonizing integration of environmental concerns during development planning; overseeing compliance with environmental laws, regulations, impact assessments and standards; and promoting environmental education and awareness.

d) The external goodwill

Over the last three decades there have been concerted efforts globally to direct attention to the management of the environment and natural resources and its linkages with social and economic development. International attention on natural resource management in Kenya picked up in 1972 after the United National Conference on Human Environment (UNCHE) which attempted

to integrate development and environment conservation as a way of stemming natural resource degradation.

According to the register of international treaties and agreements, Kenya ratified 36 out of the 152 instruments before independence in 1963. Most of the treaties date back to 1921. Between 1963 and 1973 —Kenya's first decade of independence— the country adopted 35 conventions. Between 1973 and 1983 forceful articulation and development of policies on environment and natural resource management was evident in Kenya particularly following the UNCHE and the Brutland Commission that generated the political will by locating UNEP in the country.

In 1977, UNEP initiated an action plan "Global system for combating desertification" which triggered Kenya to start preparing a national action plan of natural resource management. In 1980, the World Conservation Strategy was launched in Kenya with support from The International Union for conservation (IUCN), the Food and Agriculture Organization of the United Nations (FAO), and UNEP specifically to initiate a national approach to stop the environmental problems and diminishing natural resources. This was the precursor to the much-publicized National Conservation Strategy that yielded the National Environment Action Plan (NEAP).

In 1986, six East African countries resolved to pool resources to fight natural resources degradation under the auspices of the Inter-Governmental Authority on Drought and Desertification (IGADD). In 1987 the government started practical steps to integrate development and environment on a sustainable basis following the provisions of the report "Our Common Future" by the Brutland Commission. In 1989, the government in response to UNEP General Assembly and the United Nations Conference on Environment and Development (UNCED) started putting high priority on financial, scientific and technological resources into its national programmes to reduce the degradation of natural resources.

After the Rio Summit in 1992, virtually all the government programmes within the public investment programmes were based on the provision of Agenda 21. The immediate products have been the NEAP and the Environment and Management Act of 1999 that proposed the National Environment Management Authority [NEMA]).

The protocols come with financial and technical provisions that countries from the developing world could use to effectively manage their environment. Overall, Kenya has accepted 29 out of 54 conventions on environmental management. Trends between 1993–2003 show poor implementation of principles enshrined within the international protocols. It appears the political establishment does not support some specific provisions in the agreements. Also, the competence of professionals to manage such conventions has drastically been compromised. In addition, parliament has never been a key party to the treaty

provisions and therefore broad-based politics may be uncertain.

e) Traditional laws, skills, practices and institutions

The Loita Maasai, a sub group of the Masai pastoralists, inhabit the southern part of Narok District. Under the guidance of the cultural and spiritual leaders known as O'Loibon they have since colonial times, consistently and successfully resisted modern land tenure systems and natural resources management. Their cousins, the Purko Maasai inhabiting the northern part of the same district rapidly embraced modern land tenure systems and resource management. This, unfortunately, has resulted in a rapidly degrading environment. Conflicts arising from landlessness and lack of pasture emerged as large chunks of the grazing land were sold off to the wealthy who then converted them into wheat farms.

The Loita Maasai on the other hand enjoyed a healthy and well-managed environment. Their indigenous resource management systems continuously shielded them from drought.

Lpinguan Ranch has changed hands severally. First the Laikipia Maasai wrestled it from the Samburu. Later the Whiteman appropriated it after the 1911 Maasai Agreement and developed it into a livestock-breeding ranch under the name P&D Ranch.

Fifteen years after independence, the ownership reverted to the government under the Department of Settlements in the Ministry of Lands. The Samburu who had been squatting on the land made a claim to the ranch to which government verbally acceded. Taking the promise seriously, Samburu pastoralists from the larger Samburu District, together with a few Pokot and Turkana herdsmen, started occupying the ranch bringing with them large herds of livestock.

In four years, the productivity of the pastures declined from 6 t to 0.3 t per hectare due to overgrazing. The exposure of the topsoil accelerated soil erosion reaching losses of about 50 t per hectare per year. The water dams shrunk in volume or dried up. With the help of the Laikipia Wildlife Forum the old men sought security of tenure from the government so that they could invest their money, time and labour.

They worked on a management plan that would revive the productivity of their pastures. An immediate step in the plan was to secure tenure but to use the land to get the highest returns, through tourism. The ranch was not subdivided but individual plots would be issued to form the basis for buying shares from the limited company that would run the tourism facility. A small enclosed part of the ranch would host critical infrastructure tha would include a veterinary diagnostic laboratory, a livestock auction yard, a small stock-fattening facility, and grounds for grazing during drought.

Conclusion

The land-use problems facing Kenya today are due to the lack of an appropriate national land-use policy. The air is increasingly being polluted; water systems are diminishing in volume and deteriorating in quality. The land is threatened by desertification. The soils are being eroded and deposited in the ocean and lakes. The forests are being cut with impunity thus destroying the water catchments and the savannahs and grasslands are undergoing de-vegetation through overgrazing, charcoal burning and other inappropriate land-use practices.

The underlying causes of the deterioration of the life support systems (air, water and land) is a result of unsustainable land-use activities notably deforestation, bad irrigation techniques, overgrazing, fuelwood harvesting and charcoal burning. Others are pollution from industries, harmful agricultural practices and improper management of solid and liquid urban wastes. The ever-increasing population exerts pressure on the natural resources and drives the misuse of the resources; it is worsened by the cyclic occurrence of natural disasters such as droughts and floods.

The impacts of unsustainable land use are many. The decline in the supply of pastures and potable water fuels conflicts among pastoralists and between small and large-scale irrigation farmers. Poor quality of air and water increases disease risks in human beings and extinction of other life forms. Destruction of water catchments causes shortage of water and electricity supply necessitating rationing. Desertification reduces the productivity of land leading to food insecurity, reduced income and non-accumulation of economic assets. Eventually millions of families end up living below the poverty line. Currently, over 5 million households are unable to access basic needs such as food, medical care, and education and to meet other social obligations.

The current trend of deterioration will lead to a gloomy future for Kenya if the status quo is maintained. However, the entire Kenyan society can opt for rational land use through the application of wise-use principles. Striking a balance between satisfying the human livelihood needs and wise use of resources to ensure conservation for future generations is the biggest challenge.

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