REPUBLIC OF KENYA

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY(NEMA)

STATE OF ENVIRONMENT REPORT 2003, KENYA

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National Environment Management Authority, Kenya
P.O. Box 67839 Nairobi 00200
Tel: 020 605522; Fax: 020 - 608997
E-mail: dgnema@swiftkenya.com
Website: www.nema.ge.ke

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Mrs. Betty Nzioka	**National Coordinator, State of Environment (SoE) Report**

Editorial Team

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Prof. Ratemo.W. Michieka	Director General, NEMA

All Correspondence should be addressed to:

The Director General
National Environment Management Authority, Kenya
P. O. Box 67839 Nairobi 00200
Tel. 020-605522/3/6/7/; 601945, 608767, 608667
Mobile 0724 253398, 0733 600035
Fax: 020-608997
E-mail: dgnema@swiftkenya.com
Website: www.nema.go.ke

Printed by Advance Litho Limited
E-mail: advance@wananchi.com

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FOREWORD

Kenya's economy and the livelihoods of her people are dependent on the natural resources such as water, land, air, plants and animals. These natural resources are increasingly under pressure from unsustainable use resulting in environmental degradation. The challenge is to utilize our natural resources to develop the economy while at the same time saving the environment from the adverse impacts of pollution, soil erosion, deforestation and general degradation.

Since independence, the Kenya government has been advocating proper environmental management. This has been articulated in various government policy statements, directives and pronouncements, sessional papers and development plans. However, there was no strategic approach for integrating environmental concerns into the development planning process until the adoption of the National Environment Action Plan (NEAP) in 1994 and the consequent Sessional Paper No.6 of 1999 on the Environment and Development. The 1994-1996 Development Plan set out policy guidelines for improved environmental protection and sustainable national development.

State of Environment Reports are accepted worldwide as the means of reporting on environmental issues and of measuring progress towards sustainable development. This report provides scientific information that will form the basis for developing policies, formulating plans and initiating processes for the management of the environment in Kenya.

A State of Environment report for Kenya was last prepared in 1987. There was therefore an urgent need to assess the current state of environment of the country. The 2003 SoE Report for Kenya is the first one prepared by the National Environment Management Authority (NEMA) as mandated by the Environment Management and Coordination Act (EMCA) of 1999. It highlights various critical environmental issues revolving around six thematic areas namely: Population Dynamics, Human Settlements and Poverty; Land, Land Use and Biodiversity; Water, Human and Environmental Health; Energy, Pollution and Waste Management; Tourism, Trade, Industry and Mining; and Environmental Governance, Information, Emerging and Cross-cutting Issues.

The 2003 report on the State of Environment in Kenya identifies the driving forces that put pressure on our environment. The report also indicates the impact of environmental change and gives an overview of the policy and legislative responses the country has put in place towards the mitigation of environmental challenges in order to achieve sustainable development.

It is my honour and duty to forward on behalf of the Government of Kenya, the State of Environment report for Kenya in 2003.

Hon. Dr. Newton W. Kulundu, M.B., CH. B., M.P.
MINISTER FOR ENVIRONMENT, NATURAL RESOURCES AND WILDLIFE

PREFACE

The Environmental Management and Coordination Act (EMCA) of 1999 underscores the right of every person in Kenya to a clean and healthy environment and commits each and every one of us to safeguard and enhance the environment. However, this can only be achieved if we are informed about the status of our environment. We should also be willing to participate in environmental management. The National Environment Management Authority (NEMA) is therefore pleased to present to the people of Kenya the State of Environment Report for Kenya, 2003. The report aims to serve as a roadmap on Kenya's journey to sustainable development.

The report documents the status and condition of the environment in Kenya as at 2003. It highlights the critical environmental issues relating to how well we managed and/or mismanaged our natural resources in the year under review. This report details the factors or the pressures that have, at times, forced us to use our natural resources unsustainably, or degraded and polluted the land as well as our water and the air. It is evident that many laws and regulations for the management of the environment have not been effectively enforced. The NEMA Board of Management has developed a strategic work-plan, which includes modalities for delegating enforcement powers to lead agencies as required by the EMCA.

The Board is eager to ensure that NEMA and the lead agencies move fast in enforcing measures that promote good environmental management for sustainable development. It is my sincere hope that this report will provide a scientific basis for integrating environmental concerns and values into the national development policies, programmes, and action plans. The report should also create the necessary public awareness and commitment to conserve the environment as well as facilitate the mobilization of financial resources for the conservation of Kenya's environment.

This report was prepared in a participatory and consultative process involving many stakeholders from grassroot to national levels. I look forward to having environmentally sensitive development plans and projects that permeate every sector of our economy to ensure that every Kenyan lives in "**a clean and healthy environment**".

Prof. Canute P. M. Khamala, Ph.D, F.R.E.S., F.K.N.A.S.
CHAIRMAN, NEMA BOARD OF MANAGEMENT

ACKNOWLEDGEMENT

The State of Environment Report, 2003 was prepared by the National Environment Management Authority (NEMA) in accordance with the provisions of Section 9 of the Environment Management and Coordination Act (EMCA) of 1999 and Sessional Paper No. 6 on Environment and Development of 1999. The exercise is a follow-up of recommendations contained in Chapter 40 of Agenda 21. This is the first SoE report for Kenya under the new environmental law. It provides baseline information on the state of the environment.

I acknowledge with appreciation, the valuable information provided by experts from government departments, research institutions, universities as well as the private sector, which has assisted immensely in the preparation of this report.

I wish to extend my special thanks to all members of the technical task forces from the districts to the national level for their efforts in collecting information and putting the report together. I also thank members of staff of NEMA who have worked tirelessly to prepare this report. My gratitude also goes to the NEMA Board of Management and the National Environment Council for their technical and policy guidance during the entire process of preparing this SoE report.

I further wish to thank the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP) for their technical, financial and moral support towards the preparation of this report.

It is my sincere hope that this report will go along way in updating Kenyans on the current status of our environment and re-committing them further to the noble goal of ensuring a ***"clean and a healthy environment for all people in Kenya".*** The report will make a basis for future initiatives on sustainable development activities and comparative analyses.

Prof. Ratemo W. Michieka, Ph.D, EBS
DIRECTOR GENERAL

EXECUTIVE SUMMARY

Background

Kenya participated in the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992 and supported the provisions of Agenda 21 and other Declarations and statements of principle. Agenda 21 called *inter alia* for improved environmental information for decision-making. State of Environment (SoE) reporting has since been accepted worldwide as a standard tool for measuring progress towards sustainable development.

The Government of Kenya is committed to achieving sustainable development in accordance with the Principles of Rio Declaration and Agenda 21. In this connection, the Government developed the National Environment Action Plan (NEAP), 1994 and subsequently enacted the Environmental Management and Coordination Act (EMCA) no. 8 of 1999. EMCA created the National Environment Management Authority (NEMA) to be the principal agency of government in coordinating all matters relating to the management of the environment. This includes the preparation of a State of a Environment (SoE) report every year. The SoE report for 2003 is the first one for Kenya under the Act.

The 2003 SoE report provides baseline information on the status and condition of the environment in Kenya and it highlights critical issues and concerns within the various sectors. The SoE was prepared using a participatory process involving relevant lead agencies and other major stakeholders.

Country Profile

Kenya is located astride the equator and longitude 38^0 E. The total surface area of Kenya is about 587,000 km^2 out of which 576,000 km^2 is land area and 11,000 km^2 is water. The country has a great diversity of physical features including the Great Rift Valley. The population of Kenya was 28.7 million in 1999 and is projected to be 36.5 million in 2010. Sixty four percent (64%) of the economically active population depend on agriculture, which exerts considerable pressure on the natural resources leading to land degradation and poverty.

Population Dynamics, Human Settlements and Poverty

Population dynamics: The annual population growth rate has declined from 3.8 per cent in 1979 to 2.7 percent in 1999. Total fertility rate declined from 6.7 children per woman in 1989 to 4.7 in 1998. This is mainly due to the increase in contraceptive prevalence rate that rose from 17% in 1979 to 39% in 1998. Infant mortality rose from 62 per 1,000 live births in 1993 to 112 per 1,000 in 1998. Life expectancy at birth has also deteriorated from 58 to 54 years for males and from 61 to 57 years for females.

The high population growth has had adverse effects on the environment that includes encroachment of marginal lands, over-consumption of wood fuel resources as well as generation of waste products. The Government has adopted various policies and strategies to integrate population and environmental concerns into development processes. However, there are challenges that include ineffective programme implementation and their sustainability.

Human settlements: Human settlements are characterized by urban and rural settlements, housing and associated infrastructure. Rapid population growth and urbanization, coupled with low incomes and inefficient physical planning legislation has resulted in a shortage of appropriate housing, inadequate water and sanitation services, deteriorating road and transport system as well as shortage of energy supplies. The proportion of total urban population rose from 10% in 1969 to 27% in 1999. This growth has mainly been due to rural-urban migration, natural population growth, influx of refugees, boundary extensions for some municipalities and the creation of new urban centres. A large portion of new residents have ended up in the three primary centres of Nairobi, Mombasa and Kisumu. The impacts are falling living standards, polluted

air and water, unsanitary living conditions, increasing informal settlements and slums, wood fuel depletion, increased soil erosion and land degradation.

Poverty: Poverty is a major challenge facing Kenya today. It is estimated that about 57% of the Kenyan population are living below the poverty line. The relationship between poverty and environment is complex. The poor are often the victims of environmental degradation caused by other members of the society. At the same time the poor often engage in livelihood activities that result in environmental degradation. Poverty leads to over-use and destruction of natural resources where short-term development goals are pursued at the expense of long-term environmental sustainability. Environmental concerns in Kenya are mainly due to charcoal burning, over-reliance on firewood, tree logging and mining activities in rural areas and the impact of increased population, industries, traffic and slums in urban centers. The combined effects of these activities negatively affect the environment and reduce land potential, especially in the arid and semi-arid areas. This makes the struggle for survival hard and leads to severe over-exploitation of land and water resources. Kenyans, both in the rural and urban areas, face serious environmental problems that aggravate the poverty situation and make sustainable development an elusive goal.

Land Use and Biodiversity

Land use: About 17% of Kenya's total land area is of high and medium potential, while the remaining 83% is classified as arid and semi-arid lands (ASALs). The ASALs are considered to be of low agricultural production potential. Although the government has put in place policies and strategies to govern the use of land in a sustainable way, laws, regulations and practices that govern rights and obligations of landowners or occupiers are influenced by three broad land tenure systems, namely:

- Communal land tenure - governed by customary laws of the local community.
- Public land tenure - categorized into Trust land and Government land in terms of access rights.
- Individual land tenure - categorized into freehold and leasehold in terms of access rights.

Land use is largely influenced by a number of factors, the main ones being climate, socio-economic (culture and population dynamics – population size and densities) and government policies. However, the use of land changes with time.

Land degradation is the reduction of land capability to satisfy a particular use. Causes of land degradation include inappropriate land use, overgrazing, deforestation, poor irrigation, over-exploitation of aquifers, intensive tillage and cropping, recurrent droughts and climatic changes.

In Kenya, soil is a significant factor because of the importance of agriculture to the country and the mounting pressure upon land, constantly making this resource even more valuable. Soil patterns in Kenya are influenced by altitude, landforms, geology and climate.

Biodiversity: Kenya has a wide array of ecosystems, which include marine, coastal, freshwater and inland saline lakes. The majority of these ecosystems are rich in biodiversity. Coastal and marine biodiversity include mangroves, sea grasses, seaweeds, coral reefs, marine fishes, coastal birds, turtles and marine mammals. Coastal and marine species at risk include mammals, reptiles, molluscs and crustaceans.

Kenya has a wide range of agricultural biodiversity in plant, microbial and animal species. These species are important sources of livelihood (providing food, beverages, medicine, animal forage, oil production, fibre, hides and skins among others).

Forests rank high among Kenya's important resources and are an integral part of national development. In 1994, the gazetted forest resources covered 6,687,390 hectares. Forest uses include water catchment as well as providing energy, timber and support the wood carving industry. Threats to forests are due to: excisions, illegal logging, charcoal production, illegal cultivation, encroachments by settlements or agriculture, livestock grazing and subdivision in trustland.

Inland water ecosystems are habitats that contain a large variety of fauna and flora with varied physical and chemical features. These ecosystems include: Lake Victoria basin, Yala swamps complex, Sio port swamps, Lake Amboseli and Associated swamps, Tana River, Lake Turkana, Lake Baringo, Lake Bogoria, Lake Nakuru, Lake Naivasha and Lake Magadi.

Terrestrial invertebrates include all those organisms without a backbone and usually with an exoskeleton, which occupy dryland either above or below ground level. The majority are insects, ticks, mites, millipedes, centipedes, crustaceans, annelids, nematodes, worms (platyhelminthes) and other related organisms.

The Kenya Wildlife Service is mandated to conserve and manage wildlife since this resource has both monetary and aesthetic values. National parks, marine national parks, nature reserves, national reserves, marine national reserves, game sanctuaries, forest reserves, private reserves, biosphere reserves, Ramsar sites and proposed protected areas all occupy an area of 6,103,288 hectares. Wildlife is faced with challenges related to human/wildlife conflict, encroachment of protected areas (parks and reserves), transmission of wildlife diseases to man and livestock (zoonoses), land use changes, habitat fragmentation and degradation and poaching.

Water, Human and Environmental Health

Human and environmental health is crucial to sustainable development, while water has been recognized as an entry point to the same. It is estimated that Kenya has 19,500 million m^3 of renewable surface water converting to 650 m^3 per capita. This is expected to drop to 250m^3 per capita in 2025 when the population is projected to grow to 60 million. This is against a global recommendation of 1,000m^3, per capita and puts country in the category of chronically water scarce countries. This is a serious environmental challenge, especially in the low potential areas, which make up 83 % of the country, commonly known as arid and semi-arid lands (ASALs).

The current indicators in human health statistics give worrying trends as evidenced by the increasing child and maternal mortality rates, decreasing life expectancy and population decimation by the HIV/AIDS scourge.

Malaria accounts for over 30% of morbidity making it a leading cause of death. The HIV/AIDS scourge is the second leading killer after malaria, largely affecting the working age bracket, while the respiratory tract infections (especially tuberculosis) and water borne diseases are major human and environmental health challenges, which together make up the top ten causes of death in the country. The most common water borne diseases are diarrhoea, skin, intestinal worms related diseases, eye infection and malaria. These are caused by, among others, presence of heavy metals, pesticides and other chemicals in the environment. Chemicals of health significance include nitrates, nitrites, polychlorinated biphenyls, PCBs, dioxins, pesticides, DDT and heavy metals. Some of the government's responses include the development of guidelines for prevention and management of opportunistic infections, phasing out the use of streptomycin in 1999, Public Health Act enactment in 1994 and the Kenya Health Policy.

Development and use of natural and other resources exerts tremendous pressures on the environment with adverse effects. Industrial consumption of energy and raw materials, agricultural production, municipal and commercial activities results in the generation of various forms of waste that degrade water resources and the aquatic environment in general.

The distribution of rainfall in the country is very skewed to the disadvantage of the ASALs. This presents serious challenges in as far as water supply coverage for all uses is concerned and to meet the Millennium Development Goals (MDG) of halving the number of people without access to water and sanitation by the year 2015. Rainwater harvesting is expected to play a key role in addressing the gaps.

The status of surface, ground, wetlands, marine and coastal water resources give an indication of human and environmental health and the state of water quality and environmental pollution. Planting of eucalyptus at water catchment areas, poor soils and water conservation practices impact on water quantity. Catchment conservation and the socio-economic impacts of droughts and floods are also issues of concern.

Groundwater is estimated to be 619 million cubic meters or 14% of available national water resources. About 31% of this is located in deep aquifers, while the remaining 69% is in shallow ones. Over 14,000 boreholes have been drilled country-wide, whose average abstraction yield is estimated at 7 m^3/hr with about half of the boreholes drilled yielding less than 4.8 m^3/hr.

The impact of pollution on water resources is manifested by water of poor quality, which gives rise to toxicity to mammals and aquatic life; loss of aesthetic value rendering it unsuitable for recreational activities, high cost of water supply, eutrophication, deoxygenation, acid rain and habitat modification.

Cases of water use conflicts between the riparian and other communities have persisted and often intensified over the last four years.

Kenya participates in the East African country shared waters association. Other Existing Water use Agreements being reviewed include the Nile Waters Treaty, the Nile Initiative, Lake Victoria Fisheries Organization, EAC Protocols and NEPAD initiatives.

Kenya is prone to cyclic droughts, with the major ones occurring every decade and minor ones being experienced every three to four years. Nevertheless, localized severe droughts occur frequently in the country especially in the arid and semi-arid lands (ASALs).

Energy, Pollution and Waste Management

Kenya is a developing country and the development and use of natural resources exerts tremendous pressure on the environment. Such pressure is expected to continue increasing for decades to come, as the nation strives to attain an industrialised country status by the year 2020. Industrialisation involves increasing the quantity and quality of energy used, transformation of raw materials into high value goods and increased use of agrochemicals to improve agricultural productivity. These development activities are accompanied by generation of various forms of wastes into the environment.

Energy: The provision of energy services is essential for industrialization, social development and improved quality of life. Providing adequate, affordable energy is essential for eradicating poverty, improving human welfare, and raising living standards. The environment provides natural resources that are raw materials for the energy industry. These include wood fuels 75%, fossil fuels 18 %, hydro and geothermal powers 1.4% and others (radioactive minerals, isolation and wind) 0.2%. On the other hand, the environment is the recipient of the residues of thermal energy and solids, liquids and airborne wastes produced by other energy systems. Activities related to energy production, distribution and consumption are perhaps the largest single category of benign sources of adverse anthropogenic impacts on the environment.

Pollution of the atmosphere, especially indoor air pollution, has been linked to acute respiratory tract infections. Among the causes of such infections are emissions of sulphur and particulates from energy systems. Kenya has no known deposits of fossil fuels although petroleum based fuels are the primary movers of the domestic economy. Currently, consumption averages 2.3 million tonnes per annum. This contributes to air pollution owing to the large amounts of emissions they release into the environment when they are burnt.

The government recognizes the need for alternative, renewable energy sources, as a means of reducing tremendous pressure on woody biomass, through various legislative instruments. For instance, the Electric Power Act of 1997 facilitates and promotes rural electrification. However, high upfront costs and weak regulatory measures have hampered the development of renewable energy technologies.

Industrial Pollution: The manufacturing industry in Kenya plays a crucial role in transforming raw materials into high value goods, generates revenues and creates jobs, all contributing to poverty eradication and creation of wealth. However industrial processes are associated with exploitation of natural resources, destruction of habitats, generation of wastes and discharge of pollutants into the environment. The pollutants comprise gaseous emissions, obnoxious smells, particulate matter, liquid effluents, solid wastes, heat and

noise. They emanate from agro-processes, chemical and pharmaceutical plants, mining and metallurgical industry, among others.

Industrialization impacts negatively on the environment as the sector largely depends on old technologies such as leaded petroleum. The Mombasa oil refinery is not designed to produce unleaded petroleum and is estimated to cost Kshs. 300 million to modernise. Transportation of both raw materials and finished industrial products is currently done by road, as the railway transport is inadequate. Weak enforcement and monitoring procedures of the sector has led to the degradation of the environment through the uncoordinated disposal of industrial wastes.

There is need to enforce the provisions of the EMCA (1999) with regard to environmental impact assessments of new projects and auditing of existing projects in the sector to mitigate the negative environmental impacts.

***Municipal Waste*:** Kenyan urban population which has been growing at a rate of 8% per annum is now more than 27% of the country's total population. Generation of solid, liquid and gaseous wastes has been increasing at the same level as industrial development and the diversification of consumption patterns. Complexity of wastes, along with the rising socio-economic development, has introduced large portions of non-degradable wastes to the environment. These include plastics, scrap metals and other goods. Per capita waste generation ranges between 0.29 and 0.66 kg/day within the urban areas of the country.

Of the municipal waste generated in the urban centers, 21% emanates from industrial areas and 61% from residential areas. Generally, about 40% of the total waste generated in urban centres is collected and disposed of at the designated disposal sites. The rest of the waste, composed of chemicals including heavy metals, salts, detergents and medical waste, is either dumped in unsuitable areas or disposed off in rivers that traverse the urban centers and other wetlands. Some of the municipalities do not have designated disposal sites. The mode of waste transportation is not regulated and lacks coordination. Despite the poor level of service delivery, municipal authorities still continue to allocate substantial budgets to the sector. The decomposition of some wastes release into the atmosphere greenhouse gases such as methane and carbon dioxide. They also release into the soil and water systems, sulphur and nitrogen compounds. When burnt as a waste disposal method, paper, plastics, polythene materials and liquid hydrocarbons, release carbon dioxide and other pollutants into the atmosphere.

Of the 174 local authorities, only 32 have some form of sewage collection and disposal infrastructure, which were developed between 1972 and 2002. Two local authorities have mechanical sewage treatment works, while 30 have lagoons. The maintenance levels vary from one local authority to the other. Lack of enabling policies in the sector, has been identified as a gap in implementing waste management activities. EMCA 1999 provides for management of environment in relation to waste management.

Agro-Chemicals: Agricultural chemicals comprise pesticides and fertilizers. Pesticides include insecticides, fungicides, herbicides, acaricides, nematicides, fumigants/soil sterilants, rodenticides, hormones and insect repellents and attractants. Fertilizers include nitrogenous, phosphates, potassic and compound fertilizers, trace elements, foliar feeds and soil improvers.

Kenya imports large quantities of these agrochemicals averaging 5796.3 metric tons, at a cost of about Kshs.2351.7 million per annum. Agrochemicals have been extensively used for agricultural production without satisfactory management of their health and environmental impacts. Utilization of these chemicals results in emissions, improper dispersal and retention of poisonous substances in the air, water, soil and the human food chain. There is lack of adequate facilities and comprehensive guidelines and regulations for the management and disposal of the resulting wastes.

Tourism, Trade, Industry and Mining

For many years tourism was generally viewed as environmentally benign and hence seen as a key activity within the sustainable development strategy. It is now widely recognized that there is no 'zero-impact' tourism. In fact, tourism based on wildlife and white sandy beaches, which attract about 780,000 tourists to

Kenya annually, has tremendous impacts on the environment. The unique attractions, wildlife and wilderness have been destroyed through overcrowding and environmental destruction.

Tourism in Kenya today is almost exclusively centred within the coastline ecosystems and several national parks and game reserves. The adverse impacts of mass tourism in Kenya have been aggravated by over concentration of tourist activities in some areas of the country, notably the beaches of the North Coast and Diani in the South Coast, and some national parks and game reserves (Maasai Mara, Amboseli, Nairobi, and Nakuru). The concentration has occurred in spite of the fact that about 8% of the country has been set aside for conservation of wildlife and biodiversity. The six most popular parks (out of 57) alone accommodated 70.2% of all park visitors in 1995, while the top 15 accommodated 96.1% of all visitors. Moreover, visitation is also concentrated within some parts of the popular parks. In the Amboseli National Park, for instance, 80% of vehicle operates within 4% of the 390-km^2 park.

The majority of the industry's operators, however, routinely ignore environmental regulations. Mitigation efforts in the country are constrained by weak institutions; lack of coordination of institutions dealing with tourism and inadequate political and administrative capacity. Moreover, policy failure, including the lack of an effective land-use policy; inadequate incentives (such as secure property and access rights) to stimulate interest of local people in conservation compound the problem.

Sections of the Kenyan tourism industry have recently implemented some mitigation measures. These mitigations include the use of technology to minimize resource use and to treat wastes, recycling wastewater and other wastes. Other measures undertaken include the rehabilitation of degraded tourist attractions by planting trees and training staff on conservation. Partnership programmes involving the government, the private sector and local communities such as the Kenya Wildlife Service (KWS) and the Beach Management Programmes are achieving tremendous success.

Trade and Industry: Kenya's industrial sector is one of the largest in Sub Saharan Africa. Manufacturing accounts for 13% of the gross domestic product (GDP), a share that has remained constant since 1998.

The small medium enterprises (SMEs) are the fastest-growing part of the Kenyan economy. They account for a major share of exports and bulk of new jobs. According to the 1999 baseline survey there are over 1.3million SMEs in Kenya, employing close to 3.7million people and accounted for over 43% of Kenya's total export earnings in 2002. The sector also contributed 18% of GDP. While most SMEs are in the service sector, the one-quarter or so engaged in manufacturing produce an important share of industrial waste. It is estimated that the SMEs produce over 60% of industrial waste. SMEs are prevalent in industries with relatively high resource and emission intensity (e.g. metal finishing, leather tanning, dry cleaning, printing, dyeing, brewing, food processing, fishing, textile making and chemicals and mining. They are the major causes of pollution and resource depletion.

The cumulative and collective negative environmental impact of over 1.3 million SMEs in Kenya may even surpass that of large industrial establishments given that large industrial establishments are subjected by law (EMCA 1999) to environmental impact assessments (EIAs) and annual environmental audits (EAs). Unfortunately, the SMEs usually do not have the same levels of technology or employee training as large firms.

The current patterns of small and large industrial output in Kenya are associated with both the wasteful use of natural resources as well as the unmonitored release of emissions into the environment. As such the successful adoption of Cleaner Production (CP) strategies could provide an important solution to these problems

Mining: Mining is an activity that involves excavation of the surface and subsurface for the purpose of exploiting and processing minerals. These minerals are for economic and industrial development in local and foreign markets. Mining is a non-renewable resource activity with great potential. It occupies a small area of the land but it can have significant and often irreversible environmental impacts.

Mining activities often impact significantly on the environment. For instance, sand harvesting and quarrying, already shows some significant environmental impacts, including resource depletion, energy consumption, waste generation and emissions of air pollutants. The dangers to human life and health associated with mining include the displacement of people, land use changes, dust and noise pollution.

Environmental Governance, Information, Emerging and Cross – Cutting Issues

Environmental Governance: Environmental governance policies and legislations have evolved from important global fora such as the UN Conference on Environment and Development (UNCED), held in Rio de Janeiro, Brazil in 1992. The conference adopted *Agenda 21,* a global plan of action to achieve sustainable development. At the national level, the National Environment Action Plan (NEAP) was adopted in 1994 and this led to the enactment of EMCA, 1999.

The Kenyan Environmental Law consists of the legislation, standards, regulation, institutions and administration adopted to control activities on environmental management. These include the framework environmental legislation (EMCA 1999), and sectoral legislations. EMCA has provided institutional framework for the management of the environment from the national to the district levels.

Kenya is a signatory to several multilateral environmental agreements (MEAs) that address several sectors of the environment. Some of the MEAs Kenya has ratified include the Convention on Biodiversity (CBD), UN Convention to Combat Desertification (UNCCD) and the UN Framework Convention on Climate Change (UNFCCC). Other important MEAS include Ramsar Convention, the Montreal Protocol on Substances that Deplete the Ozone Layer, Convention on International Trade on Endangered Species (CITES), Rotterdam Convention on Prior Informed Consent (PIC) and the Stockholm Convention on Persistent Organic Pollutants (POPS). In 2001, a new African initiative on a recovery plan forming part of a New Partnership for African Development (NEPAD) was agreed to by the African Union (AU) Heads of States. This contains an Environment Component. Compliance to these agreements and their prompt domestication determines the extent to which the country benefits from the MEAs.

Data and information in Environmental Management: The main sources of environmental data and information include international organizations, United Nations bodies, public institutions, civil society, private, government ministries and departments, national research institutes, companies, research and academic institutions. The main issues of concern include data sourcing, quality, storage and management, access, dissemination and funding. The major constraints identified include inadequate capacities for access restrictions, collection, analysis, storage facilities, networking and funding.

Professional data networking will need trained personnel and adequate financial resources. There is need therefore for the establishment of fully equipped national and regional environmental information and documentation centres.

***Capacity*:** Insufficient capacity continues to hamper adequate environmental management. About fifty Community Based Organizations (CBOs) and Non-Governmental Organizations (NGOs) complement government efforts in capacity building, but their impact in reversing environmental degradation is low. Unpredictable funding and the slow rate of economic growth, compounded by donor conditionalities, means that less and less funds are committed to environmental management.

Financing for Environment: Public funding for environmental activities has always been low. For example, in the fiscal year 2000/01 the projected recurrent expenditure for National Environment Protection Programme was Kshs.14 million. However, the actual allocation was only 25% of the total requirements. During the same fiscal year, the District Environment support, a core poverty reduction programmme, was allocated only 14% of the total requirement of Ksh 70 million and covered only 32 Districts. In the consolidated multilateral and bilateral funding reports for the last 10 fiscal years, there has been a steady decline in funding from Kshs.34, Million in 1995 to Kshs.24 Million in 2000.

External funding, mainly multilateral and bilateral, provide insufficient funding for the environment. Other sources include private sector, micro-finance and voluntary contributions. Future innovative fundraising initiatives for environmental policies will be valuable sources of income.

Emerging and Cross-cutting Issues:. Poverty, in association with unsustainable livelihoods, put undue pressure on natural resources. This accentuates the vicious cycle of high population growth rate, poverty and environmental degradation. The elusive peace and security in the neighbouring countries, results in an influx of refugees whose three camps in fragile ecosystem areas in the arid and semi–arid areas of north eastern Kenya, impact negatively on the environment and the societies affected.

Civil strive and resource use conflicts such as sand harvesting in Machakos and mining in Taita Taveta districts adversely affect the environment. Terrorism is an emerging phenomenon with potential significant impacts on the environment.

The environmental impacts of disasters like flooding in Budalangi Division of Busia District is enormous. The declaration of HIV Aids as a national disaster recognizes it also as a major challenge in environmental conservation. Global fiscal policies like liberalization of the economies retarded efforts and reversed gains in some environmental conservation initiatives. The ongoing processes of gender mainstreaming at all levels of social strata is a welcome response since women are stakeholders in environmental management.

Transboundary and regional initiatives for the conservation of shared resources straddling international borders need to be pursued. Strategies must also be established to tackle environmental challenges posed by the spread of invasive and exotic species. And lastly, the application of biotechnology needs to be approached with care to avoid unmitigated environmental impacts of genetically modified organisms (GMOs).

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AAK	Agrochemicals Association of Kenya
ACFC	Agro Chemical and Food Company
ACZ	Agro-climatic Zones
AIDS	Acquired Immunodeficiency Syndrome
AG	Attorney General
AGOA	Africa Growth and Opportunity Act
AMREF	African Medical and Research Foundation
ASAL	Arid and Semi Arid Lands
ASK	Agricultural Society of Kenya
ASL	Above Sea Level
BOD	Biological Oxygen Demand
BTS	Base Transmitting Stations
CBO	Community Based Organization
CBS	Central Bureau of Statistics
CFC	Common Fund for Commodities
CGR	City Garbage Recyclers
CH_4	Methane
CHP	Combined Heat and Power
CITES	Convention on International Trade in Endangered Species of Flora and Fauna
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
COMESA	Common Market of Eastern and Southern Africa
CP	Cleaner Production
CPR	Contraceptive Preference Rate
DDT	Dichlorodiphenyl tricholorethane
DEAP	District Environment Action Plan
DEC	District Environment Committee
DFI	Direct Foreign Investment
DPSIR	Drivers, Pressures, State, Impact and Response
DRSRS	Department of Resource Surveys and Remote Sensing
EA	Environmental Audits
EAC	East Africa Community
EAPCC	East African Portland Cement Company
EE	Environmental Education
EEZ	Exclusive Economic Zone
EIA	Environment Impact Assessment
EDP	Environmental Development Plan
EMCA	Environmental Management and Coordination Act
EMs	Effective Microbes
ERS	Economic Recovery Strategy
ESH	Environmental Sanitation and Health
EAWLS	East African Wildlife Society
FAO	Food and Agriculture Organization of the United Nations
FPEAK	Fresh Produce Exporters Association of Kenya
GATT	General Agreement on Trade and Tariffs
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Green House Gases
GMOs	Genetically Modified Organisms
GNP	Gross National Product

GoK	Government of Kenya
GPE	Global Private Enterprises
GPI	Global Pollinator Initiative
GTZ	German Agency for Technical Cooperation
HACCP	Hazard Analysis Critical Control Point
HIV	Human Immunodeficiency Virus
H_2S	Hydrogen Sulphide
HMPL	High and Medium Potential Lands
IAEA	International Atomic Energy Agency
IAS	Invasive Alien Species
ICDC	Industrial and Commercial Development Corporation
ICIPE	International Centre for Insect Physiology and Ecology
ICPD	International Conference on Population and Development
IGAD	Intergovernmental Authority on Drought and Development
IMF	International Monetary Fund
ILO	International Labour Organization
ILRI	International Livestock Research Institute
IPM	Integrated Pest Management
IQ	Intelligent Quotient
ISO	International Standards Organisation
IUCN	International Union for Conservation of Nature and Natural Resources
IWRMS	Integrated Water Resources Management strategy
JICA	Japan International Cooperation Agency
JKIA	Jomo Kenyatta International Airport
KAM	Kenya Association of Manufacturers
KARI	Kenya Agricultural Research Institute
KATO	Kenya Association of Tour Operators
KEBS	Kenya Bureau of Standards
KEMFRI	Kenya Marine and Fisheries Research Institute
KEPHIS	Kenya Plant Health Inspectorate Services
KETRI	Kenya Trypanosomiasis Research Institute
KEMRI	Kenya Medical Research Institute
KFC	Kenya Flower Council
KIE	Kenya Industrial Estates
KIPI	Kenya Industrial Property Institute
KMD	Kenya Meteorological Department
KNCPC	Kenya National Cleaner Production Centre
KPC	Kenya Pipeline Company
KPLC	Kenya Power and Lighting Company
KPTC	Kenya Posts and Telecommunication Corporation
KSPCA	Kenya Society for the Protection and Care of Animals
KTDA	Kenya Tea Development Agency
KTDC	Kenya Tourism Development Corporation
KVDA	Kerio Valley Development Authority
KWFT	Kenya Women Finance Trust
KWS	Kenya Wildlife Service
LBDA	Lake Basin Development Authority
LGA	Local Government Act
LNGG	Lake Naivasha Growers Group
LNRA	Lake Naivasha Riparian Association
LPG	Liquified Petroleum Gas
LVEMP	Lake Victoria Environmental Management Programme
MCM	Million Cubic Metres
MDG	Millennium Development Goals
MEAs	Multilateral Environmental Agreements

MENRW	Ministry of Environment, Natural Resources and Wildlife
MoH	Ministry of Health
MORPW	Ministry of Roads and Public Works
MRWRMD	Ministry of Water Resources Management and Development
MPA	Marine Protected Area
MPND	Ministry of Planning and National Development
MSE	Medium and Small Scale Enterprises
MTEF	Medium Term Expenditure Framework
MW	Megawatt
MRI	Magnetic Resonance Imaging
NACADA	National Committee on Alcohol and Drug Abuse
NACC	National Aids Control Council
NALEP	National Agricultural and Livestock Extension Programme
NASCOP	National Aids and Sexually Transmitted Diseases Control Programme
NAP	National Action Programme
NBSAP	National Biodiversity Strategy and Action Plan
NCC	Nairobi City Council
NCPB	National Cereals and Produce Board
NCPD	National Council for Population and Development
NDP	National Development Plan
NEAP	National Environment Action Plan
NEC	National Environment Council
NEMA	National Environment Management Authority
NET	National Environment Tribunal
NEPAD	New Partnership for African Development
NGOs	Non-Governmental Organizations
NH_3	Ammonia
NIC	Newly Industrialized Country
NIP	National Implementation Plan
NIR	Non-Ionizing Radiation
NMK	National Museums of Kenya
NMVOCs	Non Methane Volatile Compounds
NO_x	Nitrous Oxides
NOC	National (Disasters) Operation Centre
NOCK	National Oil Corporation of Kenya
NPT	Non Proliferation Treaty
NPEP	National Poverty Eradication Plan
ODA	Official Development Assistance
ODS	Ozone Depleting Substance
OM	Organic Matter
PCBs	Polychlorinated Biphenyl's
PCPB	Pests Control Products Board
PCC	Public Complaints Committee
PEAPs	Provincial Environment Action Plans
PEC	Provincial Environment Committee
pH	Acidity/Alkalinity Scale
PHA	Public Health Act
PIP	Prior Informed Consent
POPs	Persistent Organic Pollutants
PPA	Physical Planning Act
PPCSCA	Permanent Presidential Commission on Soil Conservation and Afforestation
PPM	Parts per million
PRSP	Poverty Reduction Strategy Paper
REF	Radiological Emergency Response
PRTR	Polluter Release and Transfer Register

RCMRD	Regional Centre for Mapping of Resources for Development
RCU	Regional Coordinating Unit
RER	Radiation Emergency Response
RPB	Radiation Protection Board
SACCO	Savings and Credit Cooperative Society
SAP	Structural Adjustment Programme
SEA	Strategic Environmental Assessment
SERC	Standards and Enforcement Review Committee
SO_2	Sulphur Dioxide
SoE	State of Environment
SO_x	Sulphur Oxides
SWM	Solid Waste Management
TAC	Technical Advisory Committee
TARDA	Tana and Athi Rivers Development Authority
TB	Tuberculosis
TC	Tonnes of Cane
TFR	Total Fertility Rate
TRIPs	Trade Related Intellectual Property
TS	Tonnes of Sugar
UK	United Kingdom
UN	United Nations
UNCBD	United Nations Convention on Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	United Nations High Commission for Refugees
UNICEF	United Nations Children Educational Fund
UNLOS	United Nations Law of the Sea
USA	United States of America
VIP	Ventilation Improved Pits
WCK	Wildlife Clubs of Kenya
WHO	World Health Organization
WSSD	World Summit on Sustainable Development
WTO	World Trade Organisation
WWF	Worldwide Fund for Nature

CHAPTER 1

INTRODUCTION

1.1. Background

The Earth Summit held in Rio De Janeiro in 1992 adopted the global environmental strategy for sustainable development commonly known as Agenda 21. The Government of Kenya is committed to the Principles of the Rio Declaration and Agenda 21. This commitment is demonstrated by the development and adoption in 1994 of the *National Environment Action Plan (NEAP)*, which was followed by the development of the national policy on *Environment and Development* of 1999 and the enactment of the *Environmental Management and Coordination Act* (EMCA) in 1999. EMCA created an institutional framework for managing the environment, with the National Environment Management Authority (NEMA) as the key government institution for coordinating all matters relating to the management of the environment.

Agenda 21 called for improved environmental information gathering and reporting. The preparation of a national state of environment (SoE) report is now accepted worldwide as an important tool for articulating a country's environmental issues and indicting progress towards sustainable development. NEMA is mandated by EMCA (1999) to prepare and issue an annual report on the presentation by the Minister to Parliament for consideration and adoption. The SoE report for 2003 is the first one for Kenya under the Act.

1.2. Scope and Objectives

The 2003 SoE report for Kenya documents the status and condition of the environment in country. It highlights the critical environmental issues within various sectors of the country. The report analyses trends of various resources. The report will create public awareness on environment; promote networking and identified societal causes, pressures and impacts. It further identifies interventions and other responses societal pressure, and their impacts. It further identifies interventions and other responses sharing of information among lead agencies as well as facilitate the mobilization of resources for the conservation of the environment.

The SoE report consists of the following nine (9) chapters:

1. General Introduction
2. Country Profile
3. Population dynamics, human settlements and poverty reduction;
4. Land, land-use and biodiversity;
5. Water, human and environmental health;
6. Pollution and waste management;
7. Tourism, trade, industry and mining;
8. Environmental governance, information, emerging and cross-cutting issues;

The first two chapter presents background information on Kenyans whilethe subsequent six chapters report on their thematic areas. Each thematic chapter highlights the various responses instituted by the government. Each chapter ends by indicating the future outlook of the environment in the respective to the sector.

1.3. Report of the Preparatory Process

The preparation of the SoE report followed guidelines recommended by the United Nations Environment Programme (UNEP) and the United Nations Development Programme (UNDP). The guidelines are commonly referred to as the DPSIR model (drivers, pressures, state, impact and response). A secretariat of NEMA under the Director General coordinated the preparatory process for the SoE Report, 2003.

Overall, the Report was prepared through a participatory process and bottom up approach. The preparations were at both the district and the national levels. At the district level, a six-member SoE committee comprising key government agencies, private sector and civil society organizations prepared the district environment profiles. At the national level, professionals from lead agencies the private sector and civil

society organizations compiled the thematic chapters and enriched them with information from the district reports. It was reviewed by the NEMA Board of Management before presentation to the Minister for Environment, Natural Resources and Wildlife.

This State of the Environment will be used to create public awareness on issues affecting the environment. It will also be used to solicit support for actions intended to mitigate negative impacts and other critical environmental issues.

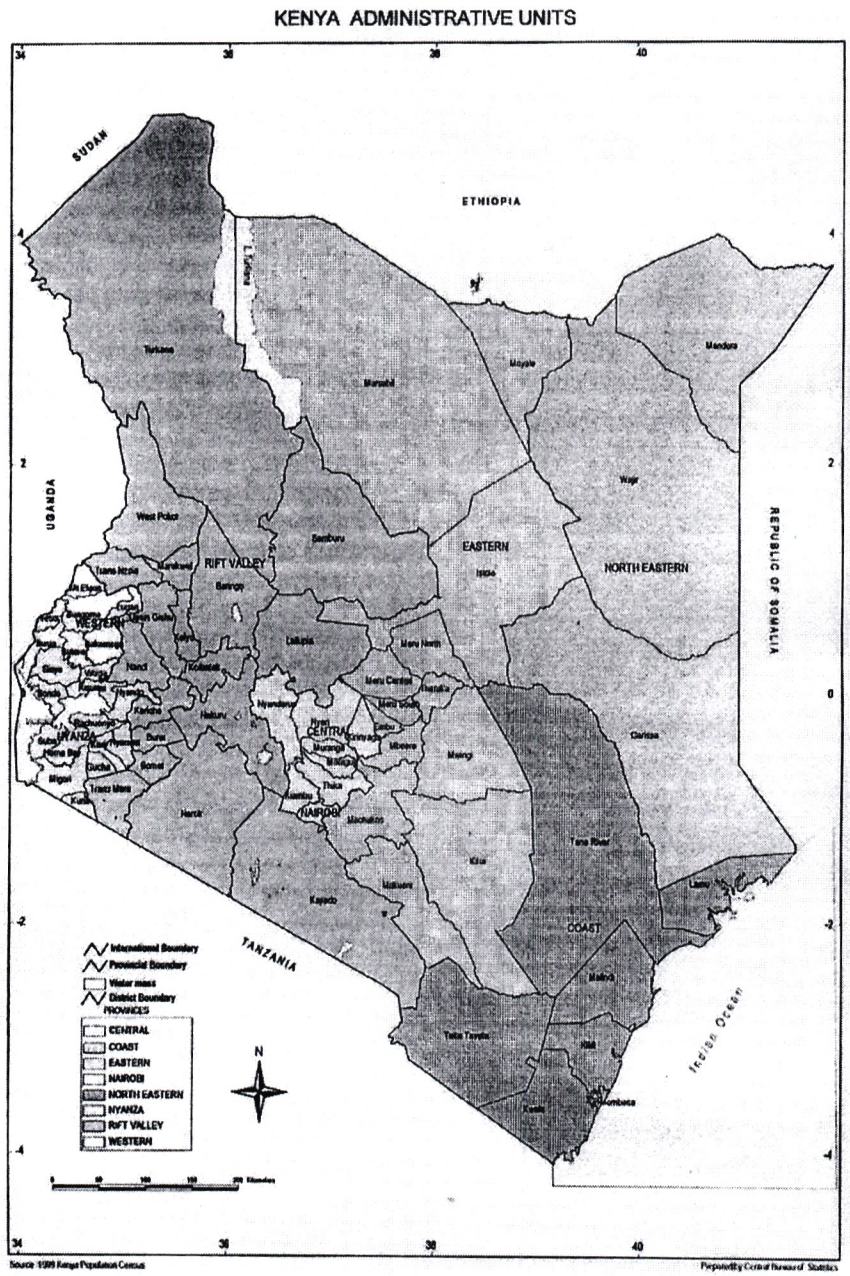
CHAPTER 2

COUNTRY PROFILE

2.1. Size and Location

The Republic of Kenya is located in East Africa approximately between latitudes 4^0 21'N and 4^0 28' S and between longitudes 34^0 and 42^0E. It is almost equally bisected horizontally by the equator and vertically by the 38^0 longitudes. It is bordered by Uganda to the west, Ethiopia and Sudan to the north, Tanzania to the south and Somalia and the Indian Ocean to the east. Kenya covers an area of about 587,000 km^2, of which 11,000 km^2 is covered by water (Figure 2.1).

Fig. 2.1 Administrative units of Kenya

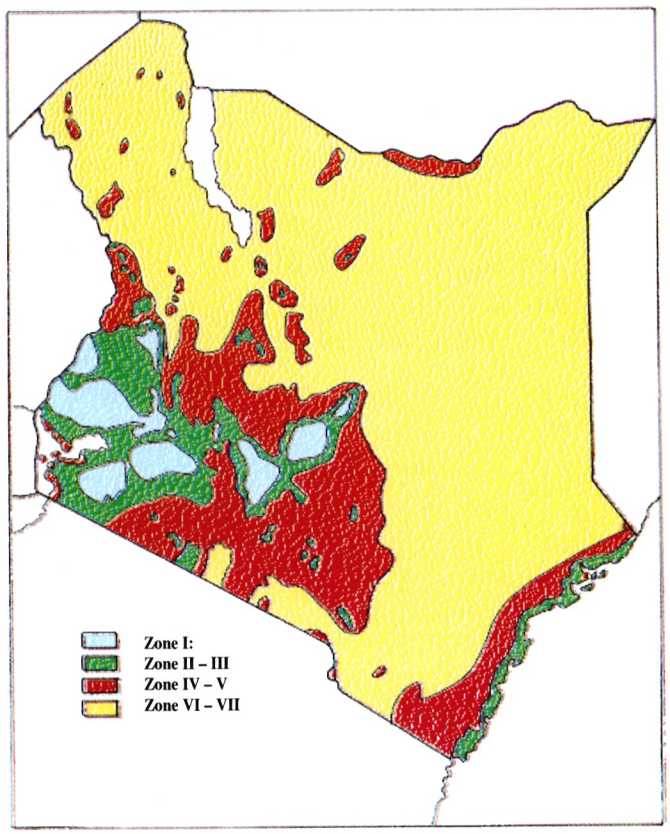


2.2. Physical Features

Kenya has a great diversity of landforms ranging from the coastal plains through a series of plateaux to the glaciated Mt Kenya peaks under permanent snow cover. The country is split by the Great Rift Valley, which is about 60 km wide and up to 330m deep. A large part of this valley is occupied by rangelands. The region immediately to the east of the Rift Valley lies at an average elevation of 2,000m above sea level and is dominated by Mount Kenya (5,230m), and by the Aberdare Mountain Ranges, which rises to almost 4000m. To the west, the country slopes down to Lake Victoria from the Mau Mountain Ranges (2000m). Mount Elgon (4,320m) is a volcanic mass on the western border with Uganda. The highlands, forming most of the southwest and central parts of the country have an elevation ranging from 1,400m to 2800m above sea level.

They receive high amounts of rainfall and have fertile soils. In contrast more than half of the country to the north and northeast is arid and semi-arid (Figure 2.2).

Figure 2.2: Ecological zones of Kenya



Source: Pratt & Gwynne, 1977; GoK, 1992.
Legend explanation:
Zone I: Afro-alpine moorland and grassland or barren land above forest line.
Zone II: Forests and derived grasslands and bush lands.
Zone III: Land of high agricultural value (intensive livestock and crop production), low forest potential.
Zone IV: Semi-humid, annual rainfall: 700 – 850 mm.
Zone V: Semi-arid, annual rainfall: 550 – 700 mm.
Zone VI: Arid, annual rainfall: 300 – 500 mm.
Zone VII: Very arid, annual rainfall: 200 – 300 mm.

2.3. Social-Economic Status

Kenya has experienced rapid increase in human population from 8.6 million to 28.7 million in the last four decades Kenya. The majority of the population is dependent on the immediate environment for their social and economic needs. About 64% of the economically active population is employed in agriculture. Land holdings are small and their outputs in the high potential areas meagre. Extensive pastoralism is prevalent in the 83% of the ASAL areas.

Since the mid-1980s there has been a sustained decline in economic performance with the country recording a negative growth rate in the year 2000. The declining economic performance is largely responsible for the persistent and increasing levels of poverty as well as social and economic inequalities. About 57% of the people are considered absolutely poor. Further more, disparity in income has been worsening over the years. The poor continue to receive less and less of the national income. For example, the bottom 20% of the population get only 2.5% of the income while 22% of the population receive 59%. Furthermore, regional disparities in terms of incomes and access to resources have increased, with rural areas being hard hit despite a majority of the population deriving their livelihoods from there.

Although agriculture is the leading sector in employment and other contributions to the economy, it has suffered from poor infrastructure, inadequate credit facilities and poor access to markets. The slow growth of the manufacturing sector stifled expansion in wage employment.

The informal sector is an important provider of employment for low skilled people. However, the sector has for a long time suffered from lack of coherent policy guidelines and favourable regulatory framework. This has slowed economic growth leading to little impact on the increasing level of poverty.

2.4. Political System and Governance

Kenya attained independence in 1963 from British colonial rule and established a representative system of Government with an elected legislature (National Assembly), an Executive headed by a President, and a Judiciary. Kenya has been a multi-party democracy except between 1982 and 1991 when it adopted a single party system.

Currently, Kenya is administratively divided into eight provinces including Nairobi. All provinces except Nairobi are divided into districts, which are further divided into Divisions, Locations and Sub-locations (Fig. 2.2). Government policies including environmental conservation are implemented through this hierarchical structure.

Under EMCA the Provincial Environment Committees (PEC) and District Environment Committees (DEC) are charged with overseeing the overall environmental management in their respective provinces and districts. The technical heads to these committees are the NEMA Provincial and District Environment Officers respectively.

2.5. Environmental Resources

Kenya is endowed with a wide range of natural resources both a biotic and biotic that form the basis of the people's livelihood and the economy. Natural resources such as water, air, minerals and soils support about 35,000 known species of animals, plants and micro organisms. The country's great diversity of biological resources provides food, fuel, medicine, wood, shelter and income. This wealth is fundamental to Kenya's economic prosperity in many ways including being a source of income, subsistence, employment and foreign exchange earnings.

However, these environmental resources are increasingly under pressure from unsustainable use, resulting in their depletion and general environmental degradation. Therefore, the poor socio-economic status of the people has far-reaching consequences for the country's efforts to conserve the natural resource base.

2.6. Regional and International Relations on Environmental Issues

Kenya's foreign policy fosters good neighbourliness, regional and international cooperation. Some of Kenya's vital regional and international interests revolve around shared natural resources and global commons. Kenya has endeavoured to cultivate good regional and international relations in the management of the environment.

Environmental issues are increasing playing an important role in international relations. Kenya has actively participated in negotiations leading to the adoption of various multilateral environmental agreements (MEAs) to regulate and conserve the environment. The main aim of these MEAs is to enhance the global responsibility in the management of the environment and natural resources. Kenya has been a signatory to MEAs as early as 1948. Kenya is committed to the implementation of these MEAs, including the United Nations Convention to Combat Desertification (UNCCD) United Nations Framework Convention on Climate Change (UNFCCC), United Nations Convention on Biological Diversity (UNCBD), Convention on International Trade in Endangered Species (CITES), the Ramsar Convention on Wetlands of International Importance, the United Nations Law of the Sea (UNLOS), the Basel Convention, and the Vienna Convention.

Kenya is also a party to several regional MEAs most of which seek to reinforce global ones by filling gaps, facilitating joint action and promoting mutual understanding in environmental policy and understanding among neighbouring states. They enable environmental issues to be treated on a regional rather than national basis, especially will regard to shared and transboundary resources.

CHAPTER 3

POPULATION DYNAMICS, SETTLEMENTS AND POVERTY

3.1. POPULATION SIZE AND GROWTH

Kenya's population in 1948 was about 5.4 million. The population doubled after two decades to reach 10.9 million in 1969. The total population was 23.7 million in 1989 and 28.7 million in 1999 respectively. The total population of Kenya is projected to increase to 36.5 million in 2010. The population growth rate in 1979 was estimated at 3.8 per cent. However, the intercensusal growth-rate fell from 3.4 to 2.7 per cent per annum in 1989 and 1999 respectively,

Currently, the Kenyan population is youthful as about 44% is less than 15 years old. Those aged 15-64 years comprise 54 per cent, while only 2 per cent is over 65 years old. The youthful structure of the population causes high dependency ratios and high demand for education. It also means that even if fertility rates are projected to continue declining, there will be a significant increase in the population in the near future as a large number of young women enter the reproductive age. However, economic growth rate has continued to fall from the early 1980s over the same period. Gross Domestic Product (GDP) in real terms declined from over 4% in 1990 to 3% in 1993, 1.4% in 1999, and 0.2% in 1999/2000 (Figure.8.2).

3.1.1. Fertility, Mortality and Migration

Fertility: The total fertility rate (TFR) fell from 6.8 to 4.7 children per women between 1962 and 1998. High fertility rates in the 1960s and late 1970s are attributed to low contraceptive rate, ineffective family planning programmes and socio-cultural and religious desire for large families and low education levels. The decline in TFR is partly due to increase in contraceptive preference rate (CPR), which rose from 17 per cent in 1979 to 39 per cent in 1998. There is need to maintain the 1989-1993 momentum so as to attain the national target growth-rate of 2.0 per cent by 2010. However, projections based on 1999 population and housing census indicate that TFR will be 3.6 children during the period 2005-2010.

Mortality: Rising standards of living, better nutrition, greater investments in sanitation and clean water supplies, expanded access to health services, and wider application of public health measures such as immunization ensure longer and healthier lives.

In the last decade both childhood and adulthood mortality has been on the increase. Infant mortality rate has increased from 63 per 1000 live births in 1993 to 71 per 1000 live births in 1998. Similarly, under five mortality ratio has increased from an estimated 365 per 100,000 live births in 1995 to 590 deaths per 100,000 in 1998. Regional disparities in mortality rates have persisted with urban areas recording relatively lower rates compared to rural areas. Life expectancy at birth declined in the 1989-1999 period from 58 to 54 for males and from 61 to 57 years for females. Some of the factors associated with this decline include increased child mortality, rise in HIV/AIDS deaths, increased incidences of deaths due to malaria and TB and the increased poverty levels.

The under five mortality during the 2005-2010 period is expected to be 108 per 1000 for females and 116 per 1000 for males. In the same period life expectancy is expected to be 47 years for males and 53 for females taking into account the HIV/AID pandemic.

Migration: People naturally move from low economic potential areas to those perceived to be of a high potential and thus offering greater opportunity for livelihood. Urban areas are seen to offer better livelihood opportunities. Consequently, the rate of urbanization has increased from 10 per cent in 1969 to 27 in 1999 (Table.3.1 and 3.2).

3.1.2. Population Distribution

About 70 per cent of the Kenyan population lives in rural areas mostly surviving on agriculture. Most live in high and medium potential lands in Western, Nyanza and Central provinces and in some parts of Eastern and Rift-Valley provinces (Table 3.3). Population density in the high and medium potential areas of these provinces is high and consequently land has been fragmented into small uneconomical units. Examples of these areas are Embu in Eastern province where 381 persons live in one square kilometer. Densities for Buret in Rift-Valley province and Kilifi in Coast province are 332 and 114 people in a square kilometre (figure 3.2). As a result of these relatively high densities, carrying capacity has declined substantially, forcing people living in these areas to seek opportunities elsewhere. Often people move to either marginal land or to urban areas or encroach on forests.

Table 3.1. Population movement in provinces

PROVINCE	IN -MIGRANTS		OUT -MIGRANTS			NET -M
	1979	1989	1979	1989	1979	1989
Nairobi	615,945	930,074	91,570	157,450	+524,372	+772,624
Central	191,102	242,969	465,253	639,782	-274,151	+195,183
Coast	222,229	275,123	47,983	79,940	+174,246	396,813
Eastern	89,966	136,465	263,957	400,378	+173,991	-263,913
N/Eastern	14,998	14,176	30,347	13,470	-15,349	-17,294
Nyanza	109,130	160,975	375,596	574,401	-266,466	-413,426
R/Valley	625,594	901,347	146,385	219,50	-479,209	+681,840
Western	103,181	149,289	390,808	556,658	-287,627	-407,369

Source: Government of Kenya, Central Bureau of Statistics. National Population Census 1948, 1962, 1969, 1979, 1989, 1999.

Table 3.2. Growth of urban centres by actual population size, 1962 – 1999

	1962		*1969*		*1979*		*1989*		*1999*	
Size of center	Towns (no)	Population (no	Town (no	Population (no)	Towns	Population (no)	Town (no	Population (no)	Towns *(no)*	Population *(no)*
100,000	2	523,079	2	756,359	3	1,321,566	6	2,371,158	20	3,316,603
20,000 – 99,999	2	61,707	3	79,582	13	568,099	21	822,971	82	3,852,778
10,000 – 19,999	3	44,005	7	685	11	149,756	19	257,775	18	259,564
5,000 – 9,999	11	69,862	11	71,396	22	154,181	32	232,259	23	154,187
2,000 – 4,999	16	49,002	25	81,886	42	122,094	61	194,554	51	170,380
Total	34	749,651	47	989,908	91	2,315,696	139	3,878,697	276	7,753,512
% of national total		7.8		9.9		15.1		18.0		27.0

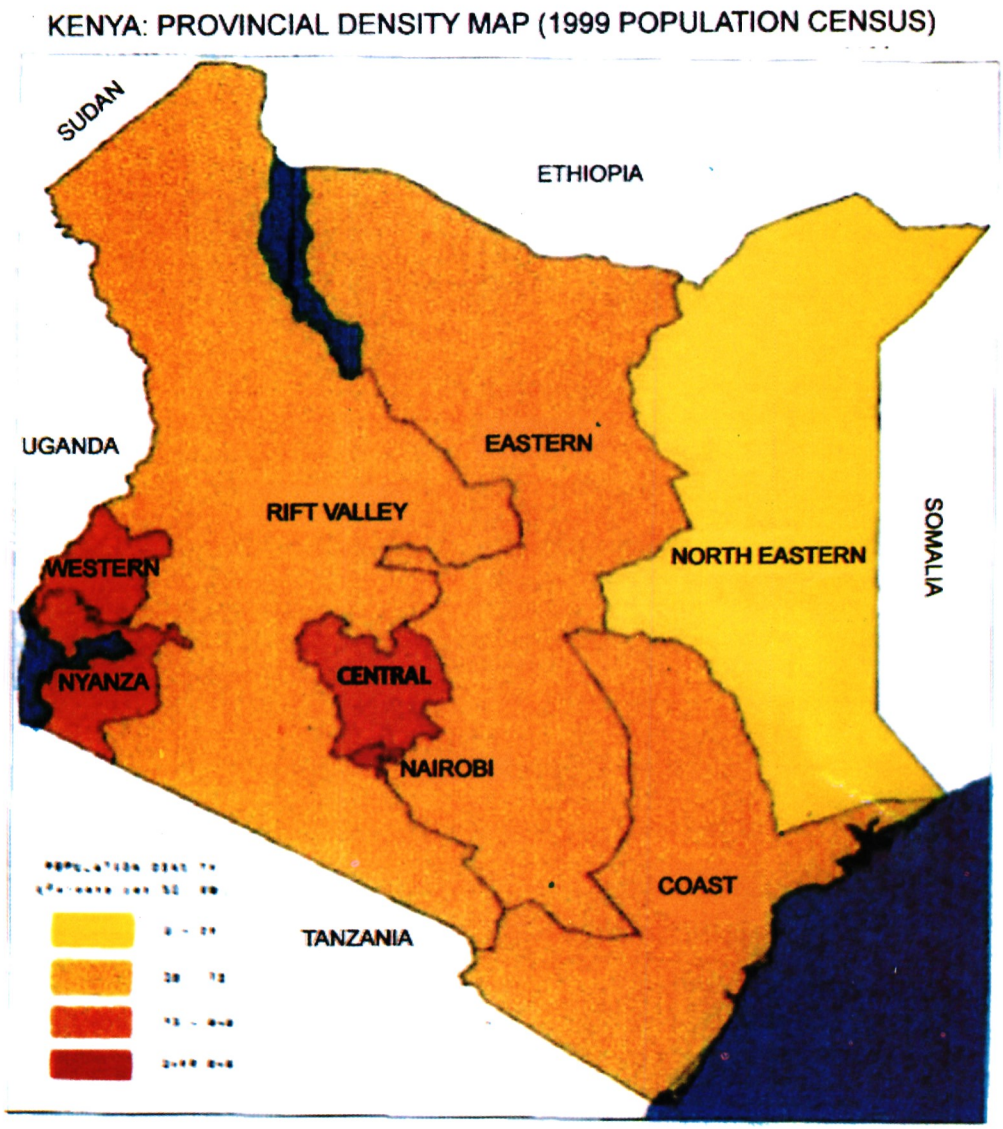
Source: Government of Kenya, Central Bureau of Statistics. National Population Census 1948, 1962, 1969, 1979, 1989, 1999.

Table 3.3. Distribution of population by province in 1999

Province	Area (km^2)	Households	Total Population	Density (persons per km^2
Nairobi	696	649,426	2,143,254	3,079
Central	13,220	924,545	3,724,159	282
Coast	82,816	527,427	2,487,264	30
Eastern	153,473	957,648	4,631,779	30
North Eastern	128,124	148,006	962,143	8
Nyanza	12,547	968,014	4,392,19	350
Rift Valley	182,539	1,494,981	6,987,036	38
Western	8,264	701,323	3,358,776	406
National Total	581,677	6,317,370	28,686,607	49

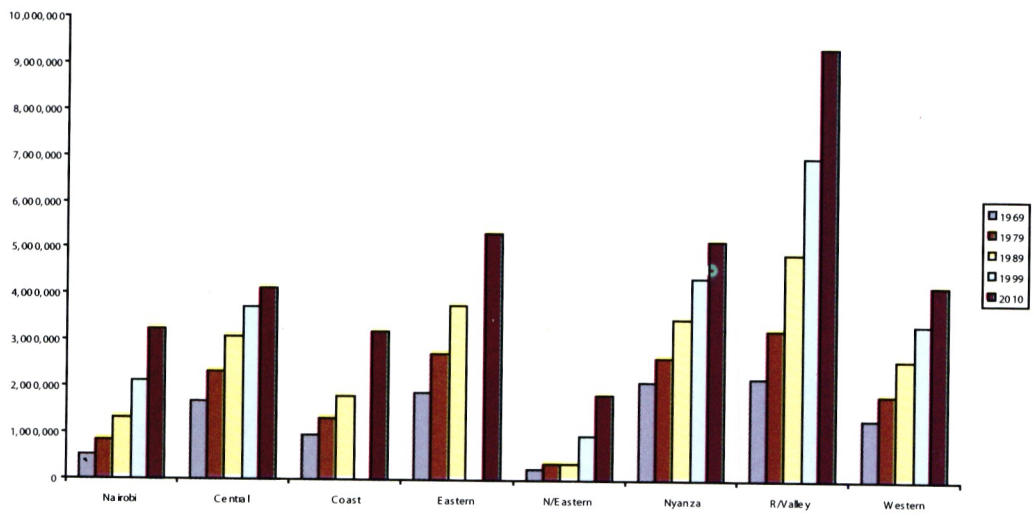
Source: Government of Kenya, CBS 1999

***Figure 3.1. Population density in Kenya*, 1999**



Source: 1999 Population and Household Census

Figure 3. 2. Distribution of population by province (1969-2010)



3.1.3. Impacts of Population Growth and Size on the Environment

Population increase over the years has exerted considerable pressure on land and related natural resources. The consequences include decline in forest cover over the years due to excisions done to settle the poor and landless lacking shelter and means of subsistence. Other impacts include soil erosion; deteriorating soil conditions, pollution from excessive use of fertilizers and pesticides; surface and groundwater pollution, deforestation, loss of indigenous plant and animal species; and destruction of water catchments areas.

Continued population growth and desire for land, have resulted in people settling in wildlife migration corridors and other wildlife habitats which have led to human-wildlife conflicts. The impact of these factors include decline in wildlife numbers over the years, (Table 3.4). Poaching has had a devastating impact on the elephant and rhino populations.

There is urgent need to develop response mechanisms to manage the environment sustainably in view of the dangers and potential human disasters which may be caused by increased demand for food production to feed the fast growing population without compromising environmental protection.

For a large number of Kenyans, inadequate access to basic means of living (food, safe water, shelter, healthcare and education) is an everyday reality. Wood-fuel provides about 70 per cent of the nation's energy requirements and 90 per cent of the rural energy requirements (Table 3.5). The demand for wood-fuel caused by the growing population is expected to continue increasing steadily, posing a major threat to existing forest resources and biodiversity. The challenge is how to reduce reliance on wood-fuel sources in order to reduce associated adverse impacts on the environment, especially our dwindling forest resource and general vegetation cover.

The single most important factor causing deforestation is the conversion of forest land to agriculture. Forest degradation through over-exploitation has led to a 45-65 per cent loss of standing wood volume in the last 30 years. The loss has been caused by vegetation clearing, overgrazing, and forest fires (either caused through carelessness during honey harvesting, shamba preparation or other careless uses of fire or through arson). The over exploitation of forests has resulted in a charcoal/wood-fuel crisis in the country. Harvesting of trees for charcoal has therefore moved to more ecologically fragile areas, especially water catchments and rangelands. As a result, there has been reduction of catchment values of forests. As the natural vegetation cover is destroyed through soil erosion and degradation the ecological conditions are changed and the possibilities for wildlife survival are reduced.

Table 3.4. Changes in wildlife and livestock populations, 1970s-1990s

Wildlife	1970s	1990s	Change	
			No.	%
Buffalo	35,453	30,187	-5,266	-15
Eland	25,775	19,123	-6,652	-26
Elephant	39,108	14,923	-24,185	-62
Gazelle Grants	247,491	103,208	-144,283	-58
Gazelle Thomsons	87,086	31,259	-55,827	-64
Gerenuk	42,918	21,418	-21,500	-50
Giraffe	62,255	50,080	-12,175	-20
Greater Kudu	233	45	-188	-81
Impala	116,177	67,934	-48,243	-42
Kongoni	29,606	18,521	-11,085	-37
Lesser Kudu	17,468	7,751	-9,716	-56
Oryx	53,653	25,824	-27,829	-52
Ostrich	25,716	33,871	8,154	32
Topi	93,822	92,934	-888	-1
Waterbuck	12,309	5,260	-7,049	-57
Wildebeest	224,404	173,354	-51,050	-23
Zebra Burchell	138,448	146,093	7,645	6
Zebra Grevy	10,364	4,868	-5,496	53
Camel	55,462	651,254	99,792	18
Cattle All	3,319,749	2,911,496	-408,254	-12
Donkey	95,059	85,350	-9,710	-10
Sheep & Goat	6,473,519	5,696,021	-777,498	-12
Total	16,913,308	10,190,773	-426,590	

Table 3.5. Percent of households by main type of cooking fuel by province 1989 and 1999

Province	Firewood		Charcoal		Paraffin		Others	
	1989	1999	1989	1999	1989	1999	1989	1999
Nairobi	2.9	1.8	8.7	4.1	68.4	75.7	20	18.4
Central	78.5	69.6	4	9	12.5	17.2	11.6	4.2
Coast	67.2	53.7	9.5	10.4	18.3	30.2	10.9	5.8
Eastern	84.8	84	6.1	7.1	6.6	6.7	8.2	2.2
N/Eastern	88.9	90.8	4.8	6.5	4.8	1.3	1.8	1.4
Nyanza	83.2	82.1	7.1	10.6	7.2	5.7	7.9	1.6
R/Valley	79.3	73.7	9.3	14.7	8.4	9.1	7.9	2.5
Western	86.8	87.3	6.2	7.3	5	4.2	6.4	1.2
Kenya	73	68.8	7.2	9.7	15.5	17.2	4.3	4.3
Rural	90.1	88.4	3.6	6	4.2	4.2	2.1	1.4
Urban	13.1	9.6	19.8	20.8	54.9	56.6	12.2	13

Source: Government of Kenya, CBS, National Population and Household Censuses 1989 and 1999.

Erosion is the main threat to arable land, which is the country's most important resource. Sub-division of family land into uneconomic parcels has forced some people to migrate to marginal and ecologically more sensitive areas. Cultivation in the arid and semi-arid areas has increased pressure on the nomadic cattle-raising people, resulting in overgrazing, erosion, and land use conflicts. There is evidence that these areas are suffering from an increased rate of desertification and frequent drought.

The fast growing population has increased the demand for expansion of urban, agricultural and industrial activities. This has led to vast amounts of waste being generated and dumped in the environment. The wastes water is usually untreated due to poorly operated treatment works, leading to pollution of the water

systems. In other cases, rivers are dammed or diverted for irrigation reducing the flow to downstream users. This causes seasonal flooding which affects agricultural systems.

3.1.4. Responses to the Impact of Population on the Environment

The government's concern about the impact of population on the environment and natural resource base has been addressed through appropriate polices and programmes. The National Environment Action Plan (NEAP) of 1994 and EMCA (1999) are instruments that have facilitated integration of environmental considerations into management and development planning programmes.

The national environmental policy aims to facilitate optimal use of the land base and natural resources with a view to promoting sustainable development. This will ensure that the ability of the natural resource base to meet our current needs and those of future generations is not compromised. The policy requires integration of conservation measures in economic development activities. It also calls for generation of income to meet national goals as well as maintain the ecological balance of the earth.

Government concerns on population growth were articulated in Sessional Paper No.1 of 1965 on *African Socialism and Its Application to Planning in Kenya.* The thrust of Kenya's population policy is to reduce population growth rate to a level which does not compromise the achievement of development goals. Prior to the establishment of the National Council for Population and Development (NCPD) in 1982, the population programme operated in uncoordinated manner and did not make the desired impact. Implementation of Sessional Paper No. 4 of 1984 has had notable achievements.

The HIV/AIDS pandemic as well as the reproductive health issues continue to be addressed by *The Kenya Health Framework, the Reproductive Health Strategy* and the Sessional Paper No. 4 of 1997 on *Adolescent Reproductive Health and Development Policy.*

Kenya participated at the International Conference on Population and Development (ICPD) held in Cairo, which adopted a 20 year programme of action on population and development. This programme of action includes issues that were previously considered of less importance to population and development. One such area is population and the environment. The ICPD programme of action complements Agenda 21 on Environment and Development adopted in Rio de Janeiro in 1992. Thereafter, the government formulated *The National Population Policy for Sustainable Development* which addresses various issues including population and the environment. The overriding goal of this policy is to improve the welfare and the quality of life of the individual, the family and the nation as a whole.

3.2. HUMAN SETTLEMENTS

3.2.1. Rural and Urban Settlements

Land is considered the most valuable resource and therefore the most sought after asset in Kenya. Two-thirds of Kenya's population is concentrated in only one tenth of the total land area; around Lake Victoria basin, the highlands east and west of the Rift Valley and the coastal strip. The latter areas contain the most productive lands. This skewed population distribution on the basis of agro-climatic zones is presented in Table 3.6.

The demands on land often creates tremendous pressures and conflicts (Plate 3.1). There is an increasing number of land use conflicts, including: urban expansion into prime agricultural zones; encroachment by human activities on environmentally fragile lands (e.g. mountain catchment forests, riverine zones and other wetlands); pressure for access to land resources by local communities (wildlife areas, conservation forest, other protected areas) and introduction of arable agricultural practices in marginal zones.

3.2.1.1. Rural Settlement

Kenya is still largely a rural society with most of its people living in dispersed rural settlements (Tables 3.3). These settlements receive minimal attention. Several reasons explain this apparent neglect. First, rural

Plate 3.1. A planned (formal) and unplanned (informal) settlements in Nairobi

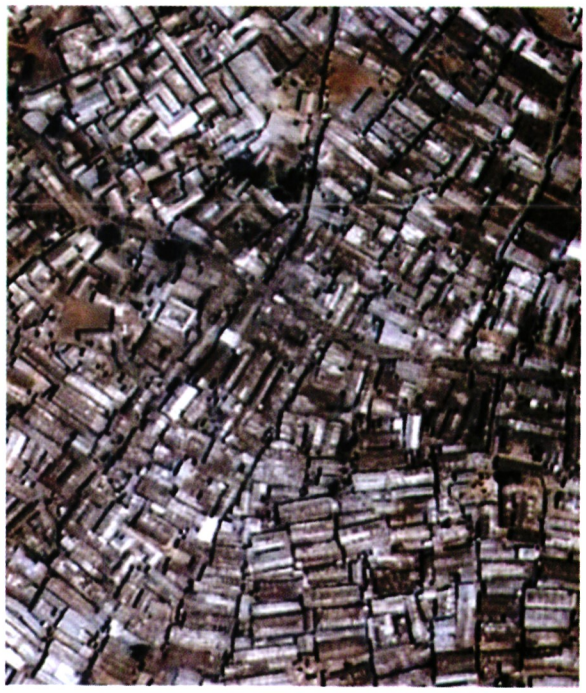


Table 3.6. Population and household analysis based on agro-climatic zones

ACZ	Area	% Area	Total Pop	% Pop	Density	Tot. Hds	Ha/Hhds
1	25,549	4	6,028,211	29	236	1,150,52	2.22
2	22,351	4	3,950,221	19	177	770,436	2.90
3	26,115	4	5,143,893	24	197	1,170,73	2.23
4	33,354	6	2,560,949	12	77	532,517	6.26
5	85,044	15	2,250,064	11	27	413,880	20.55
6	123,281	21	514,192	2	4	104,721	117.72
7	268,238	46	606,807	3	2	121,233	221.26
Totals	**583,932**	**100**	**21,054,337**	**100**		4,264,04	

Source: Government of Kenya, Central Bureau of Statistics (1989) and Kenya Soil Survey.
ACZ = Agro-climatic zone

people have always provided their own forms of shelter using locally available materials. Second, some low-density rural settlements have been seen to cause little damage to the environment. Third, funds and professionals that can be used to manage the expansive rural areas are extremely inadequate.

The rapid urbanization has placed pressure on available housing, infrastructure and other services. The disparity between the rate of urbanization and economic development (in relation to social infrastructure, industrial growth, commerce and employment) has exacerbated the proliferation of slums and squatter settlements which suffer from inadequate water, sanitation, waste disposal, health facilities, and roads. The unsanitary conditions of these settlements have impacted significantly on the quality of the urban environment and that of surrounding rural areas. Assorted wastes and their leachates find their way into river courses polluting the water and the land, which affects human health and the environment.

3.2.2. Human Settlement Planning

The planning and management of human settlements in Kenya is the function of the Physical Planning Department and respective local authorities which are mandated by the Physical Planning Act (Cap 286) and the Local Government Act (Cap 265). Physical planning refers to systematic and orderly organization of human settlement, which includes, buildings, communication lines and specific land use in order to achieve optimum economy, convenience, and aesthetics and sound environment management. Since the colonial time and post independence Kenya, physical planning endeavoured to provide a well-balanced human settlement with habitable environments. However, the physical planning process has not kept pace with development requirements, thus resulting in uncontrolled human settlements. Settlement plans under the provisions of the earlier planning statutes, such as, the Town Planning Act of 1948 and Land Planning Act of 1960, have either been overtaken by events, or were never properly implemented. Even the main cities of Nairobi, Mombasa, and Kisumu lack any current approved master human settlement plan and/or physical development plan. The only plan approved for Nairobi is the 1948 Master Plan, while the revised plan of 1973 was not approved. The same applies to Kisumu and Mombasa, whose only approved plans are of 1960. Most urbanization in the country is therefore taking place in a planning vacuum.

Very few regional physical development plans have been prepared. However, those prepared have not been implemented. In both rural and urban areas, spatial development is taking place without any planning interventions. Consequently, most human settlements, especially in the urban centres are becoming unsustainable with urban decay resulting in environmental crisis. In rural areas, increased subdivision is a major concern to deteriorating land carrying capacity. This condition is accentuated by unprecedented urban growth due to massive population increase and weak institutional urban planning and management frameworks.

The 1978 Human Settlement Strategy on Urban and Rural development gave a broad framework for both regional and rural planning in Kenya for the next 30 years. Provincial physical development plans were also prepared for the Coast, Rift Valley and Central Provinces. However, their implementation require review in order to take cognizance of the current circumstances of the newly established districts.

Table 3.7. Growth of some urban centres, 1969-1999

Urban Centre	1969	1979	1989	1999	1969-1999 % Increase
Nairobi	509,286	827,775	1,324,570	2,143,254	321
Mombasa	383,452	341,148	461,753	665,018	74
Kisumu	32,431	152,643	192,733	322,734	895
Nakuru	47,151	92,851	163,927	231,262	390
Eldoret	18,196	50,503	111,882	197,449	2187
Thika	18,387	41,324	57,603	106,707	480
Machakos	6,312	84,320	116,293	143,274	2170
Kitale	11,573		56,218	86,282	1184
Meru	4,475	72,049	94,947	126,427	2725
Kericho	10,144		48,511	93,213	819
Kisii	6,080	29,661	44,149	65,235	973
Malindi	10,757		34,047	118,428	1000
Karatina	2,436		5,554	126,337	5086
Nyeri	10,004	35,753	91,258	101,238	912
Naivasha	6,920		34,519	158,678	2193
Kakamega	6,244	32,025	58,862	74,115	1087
Kitui	3,071		9,305	106,873	3380
Bungoma	4,401		26,805	73,048	1560
Kangundo	1,540		10,880	179,952	11585

3.2.3. Issues and Interventions in Human Settlement Planning

Urban planning and management have not effectively offered solutions to the increasing urban decay and environmental crisis. Weak institutional frameworks, conflicting interests and inadequate capacities are major constraints. Physical development plans prepared by the Physical Planning Department are usually left at the whims of respective local authorities to implement. However, local authorities have inadequate capacities to implement these plans. The central government too suffers the same inadequacies where there are only about 100 planners for a population of 30 million people. Financial resources are inadequate, as the budget has more of recurrent than development funds. Plan implementation has also been hampered by inadequate stakeholder involvement. Mechanisms for implementation follow-up have not been put in place in the planning process either in the central government and/or local government. Most of the proposals made in respective plans, especially infrastructure development, have not been taken up by respective sector agencies. Human Settlement Strategy for Urban and Rural Development drawn up in 1978 for the next 30 years, has not been able to control urban development process, as it was originally envisaged.

Apart from weak institutional arrangements, physical planning, has generally not been able to focus on the majority of the urban population. Most physical development plans have colonial relics or are based on western models. These planning models do not address the needs of the urban poor that represent about 60% of the urban population mainly found in the informal settlements. The planning standards generally favour the urban rich, constituting about 20% of the urban population. Even the middle-income group is forced to move to high-density areas thus competing with the urban poor who are left with no option but to relocate to informal settlements.

The above inadequacies contribute to urban decay and deteriorating environmental quality in most urban centres. Urban decay is exacerbated by lack of environmental infrastructure. These indicators are manifested in uncontrolled urban development, overcrowding, and consequently inadequate access to safe water, sanitation, proper drainage and lack of access roads. Informal settlements have also encroached on sensitive environment areas such as, wetlands, biodiversity habitat areas, and flood prone areas. Settlements are also located close to dumping sites, railway and road reserves.

Increased subdivisions in the rural areas have led to deteriorating landscape aesthetics manifested through soil erosion and reduction of land resources.

There has been an attempt to initiate the preparation of a national land use policy, by the Ministry of Lands and Settlement. The focus is to prepare Regional Physical Development Plans and Local Physical Development Plans as per the provisions of Physical Planning Act Cap (286). The approvals of subdivision schemes and building plans have been a major constraint in land use and environment management. However, the operationalisation of the Environmental Management and Coordination Act no. 8 of 1999 should help balance environment and development concerns.

Sessional paper no. 6 of 1999 on *Environment and Development* calls for sustainable human settlement development that will balance socio-economic considerations and environmental concerns. The Environmental Management and Coordination Act (EMCA) no. 8 of 1999 provides for formulation of environmental action plans. In addition, the requirement to conduct environmental impact assessment (EIA) for all new policies, programmes, plans and projects should promote sustainable development. The EIA regulations were gazetted on 13th June 2003 to guide implementation.

EMCA (1999) is a framework law that coordinates other sectoral laws. Therefore, sector policy responses in human settlement must be in tandem. The Physical Planning Act (PPA) (Cap 286) and the Local government sector reforms have embraced the principle of sustainable development through the incorporation of participatory principle to inculcate social responsibility in the planning process. A major initiative in this process is the preparation of Environmental Development Plans (EDP) through the participatory environmental planning (PEP) commonly referred to as the "Green Towns Project". A number of these green agenda projects have been prepared for many towns in the country, including Malindi, Kisumu, Kakamega, Busia, Kericho, Machakos, Siaya, Changamwe-Mombasa, and Naivasha.

The Physical Planning Department has embarked on these EDPs, as a Strategic Environment Assessment (SEA). EDPs are prepared as part of the preparation of Local Physical Development Plans and Regional Physical Development Plans (Table 3.8). The SEA process is a requirement under the provisions of EMCA and PPA (1996). Concerted efforts to prepare such plans have been undertaken, a notable example being Nakuru town and district. New initiatives have focussed on the principal towns - Nairobi, Kisumu and Mombasa. The programmes to revise the Nairobi Metropolitan Growth Strategy and prepare the Kisumu Strategic Plan have been initiated. The Ministry of Lands and Settlement has given priority to the preparation of a National Land Use Policy to guide sustainable human settlement programmes and also to conserve the country's valuable natural resources. The geographical information systems (GIS) are increasingly being used to expedite the planning process. Additionally, the government is working on modalities to further expedite the process by privatizing or allowing consultancy services in the physical planning process. Sustainable development of human settlement will incorporate environmental concerns in the development of infrastructural facilities.

3.2.4. Housing

In Kenya, human settlements have taken two distinct patterns namely the rural and urban settlements. The demand for shelter has always outstripped supply. This has led to very poor shelter conditions in both the urban and rural areas (Tables 3.9 and 3.10). This is also manifested by overcrowding and the spreading of slums and squatters settlements in urban centres and their peripheries as well as the prevalence of low quality housing in rural areas. This situation is further aggravated by rapid urbanization, widespread poverty and escalating construction costs.

Table 3.8. Situational analysis of human settlement planning and management

Type of Plans	Inception Stage	Preparation Stage	Advanced Stage	Approval Stage	Remarks
National Land Policy	Initiated	----------	----------	----------	
Regional Physical Development Plans (Districts)	Busia, Kakamega, Kericho, Kajiado, Siaya, Keiyo, Nyeri, Meru	Kwale, Uashin- Gishu, Nyando	Nyandarua	Nakuru, Trans Mara	
Local Physical Development Plans (Urban)	Nairobi , Kisumu, Mombasa	Machakos, Kakamega	Njoro, Naivasha, Migori, Embu	Nakuru, Transmara	
Environmental Development Plans (Green Towns): Ministry of Lands and Settlements	Ruiru, Kabarnet,	----------	Embu, Kakamega, Kisumu, Naivasha Nyeri, Machakos, Kitale, Lamu, Nyahururu, Mombasa, Kitengela	Not approved as per Physical Planning Act Cap 286.	Recommendation to be considered as a Strategic Environmental Assessment Report (SEA) as per Section 58 of EMCA and EIA Regulations 2003 (Section 42)
Environmental Development Plans: Ministry of Local Government	----------	----------	Malindi, Webuye, Siaya, Homabay, Kericho, Nanyuki, Ol Kalau, Njoro, Eldoret, Busia, Mavoko, Thika		

The main constraints in proper housing development include an inappropriate legal and regulatory framework, inadequate infrastructure, limited access to affordable finance, inaccessibility to affordable and serviced land and high construction costs.

The overall goal of the reviewed housing policy is to facilitate the attainment of adequate shelter and healthy living environment at an affordable cost to all socio-economic groups in Kenya. This will curtail the mushrooming of slums and informal settlements, particularly in major urban centres. In an effort to address the housing problem, the government is:

- Coordinating the formulation and implementation of the national housing policy. The housing bill to be presented to Parliament will follow this. The current *Housing Act* will be amended to become the National Housing Corporation Act. The new *Housing Act* will strengthen the role of the Ministry of Roads, Public Works and Housing in the management of the housing sector. A permanent consultative body known as Building By-laws Review Board will be operationalised to review and update housing standards and regulations on a continuous basis. *Sectional Properties Act* that governs ownership of shared property to enhance security of tenure will be popularized to facilitate investment in housing.

- Coordinating implementation of upgrading of slum areas and informal settlements through the Kenya Slum Upgrading Programme. Upgrading of slum areas and informal settlement will be given high priority. This will be done with minimal displacement to cater for proper planning and provision of necessary infrastructure and related services. The Slum Upgrading and Low Cost Housing and Infrastructure Fund are being established for that purpose.

- In the process of establishing demonstration units (building centres) to enhance dissemination of appropriate/low cost building technologies and best practices. The Government puts emphasis on continued research as well as utilising innovative conventional building materials and technology. The Government will increase allocation of funds to research and establish a national research coordination secretariat to coordinate and disseminate research findings.

- Proposing the establishment of the secondary mortgage market and support introduction of innovative methods of financing housing.

- Reviving the housing fund to support the development of housing and human settlements.

- Coordinating the efforts of the development partners, the private sector, community based organizations, non-governmental organizations in delivery of the set target of 150,000 housing units annually.

- Looking for ways of increasing accessibility to affordable and serviced land through creation of a land bank for housing development. The policy puts emphasis on a comprehensive land use planning and management policy. It recognizes land as being a primary resource in housing development.

- Developing programmes that recognize the vulnerable groups comprising of the poor, women, children, handicapped, elderly and displaced persons. These must be involved in the project planning process.

The government recognizes that a conducive institutional and legal framework must be put in place to tap into the energies of all actors in the housing sector to bring on board their comparative advantages. It is now generally acknowledged that the housing problem facing our nation may be solved through partnerships involving the central government, local authorities, the National Housing Corporation, private sector, professionals, employers, cooperatives, private developers, individuals, civil society organisations, and development partners. This partnership-based approach is ideal not only for the provision of housing but also for the overall development of the nation.

Table 3.9. Per cent of households by main type of wall materials for the main dwelling unit

Province/	Stone	Brick/ Block	Mud/ Wood	Mud/ Cement	Wood Only	Iron Sheets	Grass Reeds	Tin	Other	Total
Nairobi	41.12	14.34	9.992	7.88	5.53	19.84	0.27	0.70	0.40	100
Central	25.25	3.52	7.95	0.99	36.61	24.38	0.20	0.77	0.33	100
Coast	11.13	22.09	43.61	15.07	0.75	0.71	5.62	0.09	0.94	100
Eastern	8.47	31.47	34.33	2.76	17.53	1.46	2.06	0.07	1.85	100
North Eastern	2.79	6.95	5.27	1.54	3.53	0.40	71.87	0.13	7.51	100
Nyanza	1.76	11.99	72.18	10.99	0.52	1.58	0.75	0.05	0.18	100
Rift -Valley	8.28	8.13	55.51	6.27	14.52	2.43	1.97	0.18	2.71	100
Western	1.11	11.03	79.75	6.88	0.46	0.27	0.32	0.04	0.14	100
National Total	12.18	14.16	46.57	6.69	11.4	4.29	3.15	0.24	1.30	100

Source: Government of Kenya, Central Bureau of Statistics (1999). *Kenya National Population Census 1999*

Table 3.10. Per cent of households by main types of floor materials for the main dwelling unit

Province	Cement	Tiles	Wood	Earth	Other	Total
Nairobi	77.14	5.22	2.02	15.33	0.29	100.00
Central	41.08	0.06	0.64	57.52	0.15	100.00
Coast	44.52	0.99	0.20	54.02	0.27	100.00
Eastern	33.71	0.38	0.46	65.18	0.28	100.00
Nyanza	24.32	0.46	0.34	74.64	0.24	100.00
Rift Valley	28.58	0.52	0.71	69.95	0.24	100.00
Western	17.50	0.21	0.20	81.38	0.71	100.00
National	35	0.98	0.63	62.97	0.30	100.00

3.2.5. Infrastructure and Services

Water is a basic need and an input in the economic and social development process. The focus has been placed on the provision of water for domestic use, agriculture, livestock development and industrial utilization. Sessional Paper No. 1 of 1999 on Water Resources Management and Development aims to facilitate the provision of water in sufficient quantity and quality and within a reasonable distance to meet all competing users in a sustainable, rational and economic way. Water supply has been exacerbated by cyclical droughts, which have plagued the country in the past three decades. The declining public resources for investment in new water projects, operation and maintenance have diminished the role of the public sector in the provision of water. Sanitation on the other hand remains a major challenge in the country largely due to the inadequate provision and poor management of existing facilities.

Access to safe drinking water varies from place to place and the source of water (Table 3.11). This has been achieved through provision of some 330 gazetted water sources and supply systems countrywide, accounting for 80 per cent of the served population; while the rest (20 percent) of the population is served with non-gazetted schemes. There are over 1800 water supplies that are currently operational out of which 1000 are publicly operated schemes. Non-Governmental Organisations, Self-help groups and communities run the rest. At present there are about 1782 small dams and 669 water pans in the country of which 1183 are operational and 1168 silted but operational; 100 have dried up or have been abandoned. In addition, there are about 9000 boreholes, the majority of which require rehabilitation or replacement.

There are 142 gazetted urban centres in Kenya of which only 30 per cent have sewerage systems. This has posed serious environmental and health problems. Main sewer systems in most urban centres suffer from constant breakage, leakage, and inadequate capacity to handle their full load. In these centres, enterprises are known to discharge effluents directly into rivers and depressions causing high pollution levels. Effluent pollution makes rivers, streams and dam water unsafe for domestic and livestock consumption. Management of solid wastes in urban areas is increasingly becoming a major concern. Human activities, particularly in water catchment areas are increasingly threatening forest cover and in some areas have resulted in

diminishing water availability. This calls for an integrated approach to the planning and management of water resources for the benefit of the whole economy.

Kenya's road network consists of 63,291km and 87,600km of classified and unclassified roads respectively. The classified road network has grown by 51 per cent between 1963 and 2000. The length of the tarmac ked road length increasing from 1,811km to 8937km over the same period. Urban road network covers approximately 10,000 km or 7 per cent of the total road network with a carrying capacity of over 70 per cent of all vehicles in the country. In the main urban centres, the road network has been characterized by heavy traffic congestion during peak hours, overloaded passenger transport, stiff competition for limited road space, few parking spaces and inadequate supply of public transport.

Ineffective urban transport management systems, poor physical planning and inefficient management of traffic have compounded these problems. The government has been unable to provide adequate resources for development and maintenance of roads due to critical financial constraints. The poor state of the road infrastructure has caused high vehicle operating costs, high fare charges and unreliable time schedules. These have further resulted in high production costs, uncompetitive exports, high costs of imported inputs and capital goods and low productivity, which constrain economic development.

Railway transport is important for the carriage of bulk goods, especially over long distances. The total railway network consists of 2765km and the system has an annual capacity of more than 6 million tonnes. However, the Kenya Railway Corporation handles between 2.4 and 3.2 million tonnes per year.

Marine transport consists of port facilities in Mombasa and minor ports along the coast, inland water transport in Lake Victoria and inland container depots at Nairobi, Kisumu and Eldoret. Mombasa Port serves the hinterland countries of Eastern and Central Africa. The port has a rated capacity of 22 million tonnes annually, the actual cargo handled has for several years been at an average of 8 million tonnes per year.

Table 3.11. Distribution of households with access to water and main water sources by province

Province	Access to various sources of waters									
	Piped Water %	River %	Lake/ Pond /Dam %	Roof Catch ment	Protected Spring %	Unprote cted Spring %	Protecte d Well %	Unprotected Well %	Borehole %	Others %
Nairobi	95.6	2.6	-	-	-	-	0.5	-	-	1.2
Central	36.2	35.3	0.9	3.8	1.8	5.3	3.7	3.2	7.0	2.7
Coast	56.2	11.6	12.4	0.1	0.3	0.7	2.5	5.2	8.6	2.2
Eastern	29.3	37.4	4.6	0.5	2.1	8.1	3.2	9.2	4.0	1.4
North-Eastern	12.7	13.5	33.8	-	0.7	3.9	3.4	15.7	13.9	2.3
Nyanza	9.2	24.8	10.2	3.0	10.1	22.2	5.8	9.3	5.1	0.3
Rift Valley	25.0	32.4	4.1	7.0	2.6	9.9	6.9	6.1	3.9	1.9
Western	14.0	9.1	0.0	4.3	14.1	17.0	10.6	9.4	18.1	3.5
National	**32.1**	**24.9**	**5.3**	**3.2**	**4.5**	**10.2**	**5.1**	**6.7**	**6.3**	**1.8**
-Urban	**90.2**	**3.1**	**0.0**	**0.3**	**0.4**	**0.7**	**2.3**	**0.7**	**0.7**	**1.4**
-Rural	**17.3**	**30.5**	**6.6**	**3.9**	**5.6**	**12.6**	**5.8**	**8.2**	**7.7**	**1.9**

Source: Government of Kenya, Central Bureau of Statistics (CBS), Welfare Monitoring Survey 11 Basic Report 1994, Central Bureau of Statistics

Kenya is strategically placed to serve as the hub for the East, Central and Indian Ocean areas and offers transit and refuelling facilities for the North/South and East/West air traffic. For this reason, the government has been investing substantial amounts of resources, on a relatively well-developed air transport industry with three international airports, four major domestic airports and over 400 smaller aerodromes and airstrips.

The volume of passengers handled at the airports rose from 2.77 million in 1994 to 4 million in 2000. Freight handled rose from 23,000 tonnes in 1994 to 145,400 tonnes in 2000.

The Kenya Pipeline Company (KPC) administers oil pipeline transport. The oil pipeline from Mombasa to Nairobi was commissioned in 1978 and was later extended to Nakuru, Eldoret and Kisumu in 1994.

Kenya's energy sector is largely dominated by imported petroleum for the modern sector and wood fuel for the rural communities, the urban poor and informal sector. The current domestic demand for petroleum fuels account for about 25.7 per cent of the total import bill. In terms of energy supply, wood fuel provides about 68 per cent of the total energy requirements, the petroleum energy 20 per cent, electricity 10 per cent and other alternative sources accounts for 2 per cent of the electricity supply. Hydro account for 624.5 MW (62 per cent) of the total installed capacity, while thermal energy and imports from Uganda provide 57 MW (5 per cent); 410.8 (35 per cent); and 30 MW (3 per cent), respectively. The effective capacity under normal hydrological conditions is 1000 MW. The power demand is expected to grow from 843MW in 2002/3 to 1202 MW in 2007/8. The energy demand is correspondingly expected to rise from 4632 GMH to 6713GMH representing a 6.4 per cent mean growth per annum. Future fuel wood management strategies will have to reconcile the potential conflict between socio-economic realities and environmental conservation. Wood fuel is projected to remain the dominant source of energy for domestic use for the foreseeable future. Its consumption impacts negatively on the environment.

Human settlement infrastructure and services are affected by several factors. Kenya lacks a clear policy on human settlement infrastructure and services. Consequently, inadequate basic infrastructure and appropriate services characterise the existing settlements. The rapid rate of urbanization in Kenya against a weak financial and human resource base has made it difficult for the government to cope with increased demand for infrastructure and services. The impact of rapid population growth rate on infrastructure and services for human settlements is more visible in the urban areas. For example, slum and squatter settlements accommodate 60 per cent of the residents of Nairobi. The rapid rate of urbanization has effectively impaired the capacity of the local authorities to provide basic infrastructure and services.

Inadequate human and financial resources have contributed to the poor infrastructure and services. Kenyan local authorities have a weak revenue base and inadequate qualified personnel in the core areas of engineering, planning, and finance to develop and manage human settlement infrastructure and services.

Since the 1970s, the government has formulate a number of policy measures to support the development of human settlement infrastructure and services. The following policies and strategies have been implemented to address the challenges of infrastructure and service provision. Growth Centre Policy, Rural Trade and Production Centre strategy, District Focus for Rural Development Policy, Slum Upgrading Strategy, Urban Transport Roads Project, Roads Petroleum Levy, El Nino Roads project and Public-Private Partnership in urban environmental services. However, these policies have made little impact on infrastructure and service provision. Growth Centre and Rural Trade and Production Centre policies benefited only a limited number of centres. However, most of these policies are now either dormant or have been abandoned because of heavy dependence on donor support for their implementation. Most donors withdrew or drastically reduced funding to Kenya since the beginning of the 1990s. Since these policies did not make provision for the operation and maintenance of infrastructure, the developed infrastructure have deteriorated and are in a state of disrepair. As a result of political interference and inappropriate selection criteria, the wrong centres were selected and inappropriate or inadequate infrastructure development package was chosen. Most of the infrastructure developed through these policies and strategies have failed to stimulate the expected human settlement development. For example, the growth centre policy has failed to stem human influx into Nairobi and Mombasa.

3.3. POVERTY

3.3.1. Poverty Status

Poverty reduction in Kenya has been a major challenge since independence. The government in collaboration with development partners has devoted a lot of resources to implement policies and programmes with the objective of reducing poverty. The number of people living below the poverty line and who subsist predominantly on natural resources has increased from 48% in 1994 to 52% in 1997 and to about 57% by 2003. In the absence of major changes in the use of natural resources, the disparities in these rates will continue to exert pressure on environmental goods and services.

The proportion of those living in absolute poverty in 2000 was about 57% of the total national population (Table 3.12). Corresponding figures for the provinces are Nyanza Province (70.11%), Coast Province (69.88%), Eastern Province (65.9%), Rift Valley (56.38%), Western Province (66.11%) and Central Province (35.32).

3.3.2. Causes of Poverty

The Poverty Reduction Strategy Paper identified the causes of poverty as follows:

- Low agricultural productivity and poor marketing: Kenya is an agricultural country and the prevalence of traditional farming methods leading to environmental degradation and coupled with low soil fertility, unpredictable weather conditions, poor and inadequate extension service, high cost of inputs, low quality of seeds and inadequate credit facilities have contributed to low productivity hence food shortages, under-employment and low incomes. Inadequate water, pasture, animal diseases, poor livestock health and inadequate information on marketing have led to poor livestock production;

- Declining economic growth;

- High levels of inequalities;

- Gender imbalance: Poverty in women is attributed to lack of ownership and control over product resources, inadequate access to credit facilities, while cultural beliefs have hindered women from owning property in some communities;

- Land tenure systems: Many families have little or no land of their own thus making them squatters. This has resulted in frequent conflicts in grazing and water points;

- High cost of education: Many families are unable to afford the high cost of education forcing children out of school and thus limiting their employment opportunities;

- Poor governance and corruption: lack of transparency and accountability in the management of resources and funds that are meant to benefit communities have denied communities their well-being;

- High cost of essential services: Poor infrastructure contributes to poor access to markets, hospitals and schools. Farmers, for example, are forced to rely on middlemen to access markets for their products. Inadequate drugs, collapse of maternal and child health services, inadequate health personnel and increased costs of drugs have made it difficult for the poor to have satisfactory access to health facilities. In the rural areas, water availability is a big problem and women are forced to walk for long distances in search of the commodity. The time spent looking for water could be utilized in other activities. In the urban areas, especially in the slums, the cost of water is too high;

- HIV/Aids: The pandemic has increased the number of dependents, orphans and caused a high financial burden as treatment is expensive;

- Unemployment and low wages: This is applicable to both urban and rural areas and it leads to lack of income which drastically reduces purchasing power.

- Insecurity and ethnic tensions.

- Vulnerability: The disabled, socially marginalized, and other disadvantaged groups are prone to poverty.

Table 3.12. Ranking of districts as per population below poverty line

Ranking	District	District population as per 1999 housing and population Census	% of population below poverty Line	Number of persons below poverty line
	National	28,6662,000	56.78	15,108.075
1.	Marsabit	121,478	88.18	107,119
2.	Isiolo	100,861	82.18	82,888
3.	Homa Bay	288,540	77.49	223,590
4.	Rachuonyo	307,126	77.49	237,992
5.	Suba	155,666	77.49	120,626
6.	Turkana	450,860	73.76	332,554
7.	Makueni	771,545	73.51	567,163
8.	West Pokot	308,086	68.46	210,916
9.	Mandera	250,372	68.03	170,328
10.	Moyale	53,479	68.03	36,382
11.	Kilifi	544,303	66.30	360,873
12.	North Kisii (Nyamira)	498,102	66.74	332,433
13.	Malindi	281,552	66.30	186,669
14.	Busia	370,608	65.99	244,564
15.	Teso	181,491	65.99	119,766
16.	Taita Taveta	246,671	65.82	162,359
17.	Kisumu	504,359	65.44	330,053
18.	Nyando	299,930	65.44	196,274
19.	Kitui	515,422	64.91	334,560
20.	Mwingi	303,828	64.91	197,215
21.	Nandi North	289,376	64.15	185,635
22.	Nandi South	289,375	64.15	185,634
23.	Machakos	906,644	62.96	570,823
24.	Vihiga	498,883	61.97	309,158
25.	Bomet	382,794	61.80	236,567
26.	Buret	316,882	61.80	195,833
27.	Kwale	496,133	60.55	300,409
28.	Siaya	480,184	58.02	278,603
29.	Bondo	238,780	58.02	138,540
30.	Migori	514,897	57.63	296,735
31.	Kuria	151,887	57.63	87,532
32.	Kisii Central	491,786	57.22	281,400
33.	Gucha (S. Kisii)	460,939	57.22	263,749
34.	Wajir	319,261	57.04	182,106
35.	Kakamega	603,422	56.69	342,080
36.	Butere Mumias	476,928	56.69	270,370
37.	Lugari	215,950	56.69	122,422

38.	Transmara	170,591	56.59	96,537
39.	Meru South (Nithi)	205,451	55.58	114,190
40.	Embu	278,296	55.76	155,178
41.	Tharaka	100,992	55.58	56,131
42.	Bungoma	876,491	55.21	483,911
43.	Mt. Elgon	135,033	55.21	74,552
44.	Trans Nzoia	575,662	54.83	315,635
45.	Kericho	468,493	52.42	245,584
46.	Narok	365,750	52.17	190,812
47.	Mbeere	170,953	51.36	87,801
48.	Nairobi	2,143,254	50.24	1,076,771
49.	Ijara	196,255	48.21	94,615
50.	Garissa	196,255	48.21	94,615
51.	Keiyo	143,865	47.82	68,796
52.	Marakwet	140,629	47.82	67,249
53.	Meru North (Nyambene)	604,050	47.26	285,474
54.	Nakuru	1,187,039	45.08	535,117
55.	Uasin Gishu	622,705	42.22	262,906
56.	Lamu	72,686	39.35	28,602
57.	Murang'a	348,304	38.62	134,515
58.	Maragua	387,969	38.62	149,834
59.	Mombasa	665,018	38.32	254,835
60.	Baringo	264,978	36.95	97,909
61.	Koibatek	138,163	36.95	51,051
62.	Kirinyaga	457,105	35.70	163,186
63.	Tana River	180,901	34.22	61,904
64.	Samburu	143,547	33.88	48,634
65.	Laikipia	322,187	33.88	109,157
66.	Nyeri	661,156	31.05	205,289
67.	Kajiado	406,054	27.87	113,167
68.	Nyandarua	479,902	26.95	129,334
69.	Kiambu	744,010	25.08	186,598
70.	Thika	645,713	25.08	161,945

Sources: Government of Kenya, Welfare Monitoring Survey; UNDP, Participatory Governance for Human Development

The welfare monitoring studies indicate that a large share of the household budget of the rural poor (83%) and urban poor (64%) goes to food consumption. The rural poor spend 17%, while the urban poor spend 36% of their budget on non-food consumption. The poor buy on relatively cheap, low quality foods. The scarce resources available to the poor households are thinly spread among the members without proper satisfaction. For example, the per capita food expenditure among the rural poor is Ksh.526, while that of the non-rural poor is Ksh.1,375. Table 3.13 presents regional mean household food, no-food and total expenditure by poor and the mean household size.

The urban poor spend less on maize (14%) than the rural poor (27%), while vegetables take about 15% of their food budget. At the national level, the poor spend the largest share of their food budget on maize and vegetables. The share of food and non-food expenditure for the poor in the rural and urban areas is presented in figures 3.4 and 3.6. Tables 3.14 and 3.15, present the pattern of food and non-food budget among the poor.

3.3.3. Child Labour

Child labour is recognized as a major problem in the country. About 588,000 children of school going age are working of which 92% are exposed to various occupational hazards. The other 7.9% are issued with protective devices in their work place.

The proportion of working children to the total population of children aged 5-17 years is higher in the rural areas (19,7%) than the corresponding proportion of the urban areas (9.0%). Rift Valley had the highest share (23.7%) of working children, while Nairobi accounted for only 5.0%.

Table 3.13: Food and non-food share in total expenditure

	Poor						Non-Poor					
	Food (Kshs)	Non Food (Kshs)	Total (Kshs)	Food Share (%)	Non - Food Share (%)	House-Hold Size	Food (Kshs)	Non - Food (Kshs)	Total (Kshs)	Food Shar e (%)	Non - Food Share (%)	House-Hold Size
Central Rural	3,149.7	703.5	3,853.3	81.7	18.3	5.3	6,190.9	3,283.8	9,474.8	65.3	34.7	4.0
Coast Rural	3,263.5	663.9	3,927.4	83.1	16.1	6.4	5,654.0	2,568.0	8,222.0	68.8	31.2	4.2
Eastern Rural	3,097.5	613.3	3,710.8	83.5	16.5	6.0	6,590.2	2,397.5	8,987.8	73.3	26.7	4.9
Nyanza Rural	2,790.0	549.4	3,339.4	83.5	16.5	5.3	5,221.0	1,864.8	7,085.8	73.7	26.3	4.1
Rift Valley Rural	2,921.6	646.9	3,568.5	81.9	18.1	5.5	5,969.9	2,576.5	8,546.4	69.9	30.1	4.3
Western Rural	2,758.9	590.1	3,349.0	82.4	17.6	5.5	5,403.9	2,037.9	7,441.8	72.6	27.4	4.4
TOTAL RURAL	2,944.5	615.0	3,559.4	82.7	17.3	5.6	5,910.7	2,558.2	8,468.9	69.8	30.2	4.3
TOTAL URBAN	4,026.0	2,2160.0	6,242.0	64.5	35.5	4.1	7,352.5	10,099.7	17,452.2	42.1	57.9	3.1
Nairobi	4,098.7	2,573.0	6,617.7	61.4	38.6	4.1	8,046.1	14,692.7	22,738.8	35.4	64.6	3.4
Mombasa	4,065.9	1,661.7	5,727.7	71.0	29.0	4.1	7,901.3	7,867.2	15,768.5	50.1	49.9	3.1
Kisumu	3,820.9	2.397.3	6,218.2	61.4	38.6	4.4	6,186.0	6,631.1	12,817.1	48.3	51.7	3.4
Nakuru	4,408.2	2,563.1	6,971.3	63.2	36.8	4.3	6,188.6	6,492.5	12,681.1	48.8	51.2	3.1
Other Urban	3,861.9	1,721.8	5,583.7	69.2	30.8	4.0	6,481.3	6,020.6	12,501.9	51.8	48.2	2.7
National	**3,152.4**	**922.8**	**4,075.2**	**77.4**	**22.6**	**5.3**	**6,216.3**	**4,157.0**	**10,373.3**	**59.9**	**40.1**	**4.0**

Source: Government of Kenya: Welfare Monitoring Survey – 1997

Table 3.14. Share of expenditure of the poor on food items (%)

Region	Bread	Maize	Cereals	Meat	Fish	Milk	Eggs	Oils and Fats	Fruits	Vege-table	Beans	Roots	Sugar	Tea and Coffee	Beve-rages	Baby Food	Other Food
Central Rural	3.3	26.6	5.4	5.7	0.1	9.4	0.8	5.7	1.7	13.4	9.7	5.1	7.0	2.8	1.2	0.0	2.2
Coast Rural	5.8	45.4	2.9	6.1	3.4	2.7	0.2	5.2	0.5	7.9	5.7	2.1	6.8	1.4	2.4	0.0	1.5
Eastern Rural	2.3	33.6	4.6	4.7	0.1	6.1	0.6	4.0	2.5	10.6	16.9	4.2	5.0	1.9	1.2	0.0	1.9
Nyanza Rural	1.9	18.8	10.0	10.2	6.5	6.2	1.0	6.3	1.6	16.1	5.3	6.1	6.4	1.3	0.9	0.0	1.4
Rift Valley Rural	3.2	26.2	4.5	8.1	0.7	13.6	1.2	4.7	0.7	11.4	8.3	3.0	7.8	2.6	2.7	0.0	1.5
Western Rural	2.7	21.8	3.6	9.5	4.2	7.0	0.7	4.2	1.4	17.6	4.6	9.2	8.2	2.0	1.7	0.1	1.5
Total Rural	2.9	26.8	5.7	7.7	2.6	8.1	0.8	5.0	1.5	13.2	8.7	5.0	6.8	2.0	1.6	0.0	1.6
Total Urban	9.2	14.3	5.7	10.1	2.4	7.8	1.8	6.7	2.0	15.4	6.4	3.5	5.6	1.9	3.4	0.1	3.5
Nairobi	9.4	15.1	5.7	9.7	2.0	8.3	1.9	6.8	2.2	16.5	5.5	3.2	5.1	2.0	3.5	0.0	3.3
Mombasa	11.6	18.9	5.9	6.4	4.0	4.4	1.7	6.5	1.0	9.5	11.4	4.4	6.2	1.5	3.8	0.1	2.8
Kisumu	9.5	7.4	5.8	11.2	6.3	5.3	2.2	8.0	2.1	16.8	5.1	2.3	7.4	1.2	6.1	0.3	3.1
Nakuru	8.7	16.7	5.1	11.1	1.5	8.3	1.8	5.6	2.2	16.7	4.7	2.9	4.8	2.1	1.4	0.5	5.7
Other Urban	8.0	11.9	6.0	11.9	1.9	8.7	1.5	6.8	2.1	15.4	6.6	4.0	6.2	2.2	3.1	0.1	3.6
National	**4.4**	**23.7**	**5.7**	**8.3**	**2.5**	**8.0**	**1.0**	**5.4**	**1.6**	**13.7**	**8.1**	**4.6**	**6.5**	**2.0**	**2.1**	**0.0**	**2.1**

Source: Government of Kenya: Welfare Monitoring Survey – 1997

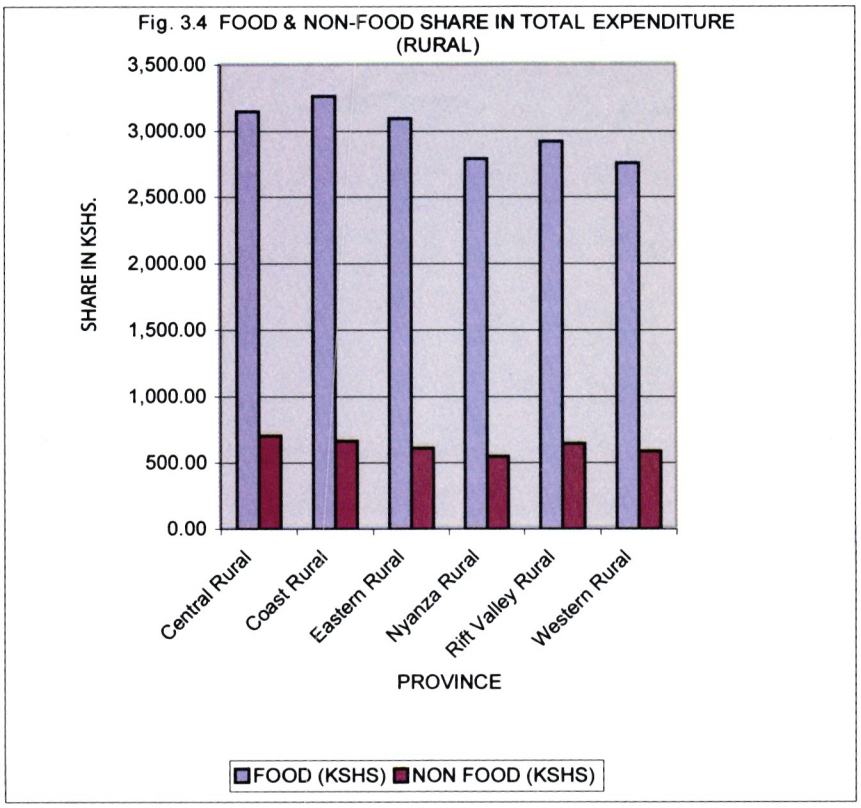


Fig. 3.4 FOOD & NON-FOOD SHARE IN TOTAL EXPENDITURE (RURAL)
3,500.00
3,000.00
2,500.00
2,000.00
1,500.00
1,000.00
500.00
0.00
SHARE IN KSHS.
Central Rural
Coast Rural
Eastern Rural
Nyanza Rural
Rift Valley Rural
Western Rural
PROVINCE
FOOD (KSHS)
NON FOOD (KSHS)

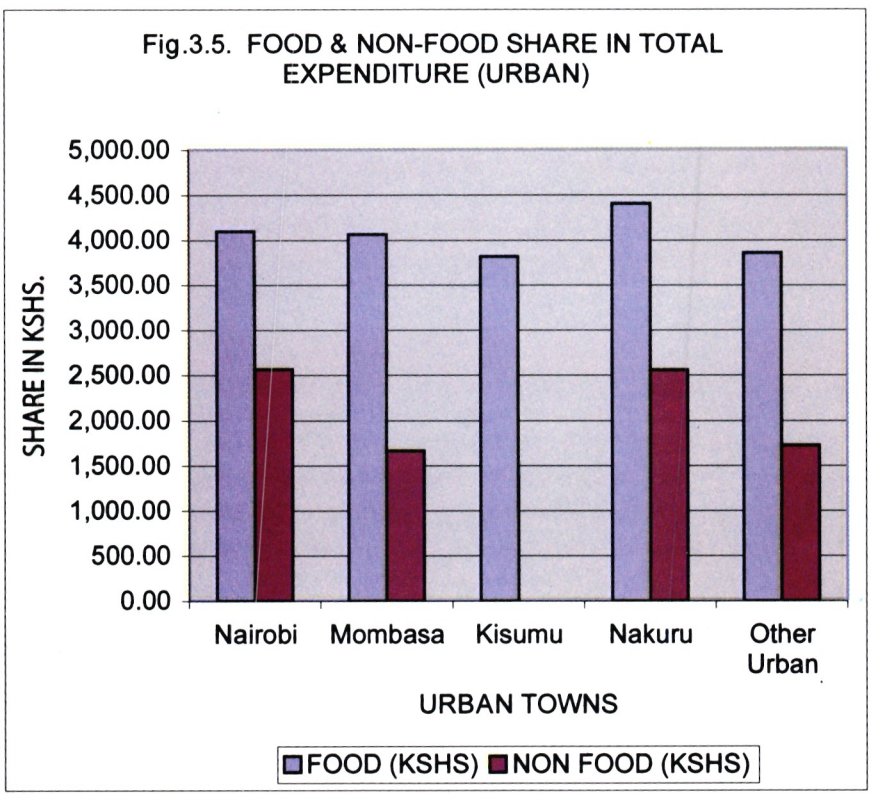


Fig.3.5. FOOD & NON-FOOD SHARE IN TOTAL EXPENDITURE (URBAN)
5,000.00
4,500.00
4,000.00
3,500.00
3,000.00
2,500.00
2,000.00
1,500.00
1,000.00
500.00
0.00
SHARE IN KSHS.
Nairobi
Mombasa
Kisumu
Nakuru
Other Urban
URBAN TOWNS
FOOD (KSHS)
NON FOOD (KSHS)

Child labour persists despite various efforts to stop it. Lack of comprehensive information on the number and structure of child labour in Kenya has led to conflicting estimates. The government and other international organizations are concerned by this phenomenon. The International Labour Organization (ILO) has developed a child labour programme, while the government has passed several legislations and policies aimed at stopping the vice.

Table 3.15. Share of non-food expenditure in poor households (%)

Region	Education	Health	Cloth and Foot Wear	Lighting and Cooking Fuel	Transport	House Rent	Non-Durables	Durables	Water	Recrea-tion and Personal Care	Trans-fers Out	Insur ance	Toba cco
Central Rural	32.1	8.7	7.3	15.3	8.2	1.5	15.5	3.0	0.3	1.5	2.1	0.5	4.2
Coast Rural	18.1	8.6	14.9	11.8	11.7	0.9	16.8	3.2	4.2	1.7	2.9	0.4	4.9
Eastern Rural	27.6	14.7	14.0	9.0	6.8	0.5	15.6	3.3	0.3	2.8	1.3	1.2	3.0
Nyanza Rural	22.8	12.4	14.4	10.3	9.1	0.4	17.5	5.3	0.2	3.2	3.0	0.8	0.6
Rift Valley Rural	23.4	9.9	14.6	11.8	9.7	0.6	16.7	3.7	0.2	2.9	3.4	0.8	2.2
Western Rural	28.7	14.3	5.7	7.9	10.6	0.0	16.1	5.9	0.2	3.0	5.2	1.0	1.4
Total Rural	25.5	11.8	12.3	10.8	9.1	0.6	16.4	4.2	0.5	2.7	3.0	0.8	2.3
Total Urban	12.6	5.0	8.3	11.8	12.1	22.0	10.0	3.1	3.4	4.4	3.1	0.5	3.8
Nairobi	12.3	3.5	7.5	10.2	16.3	23.9	8.9	2.9	2.3	4.7	2.1	0.1	5.5
Mombasa	8.4	5.0	7.9	13.5	8.9	19.0	12.9	3.5	10.7	2.8	5.4	0.7	1.3
Kisumu	10.4	8.5	9.2	14.0	6.5	15.7	10.5	2.6	8.3	4.9	7.2	1.3	0.8
Nakuru	16.7	7.6	6.1	14.0	7.1	26.5	9.3	3.3	1.6	3.4	2.4	1.4	0.7
Other Urban	14.6	6.8	10.7	13.8	6.0	19.0	11.8	3.4	2.5	4.1	3.8	0.9	2.5
National	19.6	8.6	10.4	11.2	10.5	10.5	13.5	3.7	1.8	3.5	3.0	0.7	3.0

***Source**: Government of Kenya: Welfare Monitoring Survey – 1997*

3.3.4. Poverty and Environment

Poor governance in natural resources management has increased the vulnerability of the country to extreme environmental events, such as droughts and floods that have had a strong influence on Kenya's economic performance. Recovery from extreme events is costly and extends several years after the events. Land degradation, disasters and emergencies have led to new concentrations of poor populations in ecologically fragile zones, whose livelihood and security is constantly threatened by climate variability, especially the cyclical occurrence of floods and droughts.

The relationship between poverty, environmental degradation and population is complex. The poor are often the victims of environmental degradation caused by others. At the same time, the poor have no other option, other than exploit natural resources unsustainably. The nexus between poverty and the environment cannot be explained in terms of people's lack of income alone. People's livelihoods and human development depends on a number of factors including ownership of natural resources and access to information about their rights and entitlements, the way they cope with risks and uncertainty and how they use their time.

Poverty leads to over-use and destruction of natural resources where short-term needs are pursued at the expense of long-term environmental sustainability.

The poor face another problem of high cost of fuel wood and charcoal and the long hours women have to take to search for wood fuel reducing their time to engage in other productive activities. Increased shortage of wood fuel and the high cost of charcoal may lead to the poor using dried dung causing a decrease of

organic fertilizer available for agriculture and an increase in indoor air pollution. This may lead to food poverty and poor health among the poor.

Poverty in the urban areas has led to the mushrooming of congested slums which have poor or no waste disposal mechanisms, water supply is inadequate and the houses are not fit for human occupation. Environmental pollution and waste management are rampant, leading to poor health of the population.

3.3.5. Gender and Poverty

Employment is a crucial link between economic growth and poverty reduction. The distribution of economically active population reveals a gender-based division of labour (Table 3.16). Most of the economically active females are concentrated within agriculture where they account for more than 53 per cent of the population, while men outnumber women in fishing (20:1), construction (17:1) and transport (13:1) (Plate 3.2). There are more men than women amongst the ranks of employers and regular employees (skilled and unskilled). Amongst the urban poor and unskilled casual workers, women outnumber men (Table 3.17).

Women dominate amongst the unpaid family workers. Thus, 70.7% of the unpaid family workers in poor households in rural areas are women and in the urban areas they account for 90.5 per cent. The proportion of women among the unpaid worker category in urban areas is higher than the corresponding proportion in rural areas, suggesting that the proportion of women in the family worker category remains high irrespective of location. The levels of unemployment in all areas are higher for women than for men.

Table 3.16. Gender distribution of economically active population by type of industry

Industry	Rural Poor		Urban Poor		Rural Non -Poor		Urban Non -Poor		All Poor		All Non -Poor	
	Male	Fema	Male	Female	M	F	M	F	M	F	M	F
Agriculture	46.4	53.6	39.4	60.6	44.0	56.0	35.8	64.2	46.0	54.0	43.6	56.4
Forestry	82.6	17.4	89.7	10.3	63.8	36.2	81.9	18.1	83.5	16.5	66.2	33.8
Fishing	95.4	4.6	76.6	23.4	89.2	10.8	84.3	15.7	90.9	9.1	88.8	11.2
Sales/Services	66.3	33.7	53.7	46.3	65.4	34.6	64.4	35.6	59.9	40.1	64.9	35.1
Manufacturing	70.7	29.3	89.6	10.4	83.9	16.1	75.8	24.2	81.9	18.1	80.4	19.6
Mining	91.8	8.2	100.0	0.0	100.0	0.0	89.3	10.7	93.4	6.6	95.4	4.6
Transport	92.9	7.1	97.7	2.3	97.9	2.1	96.0	4.0	95.2	4.8	97.2	2.8
Construction	94.3	5.7	99.5	0.5	98.5	1.5	96.3	3.7	97.3	2.7	97.9	2.1

Source: Government of Kenya, Welfare Monitoring Survey - 1997

Table 3.17. Gender distribution of active population by employment status (%)

Employment Status	Poor				Non-Poor			
	Rural		Urban		Rural		Urban	
	Male	Female	Male	Female	Male	Female	Male	Female
Unemployed	49.9	50.1	37.7	62.3	44.8	55.2	38.2	61.8
Employer	84.2	15.8	69.9	30.1	70.2	29.8	75.0	2.5
Regular Employee (Skilled)	84.2	11.4	82.1	17.9	75.8	24.2	72.8	27.2
Regular Employee (Skilled)	84.2	15.8	69.9	30.1	70.2	29.8	75.0	25.0
Casual Employee (Skilled)	86.7	13.3	94.6	5.4	90.0	10.0	77.6	22.4
Casual Employed (Unskilled)	67.4	32.6	42.8	57.2	66.6	33.4	58.5	41.5
Own account worker	53.8	46.2	42.4	57.6	48.8	51.2	55.6	44.4
Unpaid family worker	29.3	70.7	9.5	90.5	26.2	73.8	10.8	89.2
Student/Apprentice	56.8	43.2	50.5	49.5	54.9	45.1	57.1	42.9
Pensioner/Investor	90.7	9.3	92.7	7.3	91.6	8.4	96.6	3.4
Sick/Handicapped	50.6	49.4	5.3	94.7	41.3	58.7	6.3	93.7

Source: Government of Kenya, Welfare Monitoring Survey – 1997

Plate 3.2. Women fetching grass for livestock

The World Summit for Social Development held in Copenhagen in March 1995, attended by representatives of 185 countries and over 100 Heads of State and governments made firm commitments to poverty eradication as an ethical, social, political and economic imperative of human kind. Subsequently, the United Nations declared 1997 – 2006 the decade of poverty eradication. However, the strategies for reducing poverty begun at independence when the government identified poverty a major obstacle to attainment of improved and sustained national development. Subsequent policy documents including the 9th. National Development Plan (2002-2008), the National Poverty Eradication Plan (NPEP), (1999-2015), the PRSP and Action Plan (2002-2005), the Economic Recovery Strategy for Wealth and Employment Creation (2003-2007) and the Millennium Development Goals are all focused on poverty eradication.

The government's commitment to proper environmental management was further demonstrated by the enactment of EMCA (1999) and the subsequent creation of NEMA. The principal goal of NEMA is to promote and ensure sound environmental planning and the integration of environmental concerns into the national socio-economic development planning processes at all levels. The government is further committed to ensuring that environmental resources are sustainably utilized and conserved by communities through effective participatory management practices.

The NPEP provides a long-term national vision and institutional framework for tackling poverty. It has three major components: on rights and responsibilities of citizens, strategy for improved access to essential services by low-income households and a strategy for broad based economic growth. The PRSP has specific measures for reducing poverty in an implementation matrix which shows cost of each measure, the implementing agencies, a specified time frame and indicators for monitoring expected outcomes.

The Economic Recovery Strategy Plan focuses on job creation and expansion of economic activities for poor farmers, informal enterprises and economically disadvantaged groups.

BOX 1. FUTURE OUTLOOK ON POPULATION DYNAMICS, SETTLEMENTS AND POVERTY

Population dynamics

- In order to consolidate the gains realized in population and environment programmes, more effort will be placed on promoting awareness on interrelationships between population, environmental concerns and development planning.
- The imbalance between population and environment can be dealt with using a dual approach of a population dimension coupled with one that deals with environment and development issues. More effort will be put to ensure effective implementation of monitoring and evaluation of projects and their sustainability.

Human Settlements

- The present condition of human settlements demands a pragmatic strategy for implementing existing legal instruments and policy initiatives, especially the Physical Planning Act (Cap 286), Local Government Act (Cap 265), EMCA (1999), the Water Act, the Roads Act, the Regional and Local Physical Development Plans and the Slum Upgrading Programme.

Poverty

- The poor rely heavily on natural resources for their livelihood. There is need for building on existing initiatives and strengthening ongoing process that take into consideration participatory planning and implementation of programmes and projects that integrate environmental concerns into development planning and decision-making, while at the same time enhancing sustainability.

- Actions which are directly relevant to the environment and which are imperative if Kenya is to reduce poverty are:
  - Reducing and halting of activities that lead to land degradation.
  - Conservation and sustainable management of the rich biodiversity.
  - Reduction of high rates of deforestation
  - Mitigation of the adverse impacts of climatic change and other atmospheric conditions.
  - Promotion of environmentally sound management of chemical products.
  - Improvement of access to and quality of fresh water sources.
  - Improvement of living conditions in urban areas.

CHAPTER 4

LAND USE AND BIOLOGICAL DIVERSITY

4.1. LAND

The total surface area of Kenya is about 587,000 km^2, out of which 576,000 km^2 is land surface and 11,000 km^2 is covered by water. Of the total land area, only 17 % is of high and medium potential, while the remaining 83 % is classified as arid and semi-arid lands (ASAL).

There are three broad classifications of land tenure systems in Kenya – trust/communal, public and individual/ private ownership. Land tenure reform has been a slow but continuous process and the current policy reforms are geared towards sustainable management of land resources. Trustland is communal land held by the local authorities in trust on behalf of the local communities, while government land is held by the central government on behalf of the public. Public land is categorized into trustland and government land in terms of access rights. Individual land tenure system is categorized into freehold and leasehold tenure in terms of access rights.

Land use refers to the type of uses that different areas are used for. Land use classification is influenced by climatic characteristics, socio-economic factors and government policies. Land use is dynamic and undergoes spatial and temporal changes in response to the prevailing ecological and socio-economic conditions. The temporal changes in land use give trends. A national land use policy is currently being formulated to address some of the shortfalls in the existing policy.

Land degradation and desertification is the net result of natural and human induced processes. It amounts to the reduction of land capability to satisfy a particular use. It manifests itself in loss and or degradation of soil, fauna, flora, water and biological productivity in areas under ecological stress.

Soil is an important non-renewable natural resource that supports life. In Kenya, soils are especially significant because of the importance of agriculture. Soil patterns are influenced by geology, landforms, altitude, and climate.

4.1.1 Soils

There are twenty-two (22) major soil types in the country, eighteen (18) of which are found in the ASAL. Table 4.1 shows the distribution of different soil types in different agro-climatic zones (ACZ). The distribution of soil types in different ACZs provides information that may faciltate planning of that use and management. Soils vary in their physical and chemical characteristics, being either saline or sodic or both. Table 4.2 lists major soil types, their characteristics, distribution, degradation hazard and major uses.

The government's initiatives that relate to soil conservation and management include the establishment of the Kenya Soil Survey Project, the National Soil and Water Conservation Programme, the Arid Lands Resources Management Project, the National Agriculture and Livestock Extension Programme, Sessional Paper No. 6 of 1999 on Environment and Development, National Action Programme to Combat Desertification, 2002, the National Environmental Action Plan (NEAP) of 1994, the enactment of the Environmental Management and Coordination Act (1999), the 8th National Development Plan (NDP) (2002-2008), the Agriculture Act (CAP 318), the Water Act (2001) and the Forests Act (CAP 385).

4.1.2 Land Tenure

In the high potential areas where individual land ownership is dominant, arable agriculture and relatively intensive livestock rearing are practiced. In certain areas this has resulted in the sub-division of land into small and unsustainable units often resulting in environmental degradation. Most ASALs are communally owned as trustland under county councils. However, there is ongoing change from communal to individual/freehold land ownership. Private ownership of land in the pastoral communities tends to restrict

movement under the traditional land use and management systems, which involve seasonal livestock migrations.

The rapid increase in human population over the last few decades has influenced land tenure arrangements in both the high and low potential areas of the country. The impact in the high potential areas is the sub-division of land to un-economic units. High dependency on agriculture and scarcity of land in high potential land has motivated large numbers of people to look for land in ASALs or migrate to urban centres.

The impacts associated with a tenure system vary from one region to another. Sub-division of land under individual tenure has varying impacts on the environment. Where land sub-division has been accompanied by poor land use practices, environmental degradation has taken place.

Table 4.1. Distribution of different soil types per ACZ (000 Ha)

Soil type	Agro-Climatic Zone						
	I	II	III	IV	V	VI	VII
ACZ extent	25054	23889	25636	28550	87397	126434	265687
Fluvisols	-	-	-	85	47	224	1780
Gleysols	47	-	38	9	-	-	684
Regosols	-	-	28	75	384	675	1012
Leptosols	112	59	60	187	628	609	3515
Arenosols	-	-	91	112	-	56	2464
Andosols	334	323	261	84	66	-	-
Vertisols	-	73	184	316	558	637	750
Solonchaks	-	-	-	19	9	534	1328
Solonetz	-	30	8	84	250	2172	6338
Phaeozems	112	179	267	374	553	66	-
Greyzems	-	112	9	-	-	-	-
Cambisols	418	284	410	636	1810	1566	3118
Luvisols	49	104	66	298	1588	1805	1809
Planosols	80	112	172	178	281	495	1271
Acrisols	459	112	187	380	853	487	1608
Nitisols	791	444	362	123	131	56	200
Ferralsols	131	415	431	140	745	1997	145
Histosols	94	-	-	-	-	-	-
Total	**2647**	**2247**	**2577**	**3100**	**7903**	**11379**	**26022**

Source: Muchena et al., (1987) with adaptations
NB. 1 km^2 = 1,000 ha.

Table 4.2. Distributions of the major soil types in Kenya

Type	Characteristics	Distribution	Land use	Degradation hazard
Histosols	Poorly drained; high *OM.	Swampy areas in Kano plains, Kisii, Uasin Gishu, Cherangani hills, Mt. Kenya, Elgon, Nyandarua.	Wetlands, papyrus, reeds, grazing, reclaimed under rice, bananas	Moderate – high soil acidity upon reclamation.
Leptosols	Shallow, rocky, low moisture storage.	Hilly, mountainous areas	Grazing, forestry.	High – runoff erosion.
Vertisols	Black cotton soils, imperfect drainage, cracking, high OM.	Plains of Athi, Kapiti, Kano, Kaputiei, Mwea, Bura East.	Rice, cotton, horticulture, grazing, maize, pigeon pea.	Low – gully erosion.
Fluvisols	Stratified layers, frequent alluvial deposits.	Floodplains of Tana, Kerio, Yala, Nzoia, Athi, Tana delta, Lorian swamp.	Dry season grazing, millet, sorghum, maize	Moderate- gully from stratification.
Solonchaks	High salt content, low OM.	Extensive in Garissa, Turkana, Marsabit Districts, Chalbi desert, Amboseli National Park.	Support poor natural vegetation, sporadic grazing, salt lick.	Moderate to high – wind & water erosion.
Gleysols	Poorly drained, high topsoil OM.	Swamps and marshes shores of Lake Victoria, Kisii bottomlands, Tana delta	Wetlands and riparian reserves, dry season. grazing, subsistence crops	Low – seasonal water logging.

Andosols	Young volcanic soils, well drained, porous, low bulk density, high OM.	High altitude volcanic areas like Mt. Kenya, Elgon, Longonot, Chyulu, Nyandarua.	Indigenous/plantation forestry, tea, coffee, dairy, potatoes, grazing, wildlife conservation.	Moderate to high – mass movements, water erosion, wind deflation.
Arenosols	Excessively drained, coarse texture, low *OM, low moisture storage, support poor natural vegetation.	Coastal, Eastern and North Eastern.	Support poor natural vegetation, cashew nuts, coconuts, mangrove, cassava, maize, grazing, sand harvesting.	Low to moderate – surface sealing.
Regosols	Well drained, loose material, rocky, stony, low moisture storage.	Steep upland, hilly and mountainous areas, west of Lake Turkana.	Support poor natural vegetation, indigenous forestry, grazing, wildlife conservation, limited sorghum and millet.	Moderate to high – overgrazing, causing high runoff.
Ferralsols	Strongly weathered, porous, high moisture storage, low fertility.	Eastern (Machakos, Kitui, Kajiado), Coast (Kwale, Taita-Taveta), Rift Valley (Kericho, Nandi, Trans – Nzoia).	Coffee, tea, maize, pulses; millet, cowpea, sorghum, grazing, wildlife conservation.	Moderate – water and wind erosion.
Planosols	Imperfect – poorly drained, slowly permeable subsoil.	Plateau and bottomlands in Nyandarua, Bomet, Laikipia, Narok, Tana River, Garissa, Kericho, Kwale, Kajiado.	Pasture for dairy, shallow rooted crops.	Low – seasonal waterlogging.
Solonetz	Sodic soils, high sodium content, poor soil structure, poor aeration, low OM.	Eastern and North Eastern (Mt. Kulal, Lake Turkana area, Tana River, Garissa, Wajir, Mandera, Marsabit, Amboseli National Park.	Supports poor natural vegetation, grazing, wildlife conservation.	Moderate to high – overgrazing causing wind and water erosion (gully).
Greyzems	Moderate to imperfectly drained, high OM.	Plateau adjacent to Olooloo escarpment in Transmara	Grazing, wildlife conservation	Low – seasonal waterlogging.
Phaeozems	Well drained, porous, high OM, high moisture storage	Narok, Laikipia, Athi Kapiti plains, Lunga Lunga in Kwale.	Wheat, maize, barley, peas, rape seed, extensive grazing.	Low
Nitisols	Kikuyu red loams, well drained, porous, high moisture storage, high structure stability.	Central Kenya, South Nyanza, Western Kenya, Emali, Marsabit.	Coffee, maize, tea, potatoes, vegetations, pulses, dairy, sorghum, millet, grazing.	Low – water erosion.
Acrisols	Well drained, porous, low base status, prone to surface sealing, low moisture storage.	Eastern, Central and Western Kenya.	Millet, sorghum, maize, pineapple, cowpea, pigeon pea, cassava.	Moderate to high – surface sealing causing high runoff.
Luvisols	Well drained, porous, prone to surface sealing.	Coastal, North Eastern and Eastern	Cashew nuts, cassava, mangoes, bananas, maize, cotton, millet, sorghum, cowpea, ground nuts, grazing.	Moderate to high – sealing causing water erosion.
Cambisols	Young little weathered.	Occur in association with other soils throughout the country.	Barley, maize, millet, sorghum, grazing.	Low –overgrazing causing runoff.

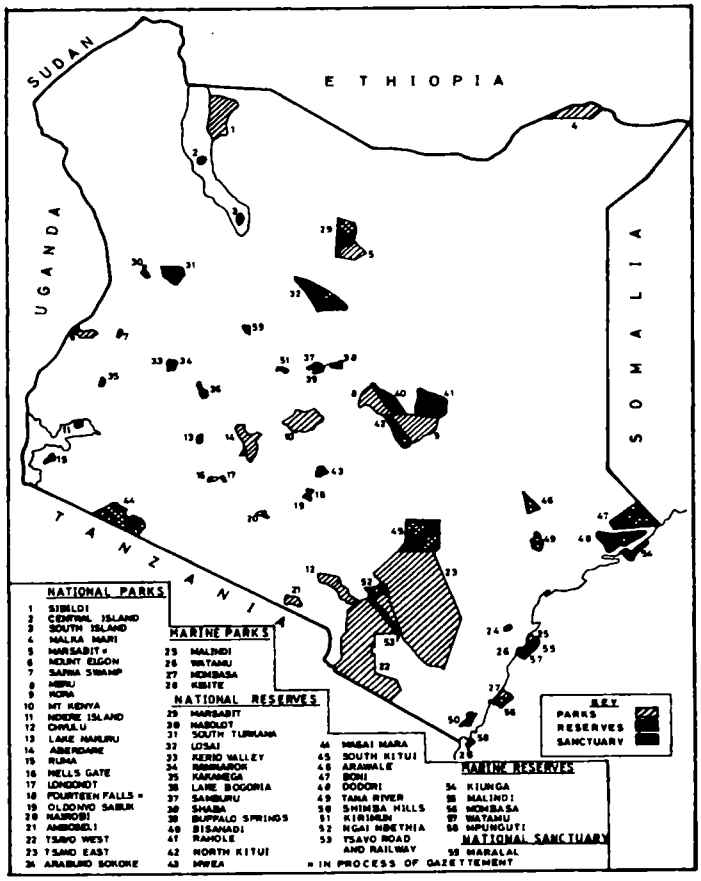
Source: Adapted from Sombroek et al (1982)
*OM – organic matter; *NP – National Park

Land use conflicts often occur in the ASALs between pastoral and agricultural communities. Conflicts arise mainly over water use and pastures. In areas affected by conflicts, conservation efforts are often neglected.

Government policies on land have historically determined the type of land tenure systems for different parts of the country. Under colonial rule, land policies set aside Scheduled Areas specifically for the White Settlers under individual land ownership. In the post independence period, the government land policies have been geared towards improving the economic status of the citizens through effective agricultural production. This was the genesis of land sub division and its inherent environmental problems.

The Government's response to land tenure issues include policies and strategies that are intended to protect public and individual interests in land and also to ensure optimal use of available land. Various legislation, policies and strategies that have been formulated over the years to address these issues include the Survey Act (CAP 299), Registered Land Act (CAP 300), Land Adjudication Act (CAP 284), the Government Lands Act (CAP 280), Physical Planning Act (CAP 286), Trustlands Act (CAP 288), Environmental Management and Coordination Act (EMCA), of 1999, Agriculture Act (CAP 318), the Njonjo Commission on Land Law Legislation, and Sessional Paper No. 1 of 1996 on Environment and Development.

Figure. 4.1. Protected areas in Kenya



4.1.3 Land Use

Land use is greatly influenced by climatic characteristics, socio-economic factors and government policies. Land use types vary with the agricultural potential and ecology of an area. Thus, the limits of productivity are dictated by prevailing climate, soils, hydrology and landform conditions. Agro-ecological factors also influence the suitability of an area for particular use (table 4.2). Land use is divided into four broad categories, namely crop production, livestock production, forestry development and wildlife conservation.

The ASAL areas cover over 48.0 million ha, of which 9.6 million ha support some form of agriculture, 15 million ha is only suited for livestock keeping and the rest (24 million ha) is dry and only suitable for nomadic pastoralism. Migrant farmers have often adopt farming techniques that are unsuitable to the ASAL environments. The high and medium potential lands (HMPL) cover 9.4 million hectares, of which about 1.1 million ha is covered by game parks (Figure 4.1), 2.8 million ha is cropland, 2.8 million ha is for grazing, 2.0 million is forested and 0.5 million ha is covered by urban centres, homesteads and other infrastructure.

Table 4.3 Land use potential in Kenya

Agro-ecological Zone	Potential land use	Percentage of total
I-III	Medium to high: intensive arable agriculture and livestock, forestry and some game parks	17 %
IV& V	Marginal to medium: Dryland agriculture and forestry, ranching and wildlife conservation	19 %
VI -VII	Marginal: extensive pastoralism and wildlife conservation	64 %
Total		100 %

Loss of biodiversity is brought about by continuous expansion of agriculture into hitherto forested or non-cultivated areas such as wetlands. Salinization in irrigated areas, soil erosion and depletion of ground water resources are some of the serious environmental damage of agriculture in the ASALs. Over-grazing and general land degradation is common in both high potential and ASAL areas where arable agriculture and livestock rearing are practised. Other impacts include land use conflicts, food insecurity, poverty and cultural erosion and social instability by immigrants, especially in the ASAL areas where populations are culturally conscious and conservative.

Responses related to land and land use include Sessional Paper No. 1 of 1965 on *African Socialism and Its Application to Planning in Kenya,* Sessional Paper No. 6 of 1986 on *Economic Development for Renewed Growth,* Sessional Paper No. 2 of 1994 on *National Food Policy,* and Sessional Paper No. 6 of 1999 on *Environment and Development,* National Policy on *Economic Recovery and Wealth Creation* of 2003, *National Development Plan* 2002-2008, Arid and Semi-arid Lands Development Policy (1992), the National Action Programme to Combat Desertification, Arid Lands Resources Management Project, National Agricultural and Livestock Extension Programme and the Poverty Reduction Strategy Paper (2001-2004). All these documents espouse the importance of sustainable land use with a view to conserving and protecting the environment and natural resources.

4.1.3.1 Crop Production

The need to feed the ever increasing population, provide employment to the labour force, provide raw materials to industry and earn foreign exchange for the country constitute the driving forces that cause environmental degradation in agricultural systems. Increasing food production in a sustainable manner in order to meet the needs of the growing population remains the biggest challenge for agriculture.

Productivity of the HMPL is declining in the face of the growing demand for food and other agricultural products. Soil erosion, declining soil fertility, flooding and loss of biological biodiversity are increasing in all areas.

Sub-division of land has resulted into small uneconomic sizes, which cannot be sustainably utilized. Intensive cultivation and encroachment on land only marginally suitable for cultivation, however, remain the main option. These options, however, have various impacts on the environment, some being negative and, therefore, not sustainable.

In the HMPL, agricultural production is mainly under rain-fed conditions or with minimal irrigation. Pests and diseases are common all the year round. However, their threshold to cause economic loss in production occurs seasonally. Most pests are detrimental to crops under dry weather conditions, while some cause damages when it is wet. Their prevalence also depends on crop type and enterprise mix at farm or agro-ecosystem levels.

Poor irrigation technologies have also resulted in soil salinization, as is the case in Kibwezi where farmers use furrow irrigation. Cultivation of riverbanks has accelerated the rate of riverbank erosion in most parts of the country. Irrigation of unsuitable soils and/or poor quality irrigation water has affected irrigation schemes in Taveta in Taita Taveta district, Matuu in Machakos district, Kinna in Meru district and along the Ewaso

Ngiro River in Isiolo district. Salination has occurred in 50% of soils under irrigation in the country. All irrigation schemes in ASAL areas are therefore considered to be under slight land degradation hazard due to salinity.

Credit for agricultural production has progressively been left in the hands of the private sector within the context of liberalization. The limited credit given to agriculture has compromised rural growth and poverty reduction. However, the government has renewed its interest in promoting credit to farmers and agricultural processors through micro-credit schemes, farmer-organizations, non-governmental organizations (NGOs), and cooperative credit programmes. Further low priority for research and development limits the contribution of technology in sustainable agricultural production. On the other hand, low rates of adoption of new agricultural technologies minimize the contribution of technology in sustainable agriculture and rural development. This is further complicated by inadequate budgetary allocation for agriculture, limiting provision and deepening of extension-research-farmer linkage through which technology transfer is realized.

Due to neglect and under-investment in rural infrastructure, most rural road and telecommunication networks have become dilapidated. This leads to inabilities to market or increases marketing costs for producers. To overcome these bottlenecks, the government has formulated a rural development strategy to provide a coherent framework for effective coordination of investment activities in rural areas.

Commodity price fluctuation either demotivates farmers to produce if prices are low or encourages them to expand production if prices are good. Inadequate policy, legal and institutional frameworks encourage unsustainable production patterns as a result of conflicting coordination with consequent negative impact on the environment upon which agriculture is based.

4.1.3.2 Livestock Production

Livestock sector contributes about 40% of agricultural gross domestic product (GDP) and about 10% of the total GDP. The dairy industry is well developed with an annual production of over 2 billion litres of milk. Small-scale holders account for 80% of the total milk production. The sector is a key source of income to over 60,000 households in the high potential areas. Sale of livestock and their products contribute significantly to incomes of rural households. Improving the productivity of all the livestock systems would significantly contribute to poverty reduction in the rural areas.

A number of factors limit increase in milk production. These include poor genetic potential of most of the existing herds, inadequate extension services, limited use of modern technologies and inadequate institutional frameworks. For example, liberalization of milk processing and marketing has led to the entry of a few private processors, which cannot cope with the total amount of milk produced by farmers.

Ninety per cent (90%) of beef cattle are owned by subsistence farmers and pastoralists. The cattle population in 1990 exceeded 10 million, while sheep was 5.9 million, camel (700,000) goat (7.7 million) most of which are found in the pastoral areas (Plate 4.1)

Emerging livestock practices include the keeping of ostrich, guinea fowls, donkeys and snakes. Snakes are kept for venom and skin and crocodiles for skin and meat. The ostrich population under domestication is approximately 10,000 and production is concentrated in the ASAL areas in the Rift Valley, Eastern and Coast Provinces. Guinea fowls and quails are mainly domesticated in western Kenya where they are considered a delicacy. Donkeys are kept all over Kenya mainly as a beast of burden.

Plate 4.1 Herding goats in a seasonal river bed in northern Kenya

Overgrazing on herbaceous and grass material as well as other vegetation types, leaves the ground bare. Soil compaction by livestock and farming machinery decreases the rainfall infiltration rate and increases surface run-off. This increases soil erosion thereby causing further land degradation. Examples of overgrazed areas are in Baringo, Keiyo, West Pokot, Turkana, Marsabit, Wajir, Tana River, Machakos, Makueni, Kitui, Nyando, and Mwingi districts.

Pastoralism is the main livelihood in ASALs. Seasonal transhumance is the major adaptation strategy for the limited forage and water. However, production faces a number of pressures/challenges such as drought, poor infrastructure and marketing systems. Pests and disease prevalence, resources use conflicts and inadequate institutional and policy frameworks further constraint the sector's development.

4.1.3.3 Forestry Development

Forest cover in the country has been decreasing due to clearing for settlement, cultivation, extraction of forest products, and fuel wood. With restricted access to government forests, the sources of tree/forest products are the agricultural and ASAL areas. The demand for charcoal especially in urban centres has caused severe deforestation, particularly in ASAL areas, which are the main sources of charcoal. The magnitude of the sale of charcoal along the Nairobi-Mombasa highway, Nairobi-Nakuru road, Mai Mahiu-Narok- Bomet and Machakos-Kitui roads gives an indication of the rate of charcoal production. It has also been reported that charcoal from Turkana district is sold in Kitale and Eldoret towns.

Cutting of trees in cultivated lands for fuel wood, timber and other construction materials is causing alarm in Central province, parts of Rift Valley province, and Eastern province. Deforestation that has occurred in water catchment areas of Mt. Kenya, Aberdares, Mau, Mt. Elgon and Kaptagat forests have negatively affected the watersheds. The ability of the water catchment areas to regulate run-off has been reduced with subsequent flooding, for example in Bundalangi in Busia district.

Forests are classified under four major types, based on climatic conditions (table 4.4).

Table 4.4 Classification of indigenous closed canopy forests

Type	Hectarage
Coastal Forest (e.g, Shimba Hills and Arabuko Sokoke Forests)	82,500 ha. (9.9% of the total region)
Dry zone forest (Dry zone hill top forests include Marsabit Forest and Taita Hills forests (main ones being Chawia, Mbololo, Ngangao, Kasigau and Vuria forests).	211,000 ha. (0.4% of the total region)
Montane Forest (Mt. Kenya forests, the Aberdares/Kikuyu Escarpment and Mau forests are examples of Montane forests)	748,500 ha. (18% of the total region)
Western Rainforest (The Kakamega and Nandi forests as well as small patches in Nyanza and Western Provinces are forests under this category)	49,000 ha. (1.9% of the total region)

Source: Forest Department records

Most forests which are classified as woodlands and bushlands are found on Trust Land and unalienated government land. There is limited information on the hectarage, quality and importance of these dry land forests. Mangroves are salt-tolerant evergreen forests that occur in the transition zone between dry land and open Ocean.

Nearly all plantation forests are found on gazetted government land. The plantations have been established to reduce pressure on indigenous forests and to maintain a sufficient supply of industrial timber for the country's needs. Between 1910 and 1946, the plantation forest cover doubled from 800 ha to 1,540 ha and by 1976, it had reached 143,120 ha. By 1988 it had reached 165,000. However, area under plantations rapidly declined from 165,000 ha in 1988 to 80,000 ha by 2003. Table 4.5 shows the stocked area by species as of 2003.

Table 4.5. Stocked area by species

Species	Area
Cypress	39,662 ha. (48.4%)
Pines	28,8144 ha. (35.2%)
Eucalypts	6,730 ha. (8.2%)
Others	6,744 ha. (8.2%)
Total	**81,950 ha. (100%)**

Source: Forest Department records

Over the years, the country has continued to lose most of its forest cover. Between 1990 and 2000 alone, the annual loss was estimated to be 93, 000 ha. A total of 67,184.6 ha was excised in 2001.

The total area of forest cover in Kenya has been a subject of debate over the recent past. This is because no recent survey has been conducted to determine the exact hectarage of forests. Further, there is no consensus on the proper definition that the country should adopt for a forest. For example, some areas that are included as forests, are not forested.

4.1.3.4 Wildlife Conservation

Wildlife contributes greatly to economic development through tourism and tourist related activities. Foreign exchange is generated through visits to the wildlife conservation areas such as national parks and reserves as well as sanctuaries. Employment is also generated through tourism. National parks and reserves currently occupy about 8% of Kenya's land area.

Major challenges to the wildlife sector are loss of natural habitats due to changes in land use, inadequate policies on wildlife conservation, poaching and encroachment of conservation areas often resulting into transmission of diseases and resource use conflict. Communities' negative attitude towards conservation is partly due to the extremely low compensation offered for losses caused through wildlife conflicts.

Environmental degradation due to loss of tree cover and soil degradation in certain parks such as Amboseli as well as overstocking in Amboseli, Masai Mara and Laikipia has also increased habitat degradation. Degradation of conservation areas results in, reduced number of visitors, decreased employment opportunities, drop in foreign exchange earnings, reduction in animals numbers, encroachment of buffer zones and migratory corridors and destruction of breeding habitats.

The Wildlife Conservation and Management Act (1976) provides for the protection, conservation and management of wildlife in Kenya, while the Forests Act (Cap 385), provides for the proper management of forest resources. Both are due to be amended to be in tandem with current challenges. The Environmental Management and Coordination Act (EMCA) of 1999 also supports the conservation of wildlife habitats both in and outside protected areas.

4.1.4 Land Degradation and Desertification

In the fragile dryland ecosystems, land degradation greatly reduces land capability to support human, animal and plant life. Land degradation also occurs in the high potential areas, especially where inappropriate agriculture is practised.

Soil erosion causes decline in soil fertility. It further causes soil surface sealing and reduced infiltration rate, which reduces water availability to plants. This problem is common in Machakos, Kitui, West Pokot, Baringo, Keiyo and Marakwet districts.

Table 4.6 Magnitude and distribution of erosion hazard in Kenya

Hazard Class	Extent (km^2)	Distribution (%)	Areas of occurrence
Very slight	253,900	43	Plains and flood plains in Northern-Eastern, Eastern, Coast and parts of Rift Valley provinces
Slight	51,600	8	Dissected plains of gentle slopes along Athi and Tana Rivers, Coastal Plains and Uplands of Kwale and Kilifi Districts, Kajiado District and North-western Kenya.
Moderate	140,100	24	Humid to semi-arid Uplands east and west of Rift valley.
Severe	56,500	10	Lower foot slopes of major mountains and mountain ranges.
Very severe	22,100	4	Mountains and ridges
Non-hazard	-	11	Lava flows in northern Kenya and Chyulu Hills.

Source: Mwango and Okoth, 1990.

The degradation hazards of saline and sodic soils in the country is estimated to cover about 217,800km^2 in the ASALs in north-eastern province which is about 40% of the land surface of the country. The magnitude and distribution of soil erosion hazard in Kenya is influenced by rainfall erosivity, soil erodibility, and slope of the land and soil cover (table 4.6).

Vegetation degradation in the ASAL is due to overgrazing, uncontrolled burning, fuelwood and charcoal burning, devegetation, and cultivation pressure after sub-division of ranches, installation of water points and settlements of pastoralists and refugees. This is found in districts like Samburu, Turkana (around Kakuma refugee camp), Garissa (around Dadaab refugee camp), Laikipia (ranches sub-division for cultivation) and charcoal burning along major highways.

Land degradation is also caused by inappropriate land use practices, overstocking/overgrazing, deforestation, poor irrigation methods, over exploitation of aquifers, intensive tillage and cropping, recurrent drought and climate change, among others. These factors often lead to problems that threaten natural resources base and the sustainability of ecosystems that support life.

Land degradation has reduced agricultural productivity, carrying capacity of grazing lands, water quantity and quality, and fuel wood output. About 35% of the country is vulnerable to land degradation and

desertification. This intense human pressure on the ecosystems has led to accelerated land and watershed degradation due to deforestation, poor land use, inappropriate farming practices, soil erosion, water pollution and sedimentation as well as siltation of lakes, dams and rivers.

Kenya is prone to cyclic droughts; major droughts occur every ten years, minor ones every 3- 4 years and yearly in northern districts of the country. Drought causes loss of ground cover. This climatic phenomenon causes significant and frequent variability in agricultural production, reduces crop diversity, causes market failures and increased economic losses. Drought also causes mass movement of people and animals, shortage of water, overgrazing, shortage of energy and food, which indirectly lead to loss of biological and economic productivity of the land.

Land degradation results in loss of soil fertility and biodiversity, which are the basis of sustainable agricultural production. This exacerbates rural poverty and social insecurity as evident in certain parts of northern Kenya.

4.2. BIOLOGICAL DIVERSITY

4.2.1. Introduction

Kenya has a wide range of plant and animal life. These are important sources of food, beverages, medicine, forage, vegetable oil, fibre and hides and skins. It has been estimated that there are 35,000 known species of plants, animals and microorganisms in the country. However, many species still remain unknown and possibly not even discovered. This indicates that the country has one of the highest gene pools with some species being either endemic, rare, threatened or vulnerable.

Inland water ecosystems contain a broad variety of fauna and flora. For example, Lake Victoria has over 250 fish species, most of which are endemic; LakeTurkana has 48 fish species of which ten are endemic; Lake Magadi has one fish species, which is endemic whereas the rest of the alkaline Rift Valley lakes are poor in fish resources. The Tana, Yala, Nzoia, Athi, Uaso Ngiro (North) and Malewa rivers largely contain non-cichlid fish species. Tana River system harbours the largest number of riverine fishes species. The cold upper reaches of the Tana River harbour trouts that were introduced during the colonial era.

The coastal and marine ecosystems are home to a wide range of animal and plant communities of the coral reefs, offshore islands and intertidal zones. The coastline is indented with river estuaries and creeks, many of them lined by mangrove forests teeming with different types of fish, crustaceans and molluscs. Mangrove swamps occur along parts of the Kenyan shoreline, especially in sheltered creeks and estuaries. Eight species of mangroves occur, the commonest of which is *Rhizophora mucronata*. Lamu district has the country's most extensive mangrove swamps.

4.2.2. Agricultural Biodiversity

Some plant and animal species are either domesticated or are in the wild. Plants that have been domesticated include cereal crops some of which have adapted very well owing to their remarkable physiological adaptability. The genetic diversity in agro-systems in the country is threatened by pressure from cross breeding and the introduction of exotic varieties of crops and animals. Today millets have been largely replaced by maize as the leading staple food and it is produced in all the arable parts of the country. The high and unsustainable consumption of resources by a small but fairly rich minority of the country's population, coupled with the destructive habits of the poor people in a desperate bid for survival, have altered, over-exploited or destroyed natural habitats where biodiversity resides, thereby affecting the status of local agricultural biodiversity.

The greatest factor contributing to the loss of crop and livestock genetic diversity in the country is the spread of high-input agriculture and displacement of the more diverse, traditional agricultural systems in the higher potential areas. Beginning in the 1960s and 1970s, high-yielding varieties of crops were gradually introduced to replace traditional crop varieties and their wild varieties. Consequently, traditional crop species suffer

from neglect and under-utilization by a wide segment of the society. This undermines conservation efforts of certain genetic resources, which would otherwise be source of livelihood were it not for the changing production and consumption patterns.

Kenya is now the second-leading world exporter of cut flowers, which are mainly grown in the central highlands and the Rift Valley. Almost all the varieties grown are exotic, with roses and carnations being the leading species. Considerable diversity occurs within and between species.

The country is also rich in animal diversity. Domesticated animal diversity includes cattle, sheep, goats and camels. The East African Goat is indigenous to East Africa and is mainly found in the semi-arid areas of the country. It is quite resilient and survives in very harsh environments.

The Galla Goat breed is indigenous to northern parts of Kenya. It has distinct intra-species diversity. The breed is hardy and thrives well in the dry low altitude parts of northern Kenya. The Red Masai Sheep is predominantly reddish-brown in colour and are kept by the Masai community. It is famous globally for its genetic trait of resistance to the flat worms, which affects the quality of wool in sheep. Encroachment of arable agriculture threatens its habitat.

The exotic sheep breeds are predominantly found in the highlands west and east of the Rift Valley and include the white Merino and the Corriedale. Their population has declined considerably as a result of the collapse of the major wollen mills, expansion of crop cultivation in the former sheep farms and inadequate policies.

The ability of the East African shorthorn Zebu cattle breed to adapt to varying ecological conditions and survive disease epidemics enables the breed to thrive in the arid and humid areas. This makes it the preferred choice of many communities. Intra-species diversity occurs within this breed. For example, two main types have developed through natural and local selection: Large East African Shorthorn Zebu, found mainly in the drier areas of northern Kenya, and the Small East African Shorthorn Zebu occurring in the wetter areas of Kenya. The animals are valued for their resilience, which enables them to survive harsh environments. The main threats to this breed are diseases such as *trypanosomiasis* and *brucellosis* and cross breeding with the exotic breeds leading to genetic loss. The Boran breed is an important dual-purpose local breed mainly found in the drier northern parts of the country. It is tolerant to extreme climatic conditions and most of the endemic livestock diseases. It is also well known for its meat quality.

A number of exotic breeds are also found in the country. They are found in the highlands, especially in large farms in the Rift valley. Dairy and beef breeds are common in the highlands and the Rift Valley.

Government policies, promoting export crops such as tea and coffee have resulted in neglect of the production of certain crops in some parts of the country. Intensification of production causes stress, nutrient depletion, soil erosion, reduction of genetic diversity among major crops and eventually broader consequences on biodiversity. The loss of indigenous knowledge on food production and ecosystems is inevitable as a result of rural to urban migration, and neglect, with the potential loss of certain indigenous crop genetic resources.

Relevant international responses include various multilateral environmental agreements (MEAs) such as the United Nations Convention on Biological Diversity (UNCBD), United Nations Convention to Combat Desertification (UNCCD), United Nations Framework Convention on Climate Change (UNFCCC). National policies and programmes include the National Agriculture and Livestock Extension Programme (NALEP) and the National Biodiversity Strategy and Action Plan (NBSAP).

4.2.3 Forest Biodiversity

Forests rank high among Kenya's important resources and are an integral part of national development. In 1991, closed canopy forests were estimated to cover 1.24 million ha. This was just about 2% of the

country's land area. Recent estimates based on remote sensing data indicate that against a global forest cover of 21.43%, and an average for Africa of 9.25%, Kenya's forest cover stands at a critical 1.7%.
Most of the closed indigenous forest canopy cover occurs in large gazetted forest blocks. This is restricted to semi-humid and humid areas, where they occur as islands on top of inselberg structures in the lower parts of the country, along rivers, and in the narrow, wet coastal belt. The savanna woodlands and bush land forests are the most expansive, occupying about 61.4% of the land cover in 1995. Most of these forests are found in the semi arid areas.

Plantation forests have been established to meet the growing demand for industrial wood. Existing indigenous forests are being replaced with the fast growing exotic trees. Kenya is also well endowed with mangrove forests, which cover 54,000 ha, found in Lamu, Tana River, Malindi, Kilifi, Mombasa and Kwale districts. Additionally, households grow trees as an integral part of their land use systems. Such trees provide a range of products including construction timber, wood fuel and non-timber forest products. The recent decrease in wood supply from government plantations raised prices of farm wood. The ban on plantation logging instituted by the government in 1999 also resulted in an increased demand for wood products from private farms.

The management of gazetted forest reserves is vested in the Forest Department. In addition, forests are found in national parks and national reserves managed by the Kenya Wildlife Service (KWS) and national monuments managed by National Museums of Kenya (NMK). Examples of forests managed by the NMK are the *Kaya sacred* forests found in the Coast Province; the City Park, the *Njuri Njeke* in Meru, *Mathembo* in Ukambani and the *Mukurwe Wa Nyagathanga* in Muranga. Table 4.7 shows indigenous forest cover in the national parks and reserves. An estimated 100,000 hectares of forest are found in trust land and vested in the respective local authorities under the Ministry of Local Government. Much of this land has been proposed for gazettment as forest reserves.

There are also indigenous forest areas under private ownership, either as units held individually or within group ranches. Many of this usually smallholdings are important for water catchment functions. Data on the actual size is not available.

Table 4.7 Indigenous forests in national parks and reserves

Category of Gazettment	Total Number	**Total area (Ha)**	**Area under indigenous forest (Ha)**	**% of area under indigenous forests**
National Parks	22	2,904,690	63,000	2.17%
*National Reserves	28	1,537,174	14,000	0.91%
**Marine Parks and Reserves (Mangroves)	8 (4 Parks and 4 Reserves)	51,000	14,000	27.45%
Total		**4,492,864**	**91,000**	**2.03%**

Source: KWS: Summary of National Parks and Reserves (1999) and Wass (1995).

* This figure does not include the Mt. Kenya National Reserve covering 2,124 km^2 (212,400 ha.) that was gazetted in 2000 by Legal Notice # 93 of 24th July 2000
** Assumed to include both parks and reserves only using the category of marine reserves.

In 1994, gazetted forest reserves accounted for 1,687,390 ha. Included in this category are most of the large, closed canopy forest units in the Aberdares, Mt. Kenya, Mt. Elgon, Mau and plantations. Since 1994 this area has declined to about 1.2 million ha.

Most of Kenya's forests are lost through excisions (table 4.8), illegal logging, charcoal production, illegal cultivation, encroachment for settlement and farming, livestock grazing, landslides and quarries/mining, forest health problems (fires, pests and diseases and game damage), and settlements in trustlands. Further, weak political and institutional framework contributed to loss of forest cover. Table 4.9 shows summary of forest additions.

Impacts of forest loss include loss of water catchments and biodiversity, reduced water availability, reduced raw materials for industry, and reduced hydroelectric power generation capacity. It also affects agriculture and tourism.

The government has put in place a number of policy instruments to deal with the problems of the forestry sector, mainly degradation of forest ecosystems. These include the Draft Forest Policy (2004), Forests Act (Cap 385) and Forest Bill (2004), Environmental Management and Coordination Act (EMCA) of 1999, the Water Act (2002), the Wildlife (Conservation and Management) Act (1985) and the Poverty Reduction Strategy Paper (PRSP).

Table 4.8. Summary of forest reserves excised/ proposed for excision

Year	Total Official Excisions	Proposed Excisions
1963 - 1969	90,716 ha.	45 ha.
1970 - 1979	12,272 ha.	12,201 ha.
1980 - 1989	44,067 ha.	4,593 ha.
1990 - 1994	6,659 ha.	1,433 ha.
1995 - 1999	701 ha	5,243 ha.
Total	154,415 ha.	23,515 ha.

Table 4. 9 Summary of additions to forest estate

Year	Official Additions	Proposed Additions
1963-1989	86,889 ha.	302 ha
1990 - 1994	25,465 ha.	1,332 ha.
1995 - 1999	863*	11 ha.
Total	113,217 ha.	1,645 ha.

** Most of these were Kaya Forests that were declared National Monuments*

4.2.4. Wildlife

To conserve wildlife, the government established the national parks, which currently occupy about 8% of Kenya's land area. The gazetted protected areas and other sites of environmental significance in Kenya are in Table 4.10. The Kenya Wildlife Service is mandated to conserve and manage the wildlife, which has both economic and aesthetic values. The major threat to genes, species and ecosystems is loss of natural habitats due to changes in land use patterns and inadequate regulatory and management instruments. For example drainage of wetlands for agricultural purposes leads to loss of biodiversity. Table 4.11 shows total number of species including those extinct or under threat in Kenya.

In Africa, Kenya is ranked as third highest in richness in mammal species. Out of the 334 mammal species known to exist in Kenya, 10 are endemic.

The conservation of the elephant has been critical in the country as the species has been heavily poached for its ivory, which is highly priced internationally. By 1989 there were 16,000 elephants having dropped from 170, 000 in 1973. This drastic drop prompted the elephant to be placed in Appendix 1 of the Convention on International Trade in Endangered Species (CITES). By 1996, Kenya had a population of 26,000 elephants but then the down listing of the elephants to Appendix 11 has impacted negatively on the population due to rising poaching activity.

Loss or damage of crops by wildlife is common among farming communities living in areas where the animals co-exist with humans and where the migratory routes and dispersal areas for animals coincide with the farming or grazing areas for livestock. The elephants have been the major source of conflicts due to the destruction of crops. The incidents of lions predating on livestock have been also a source of conflicts. Other animals, which cause damage to crops, include the buffaloes, antelopes and baboons. The human

wildlife conflicts have been exacerbated by people encroaching into protected areas, dispersal areas and migratory routes due to limited space.

Table 4.10. Protected areas and other sites o si ni icance in Kenya

	Number	Area in ha.
National parks	22	2,905,002
Marine national parks	5	5,400
Nature reserves	11	52,679
National reserves	22	1,452,755
Marine national reserves	5	70,609
Game sanctuaries	1	500
Forest reserves	203	1,669,022
Private reserves	6	13,363
Biosphere reserves	5	1,334,559
Ramsar wetlands- Lake Naivasha	1	18,800
Proposed protected area	143	938,501
Total	**272**	**6,103,288**

Source: Records of the National Environment Secretariat

Table 4.11. Total number of species in Kenya including those extinct or under threat.

Taxonomic Group	Number of species	Number of species extinct	Number of Endangered species	Number of vulnerable species	Number of rare species
Microbes	1841	Unknown	Unknown	Unknown	Unknown
Protozoa	714	Unknown	Unknown	Unknown	Unknown
Plants	6817	2	31	54	70
Animals	23375	8	89	36	67
Total	34747	At least 10	At least 10	At least 10	At least 10

Source: Records of the National Environment Secretariat

Changing land tenure system, threat of subdivision of group ranches and lack of a comprehensive land use policy are a major threat to biodiversity conservation. Another threat to wildlife conservation is the conversion of pastoral lands to crop cultivation and subdivision of land. Fences erected in wildlife migratory corridors presents a direct threat to wildlife survival in such areas. The Nairobi National Park which is neighbouring the Kitengela area is an example of a conflict prone area because of the upcoming settlements which are fast closing the migratory corridor to the Kapiti plains.

Poaching of animals such as rhinos for their horns and elephants for their ivory has forced the authorities to place these animals under special protection. Inadequate policy guidelines on land use in ASAL areas, wildlife migratory corridors and dispersal areas presents additional challenges.

Many of the conflicts around and within the protected areas are as a result of scarcity of the resources. The search for grazing pastures have often forced pastoralists to trespass into the protected areas. Another conflict is brought about by transmission of diseases which are common to both livestock and wildlife. Such zoonotic diseases include rinderpest and foot and mouth.

The government continues to support the international ban on commercial trade in ivory and continues to press for the elephant to be placed in Appendix 1 of CITES. There exist measures for the regulation and access to genetic resources and benefit sharing. There are various legislation and regulations for the management of biodiversity. These include the Wildlife Conservation and Management Act (1976), the Forests Act (Cap 385), the Fisheries Act of 1989, the Antiques and Monuments Act of 1978, the Seed and Plant Varieties Act of 1979, the Agricultural Produce and Export Act of 1983, the Crop Production and Livestock Act of 1979, the Agricultural Produce and Marketing Act of 1977, and the Environmental Management and Coordination Act of 1999.

4.2.5. Aquatic Biodiversity

Kenya has a wide array of aquatic ecosystems; namely marine, coastal, fresh water and inland saline lakes, majority of these ecosystems are rich in biodiversity (Figure 4.2). Kenya has a total of 467 lakes and wetland habitats which cover about 1,460,300 ha which is 2.5% of the total land area. This includes eighteen large lakes and many small ones, six artificial lakes, marshes, swamps and the banks of the five main watershed river systems.

Kenya's 640km long coastline has a most distinctive coral reef, running parallel to the shoreline. It has a narrow continental shelf covering an area of 19,100 km^2. Among significant coastal features are the Lamu Archipelago with its extensive mangrove forests and the Ungwana bay into which both the Tana and the Athi Rivers discharge their waters into the Indian ocean through an extensive wetland system. The most productive fishing areas are found around the Lamu Archipelago, Ungwana Bay, North Kenya Bank and Malindi Bank.

Tidal wetlands include mangrove and salt marsh swamps at and around Lamu, the Tana delta (river mouth), Ngomeni, Mida Creek, Kilifi Creek, Takaunga Creek, Shimo la Tewa Creek, Maftaha Bay, Funzi Bay and between Wasini and Vanga. Mida Creek is well known as an important site for many species of wintering Palaearctic waders and the uncommon Crab Plover *Dromas ardeola*.

The rich biodiversity in the coastal and marine ecosystems has not been fully described. Over 935 species of fin fish, 240 species of crustacean 169 species of corals, 9 species of mangroves, over 300 species of macroalgae, 12 species of seagrasses, 344 species of mammals and 5 species of reptiles have been documented. This does not include phytoplanktons, zooplanktons and many other species yet to be documented.

Important marine habitats in the area include mangroves, coral reefs, turtle nesting beaches and seagrass beds. 1039 fish species and 240 invertebrates have been described. The documentation of the ichthyological diversity of the various drainage systems is however incomplete. Of significance are colourful reef fishes, particularly wrasses and parrot fishes. The marlins, sailfishes and tunas support an important sport fishery, while the inshore fishery forms an important commercial activity.

The coral reef is an important habitat that supports 70% of the offshore fishery. The marine fish production oscillates between an annual production of 4,000 -7,000 metric tons. In 1974, it hit an all time low of 3,416 metric tons, and in 1990 an all time high of 9,972 metric tons was recorded. Artisanal fishermen use simple boats and gear that can only fish within the inshore area. In the early 1990s about 15,000 fishermen operated some 4,800 boat of which only 20% were motorized. A commercial prawn fishery exists with currently four vessels trawling for prawns in Ungwana Bay. An estimated 71 metric tonnes was landed in the 2002. A number of reasons have been attributed to the low contribution from marine resources, one of which is the inability of the largely artisanal fishery to harness this resource as their fishing crafts limit fishing activities to the inshore area.

Marine farming in Kenya is in its infancy. Other than some traditional brackish water ponds, artisanal shrimp and oyster cultivation, coastal aquaculture has been restricted to capital-intensive shrimp culture on an experimental scale. There are three types of marine farming activities on the Kenyan Coastal environment. These are pond culture in cleared mangroves, on land behind the mangroves, suspension culture (cage and raft) in sheltered waterways that are of sufficient depth and rack culture in shallow intertidal areas (Figures 4.3).

Kenya is rich in avifauna with 1089 species presently listed. Birds play an important function, particularly in pollution and seed dispersal. About 86,000 water birds have been observed on the coastline. Coastal ecosystems provide a number of habitats for migrating and local birds. Tidal creeks are often lined with mangroves that may form dense swamps, which are ideal habitats for a variety of bird species. Out of 1089

species recorded in Kenya, over 450 species (41%) are found along the coastal strip. Mida Creek is a complex of marine and tidal habitat on Kenya's north coast. It is an important passage and wintering area for Palaearctic migrant waders. The coastline and Whale Island support significant breeding and nesting populations of terns. Up to 6000 waders have been recorded at any one given time.

There are eight marine turtles worldwide. Out of these five have been recorded along the East African coast. Two of them have been found nesting on the Kenyan shores. They are the Green Turtle (*Chelonia mydas*) and the Hawksbill Turtle (*Eretmochelys imbricata).* There are 22 known nesting beaches stretching from Funzi Island on the south coast to north of Manda Island in the Lamu archipelago.

Traditionally, marine turtles have been over-exploited for their meat, oil, and shell leather. Collection of their eggs now threatens their survival. Incidental capture of green turtles in fishing nets including trawls, drift nets and gill nets, in the open sea results in many turtles being killed, often as they try to reach nesting beaches. Development at the coast has also resulted in the loss of turtle nesting sites. Security lights on the shore at night, walls and other structures, solid and domestic wastes all have impacted negatively on the turtles.

The Kenyan coast is an important habitat for a variety of *Cetaceans.* These are severely depleted worldwide. It is also popular for its sea cows or manatees. The herbivorous Dugong dugong is threatened with depletion in the Eastern African coast. Local people use the meat, oil, skin and medicinal/aphrodisiac products of the dugong. Some animals are also killed accidentally by drowning when caught in fishing nets, when hit by powerboats and as a result of seismic exploration activity. The Indian Ocean is a sanctuary for great whales. Dolphins however, are not protected and thousands are lost each year through incidental killings during fishing activities.

Table 4.12. Status of some marine and coastal species of Kenya

	Common name	Scientific name	Threat Status
Mammals	Dugong	Dugong dugong	Vulnerable
	Sokoke pipit	*Anthus sokokensis*	Status unknown
	Amani sunbird	*Anthreptes pallidigaster*	Rare
	East Coast Akalat	*Sheppardia gunningi*	Rare
Birds	Clarke's weaver	*Sokokensis*	Status unknown
	Spotted Ground-Thrush	*Ploceus golandi*	Rare
		Turdus fischeri fischeri	
Reptiles	Green turtle	*Chelonia mydas*	Endangered
	Hawksbill Turtle	*Eretmochelys imbricata*	Endangered
	Loggerhead Turtle	*Caretta caretta*	Vulnerable
Molluscs	Triton's Trumpet	*Charonia tritonis*	Rare
	Green Snail	*Turbo marmoratus*	Commercially threatened
	Fluted Giant Clam	*Tridacna squamosa*	Indeterminate insufficiently known
	Pearl Oyster	*Tridacna maxima*	Commercially threatened
	Giant Afrcan Snail	*Pinctada spp.*	
Crustaceans	Spiny Lobster	*Panulirus spp*	Commercially threatened

Source: Records of the National Environment Secretariat

Apart from fish diversity, which is well documented, other flora and fauna are least known. Out of 75 species of fresh water snails recorded in Kenya, 28 species are found in Lake Victoria. Inland water ecosystems consist of a number of reserves and important bird species, which include the blue-breasted bee-eater, blue swallow and swamp flycatcher. Important fauna include mammals, reptiles and amphibians. Some aquatic mammals are endangered, including the rare Sitatunga. Table 4.12 shows the status of some marine and coastal species of Kenya, while table 4.13 shows a summary of marine parks, reserves, and biosphere reserves on the Kenyan Coast.

Eight of Kenya's main lakes are being degraded by a combination of siltation, reduced inflow, over fishing, introduced species and pollution. Virtually all swamps and marshes are in danger from encroachment by

agricultural activities. Other threats to fresh water ecosystems include drainage of swamps, water offtake, intensification of fertilizer and biocide inputs, unsustainable exploitation of papyrus, riverine forest destruction, disturbance of water bird colonies nesting on islands by fishermen, land degradation, mass death caused by pests and diseases and heavy tourism. Alien and invasive species are also a threat. These include the Nile Perch (*Lates niloticus*), the water hyacinth (*Eichhoria crassipes*), the Louisiana crayfish (*Procambarus clarkii*), and Azolla, or Red water fern (*Azolla filiculoides*).

Serious overexploitation of marine resources has led to biodiversity loss. Pollution has also contributed to the degradation of marine resources and habitats. In 2001-02, algal blooms and unknown fungal coral disease were experienced in the coral reefs. Seagrass beds are threatened by potential pollution and adverse impacts from fisheries and shoreline erosion. In the coastal and marine ecosystems there is serious overexploitation of the resources and pollution that has led to biodiversity loss.

4.13 Marine parks, reserves and biosphere reserves on the Kenyan Coast

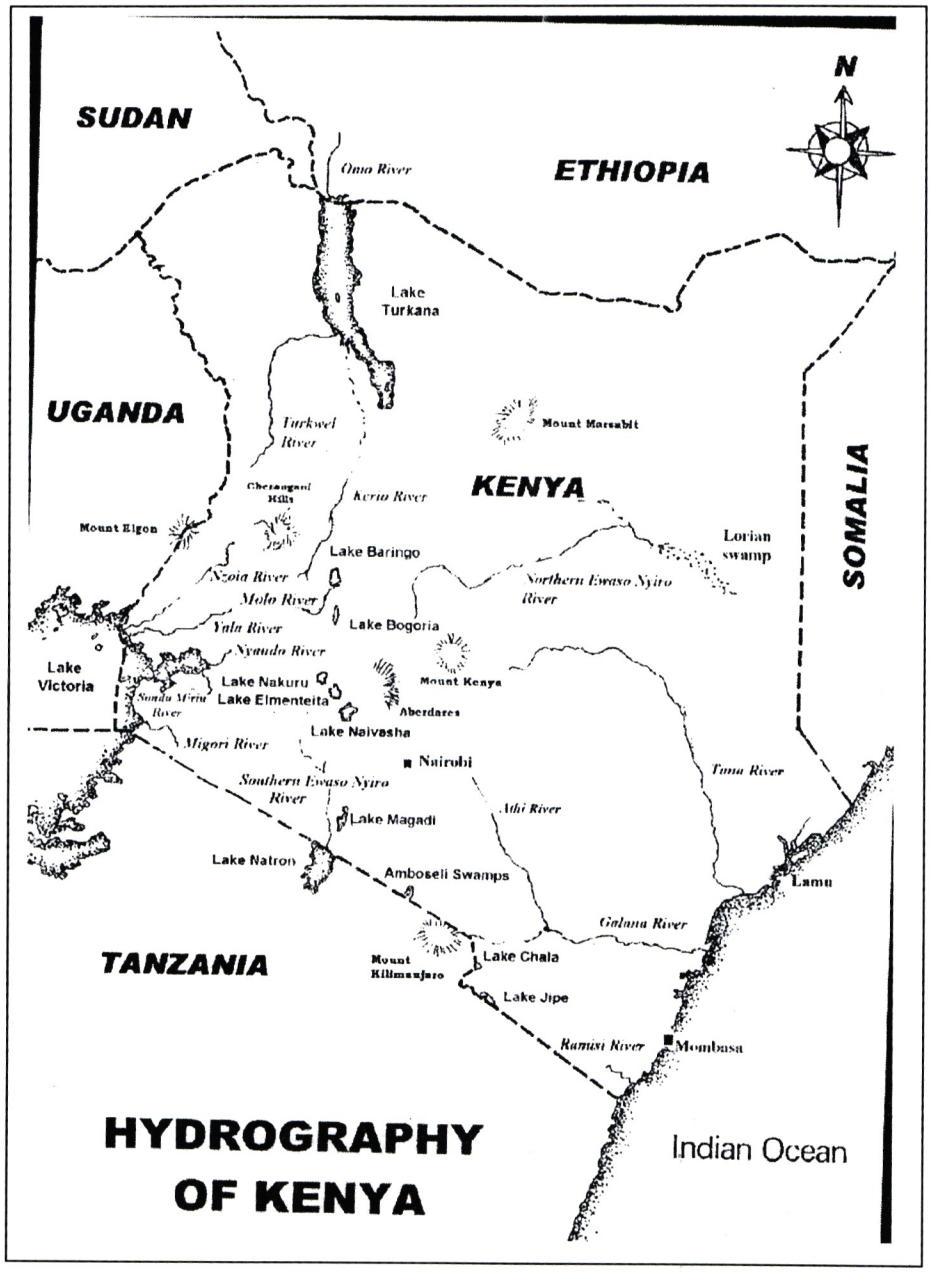
Name	Area (ha)	Year gazetted	Location	Resources
Malindi/Watamu Marine national Park and Biosphere Reserve	2000	1968	South of Malindi to Mida Creek. Close to Gedi ruins and Arabuko Sokoke Forest	Fringing reefs; coral 'gardens' in lagoons; seagrass beds; mangroves; mudflats; shorebirds
Kiunga Marine National Reserve and Biosphere Reserve	250000	1979	South of Somali border to within a few kilometres north of Lamu. Close to Dodori and Boni National Reserves.	Coral reefs; Islets with large nesting bird colonies (e.g. Roseate Tern); dugong; nesting turtles; pristine mangrove stands; remote and undisturbed.
Kisite Marine National Park and Mpunguti Marine National Reserve.	39000	1978	Off Shimoni south of Wasini Island	Coral reefs; 4 small islets important for nesting birds; fisheries etc.
Mombasa Marine National Park and reserve	200000	1986	To 13km offshore from Nyali to Mtwapa Creek	Coral reef ecosystem with associated beaches. High tourist use.
Proposed Tana River Delta Wetland Reserve	20000	Proposed	Southwest of Kipini	Undisturbed wetland (Ramsar candidate); birds turtles, numerous fish.
Diani Chale Marine Reserve	Approx 250	Being set up	25km South of Mombasa from Mwachema River to Chale Island	Coral reefs; fishing grounds; Mangroves; Seabird nesting sites; Limestone caves; High tourist use.

The introduction of the Nile perch disrupted the natural balance of the Lake Victoria ecosystem. The food chain is being altered and in some cases, broken by the indiscriminate eating habits of the Nile perch. The subsequent decrease in the number of algae-eating fish allows the algae to grow at an alarming rate, thereby "choking" the lake. The increasing amounts of algae, in turn, increase the amount of dead plant material that falls to the deeper portions of the lake before decomposing. This decomposition results in the depletion of the oxygen levels in the deeper layers of water. Without oxygen, any aerobic life such as fish cannot exist in the deeper portions of the lake, forcing all life to exist within a narrow range of depth. In this way, the Nile perch has degraded the diverse and thriving ecosystem of Lake Victoria.

Lake Bogoria is a national reserve under the management of Koibatek and Baringo County Councils. However, its existence is not free from controversy with the local people claiming not to benefit adequately from the income generated. The World Wide Fund for Nature (WWF) has supported a long-term community based wetland conservation programme aimed at enabling the local people benefit more from the conservation area. The lake is utilised for tourism, cultural purposes, pastoralism and is protected in the Lake Bogoria National Reserve. Lake Naivasha was declared a wetland of international importance (Ramsar site) in 1990. The riparian community received the Ramsar award for a community-initiated management plan.

In the long-term, perhaps the most serious impact is the potential for invasive alien species (IAS) to displace indigenous biological diversity. After habitat modification IAS is typically the second-biggest threat to biodiversity in most countries. Biodiversity is the building block of all life on Earth. Linked to the loss of

Figure. 4.2. Major aquatic ecosystems of Kenya (Adopted from Crafter et al. 1992).



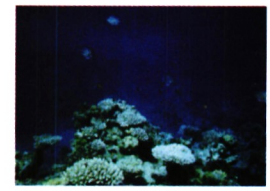


Plate 4.3. A section of hard and soft coral in Malindi (Photo by Natalie)

biodiversity is the threat that invasive species pose to the ecological integrity of natural systems. Environmental services received from natural ecosystems such as natural purification of air, water, and soil are vulnerable to ecosystem changes.

Virtually all reefs outside the marine parks are degraded to some extent. In the extreme south coast, dynamite fishing has destroyed some corals. They have been smothered by dredge spoils dumped at the mouth of Tudor creek, over fishing and pollution from direct discharge of wastewater from hotels.

Five marine national reserves have been established along the Kenya coastline, namely Kiunga, Malindi, Watamu, Mombasa, and Kisite-Mpunguti Marine Park and Reserve. A sixth is proposed for the Diani/Chale Marine refugia. They protect against excessive pressure on the resources since regulated fishing is only permitted in the Reserves.

Conservation action is done within a framework of several legislation and legal notices. Some of the recent measures include the agreement on uniform slot sizes, the ban on trawling, and the establishment of closed fishing areas for Kenyan waters.

4.14. Examples of threatened species

Threat level	Animal (Species)
Critically Endangered	Black Rhinoceros (*Diceros bicornis*). Tana River Red Colobus (*Procolobus rufomitratus*). Ultimate Shrew (*Crocidura ultima*). Tana River crested mangabey
Endangered	Blue Whale (*Balaenoptera musculus*). Fin Whale (*Balaenoptera physalus*). Giant African Water Shrew (*Potamogale velox*). Sei Whale (*Balaenoptera borealis*).
Vulnerable	Dugong (*Dugong dugon*). Dwarf Multimammate Mouse (*Mastomys pernanus*). Hopkins's Groove-toothed Swamp Rat (*Pelomys hopkinsi*). Humpback Whale (*Megaptera novaeangliae*). Rombo Shrew (*Crocidura monax*). Smoky White-toothed Shrew (*Crocidura fumosa*). Soemmerring's Gazelle (*Gazella soemmerringii*). Sperm Whale (*Physeter catodon*). *Spotted-necked Otter (*Lutra maculicollis*). (Not listed in 1996.)

There are also a number of statutes, which relate directly, or indirectly to the coastal and marine environment, its resources and their management. These include the Environmental Management and Coordination Act of 1999, the Water Act (Cap. 372), the Agriculture Act (Cap 318), the Forestry Act (Cap 385), the Government Fisheries Protection Act (Cap 379), the Industry Act (Cap 378), the Merchant Shipping Act (Cap 389), the

Wildlife Conservation and Management Act (Cap 376), The Maritime Zones Act, the Continental Shelf Act (Cap 312), the Land Planning Act, the Town Planning Act, the Local Government Act (Cap 265) and the Coast Development Authority Act. Kenya has also made a number of international commitments for the protection of the coastal and marine environment and its resources through ratification of relevant regional and international environmental agreements. Tables 4.14 show a list of threatened species.

4.2.6. Invertebrates

Invertebrates include all those organisms without a backbone and usually with an exoskeleton. They occupy dryland either above or below ground level and majority of them are insects, ticks, mites, millipedes, centipedes, annelids, nematodes, worms (platyhelminithes), molluscs and other related organisms. They are a very important biodiversity component of the environment but usually tend to be ignored in conservation matters.

Invertebrates play important role in the environment. Such roles include soil engineering (termites, earthworms and other soil dwelling organisms), plant pollination (bees, wasps, moths, butterflies and beetles), organic matter transformation (beetles, termites, flies, ants), trophic level relationship (majority are herbivores, which support organisms higher in the food chain such as birds, snakes, mammals including humans), destruction of food crops, pasture and vectors of diseases. Some invertebrates such as predators, parasitoids and parasites are important components of the integrated pest and vector management. Others are important in industry (the silkworm and butterflies). Some invertebrates are indicators of environmental health, while others are associated with religious and social values.

Terrestrial ecosystems are threatened by human activities. Such activities include bioprospecting for genes and species for biotechnology research and health management programmes. The impacts of overpopulation, climate change, biotechnology, food security needs, alien and invasive species on the invertebrates are manifested through loss of biological diversity of plants and grass species, which rely wholly on invertebrate pollination services. Globally, the Convention on Biological Diversity (CBD) identifies and recommends habitat conservation through the ecosystem approach in order to sustainably maintain the natural balances within species and populations. This includes the terrestrial invertebrates. The CBD agricultural biodiversity programme has identified the Integrated Pest Management (IPM) as a tool in conservation and also as a pollinator conservation component. The Africa Pollinator Initiative is the continental programme aimed at achieving the Global Pollinator Initiative (GPI), which aims at enhancing pollinators' conservation consciousness and promoting their management. The national initiatives on the conservation of invertebrates include: the Poverty Reduction Strategy Paper (PRSP) which addresses the overall strategies for the conservation of natural habitats and sustainable agriculture and the National Bee Keeping Research Station which promotes bee conservation as a livelihood activity and enhances the maintenance of habitat quality. The local universities also have courses on invertebrate biology.

4.2.7. Micro-organisms

Microorganisms include bacteria, fungi and viruses all of which have various roles in the environment. Some of their contributions to the environment include decomposition of organic matter, mineralization and nutrient cycling, biogeochemical cycling of elements, and the degradation of xenobiotics. Some are disease-causing pathogens to both plants and animals including human beings.

Micro-organisms have been used to advance medical technology, food processing, safety and quality, environmental cleaning and agricultural biotechnology, with remarkable achievements. However, the microbiological database in Kenya is quite scattered since there is no national microbiological culture collection centre. Most bacteria have large plasmids, which are useful for gene transfer in nature; this can help in the spread of antibiotic resistant genes. Research on effective microbes (EMS) indicates that several micro-organic species may have domestic and industrial and or commercial applications to treat water, soils and for medical uses.

There are several pressures that affect micro-organisms. Activities that have negative impact on microorganisms include agricultural practices, forest clearing, release of effluents to the environment and

water sources, air pollution and biotechnology. Other source of impacts are climate change, which has altered the global weather patterns, and led to loss of microbial diversity associated with soils and plant life. Plants play a key role in the microbial populations since they are a source of organic matter for decomposers in various bacterial groups and fungi. Poor agricultural practices lead to land degradation which affects microbial diversity

Both bacteria and fungi play an important role in environmental sustainability. Plants are a source of nutrients to those microbes within the rhizosphere. Research has shown that rhizosphere soils have up to 10 times more microorganisms compared to non-rhizosphere soils. Microorganisms can only carry out their activities with constant supply of nutrients. If this is depleted then the numbers drop drastically. Plants also form some symbiotic relationships with microbes, such as the legume-Rhizobium symbiosis and mycorrhizae. Genetically Modified Organisms (GMOs) also called Living Modified Organisms (LMOs) possess a novel combination of genetic material obtained through the use of modern biotechnology. The impact of genetically modified crops are yet to be seen.

However, the impacts of altered environmental state on the microbial life is tremendous. Use of antibiotic marker genes in the transformation process is a genuine concern considering that antibiotic resistance amongst bacteria of medical importance is already a problem. The impact of *Bacillus thuringiensis* toxin released by certain crops on non-target soil microbes is not known.

Clearing specific plant hosts of various disease-causing organisms will create a big imbalance with potentially significant consequences. These microbes will look for alternative hosts, which are likely to be crops and cultivated tree species. Forest clearing, soil erosion and agricultural practices, which use high doses of inputs will result into reduced microbial diversity, clearing of most saprophytes and several other groups which cannot resist the various stresses that accompany environmental change.

4.2.8. Biotechnology and Biosafety

Biotechnology has been used for thousands years to make the well-known products such as beer, cheese and a whole range of fermentation products. Biotechnology has advanced rapidly following the discovery of the recombinant DNA in the 1970s. This discovery introduced new and modern biotechnology techniques known as genetic engineering. This technology is used to break the hybridization biological barriers to such an extent that new products, which hitherto could not be produced by conventional biotechnology, are now being produced in laboratories.

There is also research on the identification and use of molecular markers for various crops such as tea, coffee, maize and bananas. Other areas that are receiving attention relate to the production of vaccines for control of livestock diseases such as rinderpest, contagious bovine pleuro-pneumonia and foot and mouth diseases. On human health, some work is being undertaken to develop vaccines for control of some of the tropical diseases such as malaria and leishmaniasis.

Genetically engineered crops may release Bt toxins to the environment with unknown consequences to the non-target microoganisms. They may also become invasive or modify world relatives with unknown consequences to the food crops and the environment in general. Imbalance on biological processes in the soil and pathogenic populations associated with forest trees affect the soil quality.

Importation of living modified organisms for food, feed and industry is covered by the Cartagena Biosafety Protocol within the article on Advanced Informed Agreement. However, the regulations and guidelines for Kenya states that the importation of biotechnology products such as GMOs into the country will require information relating to the description of the organism together with the natural history of the organism, its laboratory of origin, its destination in the country and its intended uses. Biotechnology activities are undertaken in various institutions, including the public, private and international organizations according to their research needs and mandates.

Most legislation directly or indirectly relate to safety issues. EMCA (1999) has specifically mentioned biotechnology and biosafety. The Science and Technology Act, which is under review also gives

prominence to matters of biotechnology and biosafety. There is also a draft legislation on biotechnology, which covers all living modified organisms. Regulations and guidelines on environmental conservation and management including biodiversity are being developed by NEMA in consultation with relevant stakeholders.

4.2.9. Access to Genetic Resources and Benefit Sharing

The main driving force on access and benefit sharing of biodiversity is sustainable utilization, commercialization of genetic resources and sustainable strategies for ownership, transfer of property rights and growth of biodiversity prospecting enterprises. Whereas the developed nations have access to value added products and developing countries possess raw materials, the latter benefit less than the former. Table 4.15 presents examples of selected world markets based on biodiversity.

Table 4.15 Examples of selected world markets on biodiversity-based products

	Pharmaceuticals	**Value**
1.	Drug market, 1993	≈ US$ 235 billion
	Pharmaceutical derived from plants	≈ US$ 59 billion
	Phytomedicine, 1993	US$ 12.4 billion
2.	**Agriculture**	
	Sales of pesticides	US $ 47 billion
	Seeds – 2000	US $ 7 billion
	Horticulture (UK, fresh flowers and plants 1991	US $ 1.6 billion
3.	Cosmetics, toiletries and perfumes	
	Total sale in the USA 1994	≈ US$ 20 billion
	Natural cosmetics & toiletries 2.5%	below $ 20 billion
4.	Tourism global output, 1995	US $ 3,400 billion
	Ecotourism in developing countries in 1998	US $ 12 billion

Regardless of the money generated from biodiversity as indicated in the above table, little goes back to conservation. Various treaties and conventions have addressed aspects of biodiversity and property rights within the context of environmental economics, equity and ethics. The Convention On Biological Diversity (CBD) is seen to facilitate a consultative forum for agreements on conservation, development and benefit sharing by recognising the sovereign rights of countries over their biodiversity. Access and benefit sharing regime has not been developed in Kenya. The draft "African model law for the protection of the rights of local communities, farmers and breeders, and for regulation of access to biological diversity" is basically derived from the CBD.

Intellectual property rights have been viewed as a tool to accelerate industrialization in the country. The country is a signatory to WTO, which was mandatory for anyone wishing to participate in global trade. Under WTO there is a section on trade related intellectual property (TRIP), which commit countries to patent their technologies.

The CBD commits countries to conserve biodiversity, access its components and equitably share resulting benefits. A major reason for forest degradation in Kenya is because forest adjacent communities have not been involved in decision-making and therefore do not feel responsible for its well-being. Under existing laws, adjacent communities have no role in gazetted forests.

However, there are examples of communities which have successfully managed forests jointly with the government. These include "Ekwar" of Turkana district, The "Kaya" forests of Coast province, protected for cultural purposes. There are ongoing initiations for joint forest management involving the following forests: Arabuko Sokoke, Mt. Kenya, the Aberdares, Taita forests, Leroghi forests in Samburu, Mt. Elgon and Kakamega forests.

Distribution of tourism benefits to local communities in Samburu is an example of benefit sharing. Samburu County Council derives 90% of its revenues from tourism. Benefit sharing from wildlife was distributed to Samburu communities in form of school bursaries and local employment.

The main pressure has been environmental degradation, extinction of some species, even disappearance of biodiversity- related indigenous knowledge. Intellectual property rights do not include protection of

traditional knowledge, innovations and rights of indigenous and local people. Right of indigenous and local people on biodiversity have been ignored by national and international laws.

CITES regulates exploitation of designated species to enhance conservation and sustainable utilization. Some of the plant species included under CITES in Kenya include, *Prunus africana* and Aloe species. Whereas this species have been regulated under CITES they continue to be illegally traded out of the country because no guidelines and enforcement mechanisms have been instituted.

The Kenya government has established KIPI (Kenya Industrial Property Institute) and the Kenya Plant and Health Inspectorate Services (KEPHIS) to handle matters regarding intellectual property rights. Kenya is signatory to most international arrangements on intellectual property through KIPI membership and participates actively in their negotiations.

Other government institutions, which play important roles in access and benefit sharing, are the Kenya Wildlife Services, National Museums of Kenya and the Forest Department. The government through EMCA (1999) recognises the need to involve local communities in biodiversity conservation and fair benefit sharing derived therefrom.

BOX 2. FUTURE OUTLOOK FOR LAND USE AND BIOLOGICAL DIVERSITY

Land-use

- The national land use policy being formulated should streamline land use in the country. It should address inadequacies, overlaps and conflicts in land use and tenure policies as well as implementation of the National Action Programme (NAP) to combat desertification.
- Enforcement of the development of environmental impact assessment (EIA) regulations, procedures and standards.
- Implementation of a national soil and water conservation programme.
- Promotion of environmental education.
- Promotion of private sector involvement in land management.

Forestry

- Drastic changes are required to address problems affecting the forestry sector
- Stringent measures on excisions and eliminating or significantly reducing existing backlogs in planning.
- Community involvement in forest management and proper silvicultural treatment should alleviate some of the problems affecting the forestry sector. Exploitation of indigenous forests should be based on sustainable yield principle.
- Constant policing of forest estates is necessary to ensure minimum destruction.

Biological Diversity

- Control inappropriate land use and encroachment into wildlife conservation areas.
- Create awareness on conservation and sustainable utilization of wildlife resources among the communities living adjacent to the wildlife sanctuaries and dispersal areas.
- Apply indigenous knowledge in biodiversity conservation alongside other approaches.
- Conduct regular surveys and monitoring of wildlife movements in the designated conservation areas as well outside to understand problems such as poaching in the parks and reserves.
- Share revenue generated through tourism with communities living in areas adjacent to wildlife conservation areas including sanctuaries and dispersal areas. This will not only improve the communities' welfare but will encourage them to conserve the resource.
- Develop a strategy on benefit sharing to address major concerns on biodiversity utilization.
- Enhance human, financial and technical capacity for biotechnology management. The activities in biotechnology should be coordinated centrally so that all work at all levels is channeled through a focal point.
- Intensify research to generate data on all aspects of biotechnology and genetically modified organisms (GMOs).
- Regulate utilization of aquatic, marine and coastal resources. Punitive measures should be taken against those who degrade the resource base in all ecosystems.

CHAPTER 5

WATER, HUMAN AND ENVIRONMENTAL HEALTH

5.1. WATER RESOURCES

5.1.1. Introduction

The total annual volume of rainwater in Kenya has been estimated at 360 billion Cubic Metres, contributing to both surface and groundwater. Population growth and proportionate demand for food has resulted in the reduction of vegetation cover both in the HMPLs and ASALs. The low vegetation cover results in reduced water catchment capacity. The problem is mainly a result of rainfall distribution and inadequate water supply infrastructure. The cost of installing efficient water supply systems is colossal, hence the government's decision to transfer direct provision of water services to independent water service providers.

5.1.2. Surface Water

Surface waters comprise of rivers, lakes, dams, pans/ponds and the ocean. Generally, the water in most rivers, streams and pans is fresh, but is turbid and often coloured at lower levels. They also contain bacteria and it is recommended that water from those sources should be treated before use.

The country has numerous permanent and seasonal rivers. Among the large and permanent rivers are Tana, Athi, Yala, Nyando, Miriu, Kerio and Turkwell. Tables 5.1 and 5.2 depict the characteristics of the major rivers and lakes in Kenya respectively. Over 28,000 abstraction permits have been issued for these surface water sources for domestic and livelihood use.

The water flow in the rivers and streams and the volume in the lakes, ponds/pans and dams have been decreasing as a result of demand by livestock, agriculture, domestic and industrial uses.

Table 5.1. Characteristics of major rivers in Kenya

River	Total Length (km)	Station Measurements Taken	Width (m)	Depth (m)	Flow (m3/Sec)
Tana	725	Kiganjo	12.00	0.36	0.35
		Tharaka	43.28	3.68	63.59
		Garsen	63.00	3.45	61.99
Athi	591	Thika	26.00	0.10	1.50
		New Kibwezi	5.70	0.48	0.38
		Lugard Falls	102.58	0.30	4.88
Kerio	320	Turgard	2.30	0.34	13.00
		Falls	0.70	0.10	0.10
			14.10	0.18	0.30
Turkwel	305	Turkwel Gorge	20.50	0.29	1.84
Nzoia	240	Webuye	28.69	1.77	10.14
		Moiben	4.70	0.31	0.44
		Nambale Market	26.00	1.86	23.30
Miriu	150	Matunda	1.60	0.11	0.01
		Sondu	35.00	0.72	4.73
		L. Victoria	17.00	0.83	5.64
Nyando	125	Ahero	16.00	0.50	1.88
		Muhoroni	10.48	0.40	1.14
		Londiani	3.50	0.38	0.08

Source: National Water Masterplan, 1992

Table 5.2. Major Lakes in Kenya

Lake	Area (km^2)	Average depth (m)
Naivasha (Fresh)	115	6.5
Victoria (Fresh)	3785	45
Baringo (Fresh)	130	10
Turkana (Brakish)	6405	120
Elemeitaita (Saline)	18	1.1.
Nakuru (Saline)	5-30	4
Magadi (Saline)	100	-
Bogoria (Saline)	34	10

Water supply is affected by uncontrolled diversion, degradation of catchments, microclimatic and weather changes, changes in settlement patterns and increased human population. The need for good sanitation to control water borne diseases exerts pressure on the existing water supply facilities. Furthermore, large populations in refugee camps at Kakuma and Daadab have exerted a lot of pressure on existing water resources. Among the major impacts are increased treatment costs arising from high chemicals usage and increased incidents of waterborne diseases where untreated water is consumed. Declining water source yields results in lower water supply per capita and people travelling longer distances to water collection points. In some instances, conflict over water resources have been on the increase.

Some programmes put in place as a response to the above problems include additional financing to the sector, compliance and enforcement in water apportionment, environmental inspection, water resources planning, quality surveillance and small scale rainwater harvesting. A major policy shift was the creation of a new Ministry of Water Resources Management and Development (MWRMD) under the Water Act (2002). Additionally, irrigation units, formerly in various ministries have now been placed under MWRMD as has the ASAL Programme. The Water Act (2002) provides for the coordination of lead agencies in water quality and supply management. Recent developments include enforcement of requirements in EMCA (1999) in regard to environment impact assessment as well as environmental audits and monitoring. Development of environmental regulations, standards and guidelines is ongoing.

5.1.3. Groundwater

Groundwater is estimated to be 619 million cubic meters, which is 14 % of national water resources. Of this amount, 69% is located in shallow aquifers, while 31% is in deep ones. Ground water resources vary both qualitatively and quantitatively and are unevenly distributed. In most of the high rainfall areas, there are many fresh water aquifers with high yields, while in the drier areas, aquifers are low yielding and of poor quality. Over 14,000 boreholes have been drilled countrywide with the average abstraction yield of 7 m^3/hr. About half of the boreholes drilled yield less than 4.8 m^3/hr. Most of the 4,500 boreholes in ASALs require rehabilitation or replacement. Ground water quality depends on the local strata. However, it is threatened by intrusion of salt water in coastal areas, leacheates from garbage dumps in urban areas and infiltration of fertilizer and pesticide residues in the agricultural areas.

Among the main aquifers constituting ground water are the Tiwi aquifer (5 m^3/hr average yield), the Lamu sand dunes (10 m^3/hr), Magharini, Vipingo and Mtwapa aquifers and the Merti aquifer with average yield of 6 m^3/hr. Nairobi and Naivasha have several aquifers whose average yields are 7 m^3/hr. Wajir has a unique aquifer whose depth averages 6 meters, while the yield of the fluvial deposits in Garissa, Lodwar and Kitui averages 5m^3/hr.

The main source of water for most people at the Kenyan coast is groundwater, which is normally drawn from boreholes and wells. The ground water is greatly influenced by the location, the depth and the nature of the recharge. Table 5.3 presents the ground water characteristics of four basins in Kenya.

The national water policy also recognizes groundwater as an important resource to supplement surface water sources. Groundwater is widely used in some parts of the country, but is generally under- utilized. In some areas groundwater is supplied for domestic and industrial use as well as the irrigation of high value crops. The high demand for water, encroachment of recharge areas and unregulated use has potential to threaten depletion of the ground water resources. It is for this reason that the Nairobi and the coast aquifers have been made conservation areas on account of over abstraction. Groundwater abstraction is now only permitted under licence.

Table 5.3. Ground water characteristics of four river basins of Kenya

Basin	Groundwater Characteristics
Lake Victoria	Over 90% of the boreholes have good quality water
Rift Valley	Most of the ground water is fresh, neutral, soft and free from colour and turbidity. However about 50% of the borehole waters tested have fluoride levels in excess of the WHO recommended value of 1.5 ppm
Tana	Ground water is generally fresh and free from colour and turbidity. Hardness varies from soft to moderately soft. There are some amounts of fluoride (around Kiambu).
Athi	The water around Nairobi is generally palatable. Over 50% of boreholes contain hard and saline water. Shallow wells and boreholes around the coast are prone to contamination.
Ewaso Nyiro North	Boreholes tend to have high fluoride contents and occasional hardness with high levels of iron and manganese. Each borehole should be treated individually as the water quality will depend on the local geological formations. Most of the boreholes drilled indicate that the water is often hard and varies in salinity levels.

Source: MWRMD Records

The impacts associated with the exploitation of groundwater resources have given rise to positive social and economic changes. Many of the flower farms countrywide utilize groundwater sources. However, ground waters along the coast are threatened by sea water intrusion. Pollution from natural sources affects the ground water quality in many areas due to high occurrences of nitrates, fluorides, iron, manganese and mineral salts.

The government, through the 2002 integrated water resources management strategy, outlined guidelines for effective management of groundwater resources.

5.1.4. Rainwater

The national supply coverage of piped safe drinking water is very low, averaging 40%. This makes rain water an important and reliable alternative to conventional water supply systems. This is because Kenya receives 360 billion cubic meters, a good percentage of which could be harvested (Figure 5.1). However, problems of technological adaptation coupled with high levels of poverty have impeded efforts. In the absence of sufficient surface conservation structures, ASALs depend on boreholes, which are expensive and may not last through the dry seasons. Lately, changes in rainfall patterns have led to crop failures and hence shift to more irrigated practices thus making rainwater harvesting in ASALs more critical. Runoff catchment systems like subsurface dams, sand dams, earth dams, pans, roof tops, rock catchments and related structures are alternatives the government, NGOs, CBOs, Local Authorities, Regional Development Authorities and other stakeholders focus on.

The World Summit on Sustainable Development (WSSD) recognized the provision of water as a critical component to sustainable development. Rainwater harvesting should meet a substantial part of this demand. Physio-chemical properties of rainwater are generally good. However, rainwater quality depends on the locality and the surface over which it is collected and handled. Colour, turbidity, taste and odour in rain-harvested water have negligible health significance. However, there has been a complaint about acid rain in some parts of the country. Additionally, waters collected from roofs painted with certain materials and asbestos are not potable. Well maintained rock catchments yield good quality water.

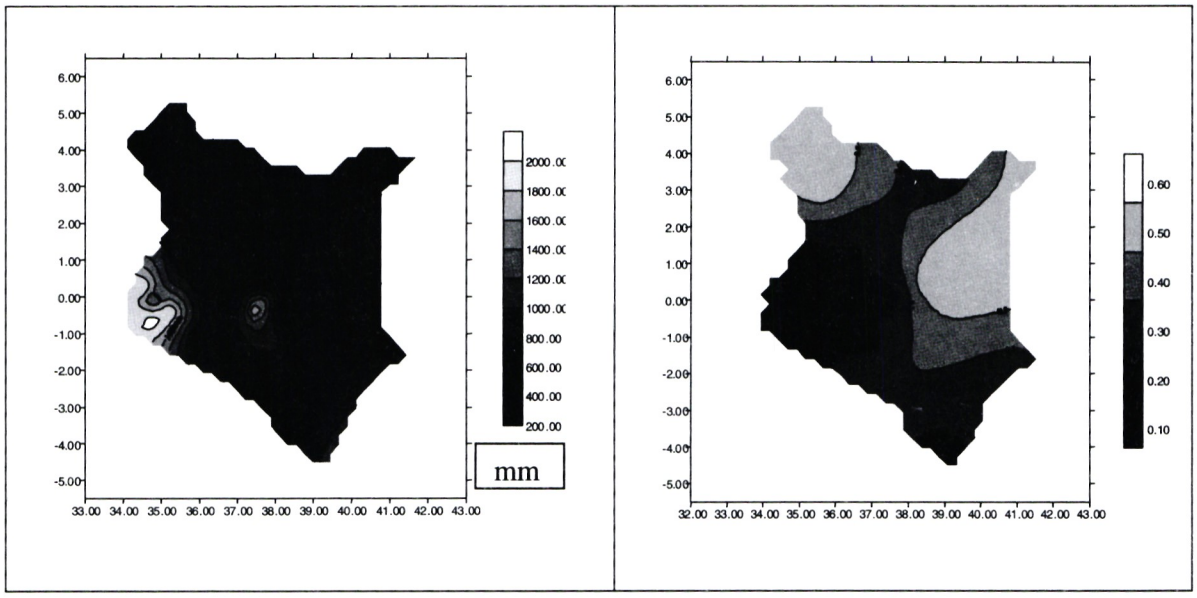


Figure 5.1. Distribution of mean annual rainfall over Kenya

Other impacts include potential of acid rain in urban areas, suspect quality water from multipurpose roofs, mosquito breeding from open storage rainwater and improved sanitation. Zero grazing, agro-forestry and small industrial and commercial income generating projects are some of the impacts seen from rainwater harvesting projects. Rural women, being major players in household welfare, have been under pressure to provide water for their families. They continue to install roof catchment facilities.

Most inhabitants of informal urban settlements, are not connected to the water reticulation systems. They have therefore resorted to rainwater harvesting for their domestic water needs to supplement those from water vendors. Dilapidated existing facilities and inadequate investments have aggravated matters.

The catchment approach to soil and water conservation of the Ministry Agriculture and the National Agricultural and the Livestock Extension Programme (NALEP) are key policy responses that support farmers' efforts to harvest rain water for agriculture. Other responses in rainwater quality include the use of alum for sedimentation for turbid rainwater and mobile water laboratories for testing and disinfecting.

Soil and water conservation is important in the integrated management of water resources. These are critical for the hydrological processes that result in rain and also in sediment control in reservoirs to ensure reservoirs.

5.1.5. Water Quality and Pollution

Water resources are increasingly being polluted by organic, inorganic and microbial matter. For example, nitrate pollution of groundwater from agricultural practices has been observed. The use of pesticides has increased considerably since the 1960s and 1970s, especially herbicides and fungicides. All pesticide compounds potentially pose an environmental health hazard as they are toxic.

Municipal solid and liquid wastes can be major sources of surface and groundwater contamination if they are not well treated. Solid wastes in towns are mainly made up of garbage, wastepaper, plastics, textiles, glass, remains of food and wood. Sludge from water and wastewater treatment plants is also regarded as solid waste. It may contain high concentrations of pathogenic bacteria, which may render it hazardous during handling as well as containing toxic heavy metals. Disposal in a sanitary and safe manner is therefore necessary to avoid polluting surface and groundwater sources.

Activities that have been identified as the major sources of pollution leading to poor water quality include agricultural activities, industrial activities, and urbanization.

Table 5.4. Characteristics of discharges from some industries

Industry	**Total dissolved solids (TDS)**	**Biological oxygen Demand (BOD)**	**Suspended solids (ss)**	**pH**
Coffee Factories	-	(9000 mg/l)	(790 mg/l).	4.4
Sugar Factories	4000 mg/l	1600 mg/l	1300 mg/l	-
Breweries	10,000 mg/l	5,500 mg/l	-	6-7
Dairy Factories	450 mg/l	180 mg/l	600 mg/l	-
Tanneries	10,000mg/l	2300mg/l	-	-

In addition to producing waste-water which are characterized by high BOD levels, discharges from the tanneries, textiles and pulp and paper industries are highly contaminated with various chemicals (Table 5.4). Mining and metallurgical industries are also other sources of chemical pollution. The high levels of metallic elements, salts and other substances are a cause for concern.

Nitrate levels in groundwater have increased since the 1960s due to many factors including changed land use, the increased use of nitrogenous fertilizers and recycling of sewage effluent. Other water pollutants include asbestos, which is transmitted through asbestos cement pipes and roofing material although the percentage of fibres picked up is usually small except under unusual conditions.

Many indicators such as moderate BOD values, pathogenic micro-organisms, suspended matter, oil and grease, detergents and other chemical substances normally characterize municipal domestic sewage. It is important to ensure that the sewage is properly treated before being discharged into any receiving body.

Polluted water has a very strong impact on human beings and other living organisms and the environment in general. Generally, the impact of pollution on water resources is manifested through the deterioration of water quality, toxicity to mammals and aquatic life, environmental health effects and loss of aesthetic values. High costs of water supply, eutrophication, deoxygenation, acid rain and habitat modification are other impacts on the environment.

Surface water quality has been declining since 1960s as evidenced by high colour, turbidity and presence of pathogens.

The quality of water in this country is the responsibility of various government bodies, which operate under various statutes. These statutes include Public Health Act (Cap 242), Water Act 2002 (Cap 372) the Chiefs Authority Act (Cap 128), EMCA (1999) and the Standards Act (Cap 496) of the Laws of Kenya. MWRMD enforces the water effluent guidelines through the development and implementation of water effluent discharge standards, monitoring of water quality in rivers, lakes and boreholes classification of water bodies,

development of water quality standards by Kenya Bureau of Standards (KEBS) and monitoring of water quality by the Provincial Water Committees under the supervision of KEBS. The implementation of EMCA (1999) should enhance the coordination and regulation of these existing efforts.

KEBS has been implementing the standards on drinking water. They have also been sensitising the public on quality issues. KEBS has also been coordinating Provincial Water Committees made up of representatives of Ministry of Health, MWRMD and the Ministry of Local Government, the Provincial Administration and the National Water Cap Corporation in matters pertaining to water quality in the provinces. These committees have been formed and are operating in Western, Central and Coast provinces. The committees ensure that community water is treated to kill micro-organisms before supply. This has ensured that drinking water is safe and of acceptable quality. MWRMD is implementing quality guidelines for surface and ground water.

5.2. WETLANDS ECOSYSTEMS

Wetlands are defined by the Ramsar Convention as "areas of marsh, fern, peatland or water, whether natural or artificial, permanent or temporary with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tides does not exceed six meters". Wetlands in Kenya occupy about 3% - 4% of the land surface and up to 6% during the rainy season. Figure (5.2) shows the main drainage systems areas in Kenya.

Wetlands are productive water storage, flood control, water filtration, recharge, discharge and pollution control systems. They are highly productive and rich in unique biodiversity. They are key resources for sustainable development especially poverty alleviation and improvement of the livelihood for communities through water related functions.

Wetlands in Kenya cover marine and coastal areas and inland freshwater, including lakes, rivers and swamps, alkaline and saline lakes and constructed wetlands. Table 5.5 is a summary of the status of major Rift Valley wetlands, while table 5.6 presents some characteristics of natural and constructed wetlands round Nairobi and its environs.

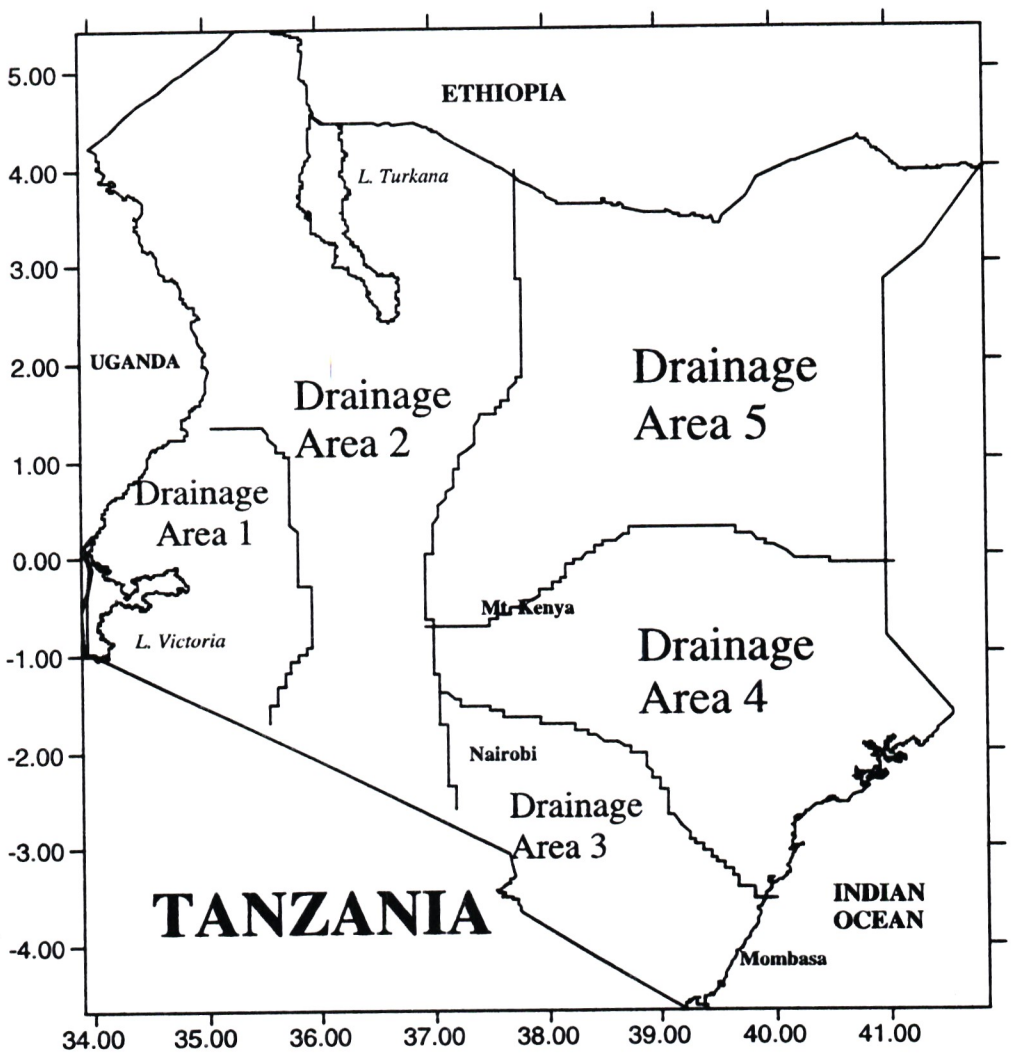
5.2.1. Shared Water Resources

Kenya shares water resources with Tanzania, Uganda, Sudan, Somalia and Ethiopia. Several rivers such as the Yala, Nzoia and Sondu flow into Lake Victoria and form the headwaters of River Nile. The Omo River flows from Ethiopia into Lake Turkana. Daua River flows from Ethiopia into Kenya before entering Somalia. Umba River flows from Tanzania through Kenya to the Indian Ocean and Mara river flows from Kenya to Tanzania before emptying into Lake Victoria. However, for these shared water systems there are no integrated transboundary management plans.

Water quality for rivers discharging into Lake Victoria has deteriorated due to discharge of municipal industrial pollutants in addition to silt-laden run-off from agricultural and urban areas. This has resulted into algal blooms, the spread of invasive species and the loss of biodiversity. Water use and related environmental problems between the riparian states are beginning to emerge.

Kenya's participation in the Lake Victoria Environmental Management Program (LVEMP) initiated in 1994 through a tripartite agreement between the three East African countries is one major response. The existing water use agreement of the Nile Waters Treaty is being reviewed. Other recent initiatives include the Nile River Initiative, the Lake Victoria Fisheries Organization, East African Community Environmental Protocols and New Partnership for African Development (NEPAD).

Figure 5.2. Major drainage basins of Kenya



Area	Drainage Basin Name
1.	Lake Victoria Basin
2.	Rift Valley Basin
3.	Athi River Basin
4.	Tana River Basin
5.	`Uaso Nyiro North Basin

Table 5.5. The status of major Rift Valley wetlands

Wetland Site	Location/area/ Elavation	Description	Importance/ Uses	Biodiversity	Conservation Status/ Ownership	Threats/Constrains	Water Quality
Lake Nakuru	$0^0$19'-$0^0$24'S/$36^0$04'-$36^0$07'E **Area:** c. 4900 ha **Altitude:** 1758 m asl	Water permanency and depth Permanent, with varying water depth depending on season, Maximum depth 4m	Eco-tourism Conservation Education and Research	Numerous waterfowl species including flack ship. greater and lesser flamingos and Fish e.g.*Oreochromis alcalicus grahami*	Protected, Ramsar Site	Pollution, Siltation, Invasive species, Human-wildlife conflicts. In adequate resources, Catchment degradation, Poor land use and Inadequate implementation of policies in the catchment	P^H 10.4, Temp 8^0C-32^0C, Productivity ~ 500gm^{-2}, Solar radiation 455-550 Kerg^{-1}cm, Humidity 20-90%, evaporation 1,600-1,800 mm^{-1}yr, Conductivity 6,500–165,000*us*cm^{-1}. Secchi depth 0.4m , Dissolved Oxygen5-28mgl^{-1}. Alkalinity 5,000 90,000 mgl^{-1} $CaCO_3$ Ionic composition 96.4%Na^+, 84% HCO_3- and CO_3
Ewaso Nyiro South	Rift valley **TYPE:** Permanent 609-653m ASL	Riverine Trans boundary wetland sinking into a critical flamingo breeding area	Grazing of both domestic and wild animals, pastoralism.	A variety of birds, fish, and riverine vegetation.	Unprotected The Shompole Group Ranch members communally own the area.	Inadequate data, Inaccessibility Hostile climate, Inadequate environment monitoring, Low levels of community involvement in conservation activities, Lack of cross-border integrated conservation initiatives, Overstocking within the floodplain area, Unsuitable land use practices	P^H 7.4-7.6 Temp 21^0C-32^0C Conductivity 198–223*us*cm^{-1}
Saiwa Swamp	34°35' to 35°22'E; and 0°48' to 1°18'N. Area 2.9km^2	Permanent swamp rich in endangered & threatened species	Conservation, water supply, Education & research	Various bird life, Endangered de' Brazza Monkey, threatened Sitatunga	Protecte	Pollution, Siltation, Invasive species, Human-wildlife conflict, In adequate resources, Catchment degradation, Poor land use in the catchment of policies in the catchment	Kapenguria River velocity before the park 74.22 •0.58, in the park37.60 •0.53, after the park 56.75 •1.72. River Kipsaina Water P^H before the park, 7.67+_ 0.05b, in the park 7.06+_0.09, after the park7.55+_ 0.05b, Water velocity before the park 50.68 •0.98d, in the park 34.11 •0.85, after the park 51.74 •0.75d
Lake Kamnarok	$0^0$38'N-$35^0$37'E, 2km long and 0.5km wide Area 1km^2	Inland depression located adjacent to Kerio valley	Conservation, community grazing, watering livestock, cultural importance	Various water bird species, Crocodile, Cyperus species	Conservancy protected	Eutrophication, invader plant species like pistia, overgrazing, encroachment, human/wildlife conflict, Natural drainage	Fluoride level 0.6mg/l

Lake Naivasha	$0^0$42'-$0^0$50'S/$36^0$16'-$36^0$26'E **Area:** 15600 ha **Altitude:** 1884 m asl	One of the only fresh water lakes in the region, with multiple uses threatening its survival. Composed of Oloidien saline	Fishing and eco-tourism. Geothermal plant, Horticulture, education	Plants e.g.*Cyperus papyrus* and *Typha domingensis*, Fish e.g. Black bass, *Tilapia zillii*	Conservancy unprotected, Ramsar site	Eutrophication, Colonization by invader plant species, over exploitation of natural resources, water, abstraction, encroachmentstakeholder conflicts, human wildlife conflict	P^H 8.5-9.0 Temp 19.5^{0}C-23^{0}C Conductivity 200–350*us*cm^{-1} Secchi depth 5-150cm Dissolved Oxygen5.6-8.2mgl^{-1} Alkalinity 150–185 mgl^{-1} $CaCO_3$
Lake Baringo	$0^0$32'-$0^0$44N and $36^0$2'-$36^0$8'E, altitude 975m **Size:** 130 km^2, 22km long 10km wide, depth maximum 8m	Relatively fresh water lake located in the Rift Valley floor, has several islands the largest being Ol Kokwa	Fishing, scenic area with a variety of tourist attractions. Grazing, education Irrigation	Avifauna and Acacia scrub. Has phytoplankton, zooplanktons, macroinvertabrates, vertebrates, macrophytes	Conservancy unprotected, Ramsar site	Pollution, eutrophication, Changing water quality, siltation, sedimentation, catchment degradation, proliferation of invader plant species, encroachment, over exploitation, over grazing, flooding	Has hot springs at Ol Kokwa Islands, well oxygenated but turbid, Secchi depth < 10 cm Ph 8.0-9.0, Conductivity 420*Us*/cm,
Lake Bogoria	$0^0$11'-$0^0$20'N/$36^0$07'E **Area:** 4250 ha **Altitude:** 963 m asl, depth 8.5m	An endorheic lake, soda in nature with hot springs, geysers and fumaroles along its shore. Fed by hot springs, wasenges	Bird Watching and eco-tourism, Conservation being a seasonal area for flamingo	*Spirulina platensis* and Acacia *tortilis zooplankton*	Protected (Reserve) Ramsar site	Eutrophication, siltation, plant invader species, serious declining of water levels, changing water quality, encroachment, over exploitation of resources,	Salinity 35% , conductivity ranges from 10 ms to 70 msm/cm, alkalinity 113.9 meq, P^H 9.8 to 10.3, fluoride level >100mg/l
Lake Elementeita	$0^0$27'S/$36^0$15'E **Area:** 1800 ha **Altitude:** 1776 m asl	Lies in Great Rift Valley bed with sandy alluvial bottom and a drainage basin with dendrite pattern with geothermal evidence, has islands of black lava	Bird watching, settlements, Salt extraction, surrounding area used for livestock grazing and the hot springs for watering livestock	Cyanophytes and flamingos and other water birds, *Sporobolus spicatus, and Chloris gayana.* Breeding site for pelican, introduced *Oreochromis alcalicus grahami* from lake nakuru	Conservancy unprotected	Encroachment, water diversion, Conservation status not clear, declining levels due to catchment degradation.	P^{H9}.6 springs lake 10.3, Temp ^{0}C-32^{0}C, Conductivity6,500 – 165,000*us*cm^{-1}. Secchi depth0.4m, Dissolved Oxygen5-28mgl^{-1}. Alkalinity5,000 – 90,000 mgl^{-1} $CaCO_3$, Ionic composition96.4%Na^+, 84% HCO_3- and CO_3^{--}. Water depth permanent, with varying water depth depending on season, Maximum depth 4m
Lake Magadi	$1^0$44'-$2^0$00'S and $36^0$18'E altitude 580m, area 100 km^2 29 km long and 4.5 km wide.	Shallow hypersaline lake covered by crusts of sodium carbonate and fed by springs to the North, South and West	Exploitation of sodium carbonate deposits. Biodiversity conservation	Fish – *Oreochromis alcalicus* Waterfowl	Conservancy for mineral mining	Lack of management plan, land degradation, encroachment, inadequate public awareness and education.	Total dissolved salts 30% w/v with the lake sometimes being covered by a vast expanse of trona deposit of 75km^2 and 40m thick Temp 40°C P^H 10.5, has no outlet

Lake Turkana	$2^0$23'-$4^0$35'Nand $35^0$50'-$36^0$42'E, altitude 375m **Size:** 7560 km^2. The largest in the rift valley. 249 km long in north-south direction, depth 114m	Lies in hot barren desert area of rainfall < 200mm, has 3 islands North, Central and South	Fishing, eco-tourism and pastoralism.	*Microcystis aeroginosa*, common birds are pelicans, herons and flamingos. Resting site for visiting water-edge birds like the Kentish plover and long tailed	Partly protected, conservancy	Siltation, sedimentation, abstraction and diversion of water, catchment degradation, over exploitation of resources, lack of management plan, international issues, inadequate education and awareness, declining water levels, disturbance of water bird colonies by fisher men	Salinity 1.7 to 2.7 %
Lotikipi Plains	$3^0$52'-$5^0$04'N/$34^0$18'-$35^0$27'E Area 500,000 ha **Altitude:** 490-500 m asl	Seasonal floods plain/swanp	Hunting, grazing and pastoralism.	Acacia and Balanites.	Unprotected	Declining water recharge, encroachment	Variable
Lake Amboseli	$2^0$33'-$2^0$44'S, $37^0$01'-$37^0$15'E, area 10,000ha, altitude 1189m .	Several swamps fed by seepage from Mt. Kilimanjaro	Tourism Wildlife Livestock grazing	Refuge area for wildlife and supports a variety of plants.	Protected, biosphere reserve		
Lake Oloiden	$0^0$50'S/$36^0$18'-$36^0$24'E **Area:** 156 ha **Altitude:** 1884 m ASL	Moderately saline lake that has been separated from the main Lake Naivasha over time due to declining water levels	Conservation, eco-tourism, Grazing and livestock watering	Various waterfowl species, Hippo, phytoplankton, zooplankton, macro invertebrates, fish	Non protected, Conservancy and Ramsar site	Eutrophication, Colonization by invader plant species, over exploitation of natural resources, abstraction, encroachment, stake holder conflicts, human wildlife conflict	P^H 8.5, conductivity 1-3Ms/cm
Lake Sonachi		Crater lake lying within an old volcanic crater	Conservation	Cynobacteria	Non protected, private conservancy		P^H 9.5
Lake Solai	Altitude 1500m< area 6km2	Seasonal lake that dries at extreme droughts	Conservation, various water birds, livestock,grazing, source of water		Non protected, partly privately owned	Siltation, encroachment by human beings and bush, water diversion	

Table 5.6. Chemical status of some wetlands around Nairobi and its environs

Wetland name	Type	Soil pH	Water pH	Water temp °C
Lake Simek	Seasonal lake	10.92	Indeterminable	-
Kimana I	Permanent swamp	10.58	10.45	22
Kimana II	Permanent swamp	10.55	Indeterminable	-
Namelok	Permanent swamp	10.50	10.55	25
Ongarua site I	Permanent swamp	9.99	9.96	25
Ongarua site II	Permanent swamp	10.22	9.98	26
Ewaso swamp/Shompole	Permanent swamp	10.40	10.43	25
Nagolomon	Constructed	7.56	7.62	20
Hyena	Constructed	7.59	8.26	20
Ruai	Constructed	7.35	8.5	23
Karen	Constructed	7.11	7.84	27
Athi Basin	Constructed	7.79	7.67	20
Kingfisher	Constructed	7.35	7.46	20
Olomanyi	Constructed	731	7.71	18
Eland	Constructed	7.44	8.3	19
Hippo pools	Constructed	6.94	8.21	20
Ondiri	Constructed	7.5	7.52	20
Manguo	Permanent swamp	7.55	7.54	19
Ruiru	Permanent swamp	7.60	7.62	18
Carnivore-Splash	Sewage plant	8.15	8.2	22
Dandora –TW	Sewage plant	8.72	8.8	23
Nairobi dam	Constructed	8.64	7.94	20
Njumbi dam	Constructed	7.5	7.98	19

5.3 OTHER WATER ISSUES

5.3.1. Droughts and Floods

Kenya is prone to drought and floods caused by natural and manmade activities. The floods and droughts have adverse impacts on the social, economic, public health and environment sectors (Plates 5.1). These include loss of human life and destruction of property, famine, hunger and starvation, outbreak of diseases and the destruction of infrastructural facilities. However, the major floods of 1951, 1961 and 1997/1998 were rare and extreme climatic events. These disasters are now recurring much more frequently and with greater devastation, thus undermining the government and societal efforts to fight poverty and enhance sustainable development.

The 1997/98 El Nino floods occurred due to the heavy continuous rainfall that fell throughout the country. The floods caused loss of human life, human and animal displacement, and destruction of property and heavy economic loss, especially to infrastructural facilities. The government immediately embarked on El-Nino emergency and economic recovery. The destruction caused by the floods is still evident and reconstruction continues to date.

There are few areas that are prone to occasional flooding due to their location in the floodplains. They include the Tana River Delta, the Kano Plains (Nyando River) and the lowlands of the Nzoia and the Yala rivers. In the recent past, flash flooding has occurred in major urban areas such as Nairobi, Mombasa and Kisumu due to poor drainage systems and poor planning. In the rural areas, flash flooding has intensified due to increased environmental degradation, evident as landslides etc.

Kenya is also prone to cyclic droughts, with the major ones occurring every decade and minor ones experienced every three to four years. Nevertheless, localized severe droughts occur frequently in the country, especially in the ASALs. The recorded droughts since the last century include severe droughts

followed by famine, starvation and even deaths which occurred in 1800, 1835, 1865, 1883, 1889/90, 1894/95, 1896, 1900, 1921, 1925, 1943/44, 1947-50, 1952-55, 1960/61, 1964/65, 1972, 1973/74, 1974-76, 1980/81, 1983, 1984, 1987, 1992/93, 1994, and 1999/2000. The duration between droughts continues to shorten, while droughts persist longer. Thus, the drought phenomenon has become difficult to predict with accuracy. Following the above pattern, the next severe drought is predicted to occur between 2009 and 2015.

Plate 5.1. A flooded road in Samburu district (photo by NEMA staff)

The beneficial effects of floods are few and include the recharging of underground aquifers, increase of water levels in rivers, dams, pans and lakes, provision of sufficient water in ASALs for pasture, livestock, domestic use and improvement of crop harvests in ASALs.

The drought of 1992/93 that affected 2.7 million people was considered the worst drought in the last 50 years. However, the recent La Nina drought of 1999/2000 was the worst in living memory resulting from failure of precipitation for four consecutive rainy seasons. This drought affected 4.7 million people countrywide who required famine relief. The government declared it a national disaster and sought for emergency assistance. The International Monetary Fund (IMF) estimated that US$ 480 million was needed for recovery from the drought. The above trends indicate that the next drought could be equally disastrous or even worse because of the climate change phenomenon being experienced globally.

There are various government institutions with responsibilities to take precautionary and remedial measures with regard to drought and floods. Notwithstanding the existence of these institutions, disasters continue to cause havoc. Other intervention measures include the drought contingency plan of 1992 and the National Disaster Management Programme of 1994. A National (Disaster) Operation Centre (NOC) has been established in the Office of President for the coordination and management of disasters. The provisions of EMCA (1999) adds value to flood and drought management.

5.3.2. Conservation of Catchment Areas

Other than the clearing of vegetation on catchment areas, an emerging problem has been the planting of eucalyptus around surface water courses. There are about 600 known species of Eucalyptus worldwide and four species grow in Kenya. Eucalyptus grows well in both wet and dry areas. Eucalyptus has been perceived as a heavy user of water. It is also believed to cause soil erosion due to limited undergrowth.

There is also less biodiversity as the ecosystems are simplified and distorted. Eucalyptus has been thought to cause the drying up of springs and draining of marshes, swamps and wetlands in some areas.

As noted earlier, both in the HMPL and ASALs there has been extensive clearing of vegetation in most catchment areas. The consequences have been severe erosion, siltation of water systems, less volume in rivers and diminished re-charge of underground water resources. As a result, the functions of ecological catchments have been rendered ineffective.

To arrest the emerging crises of catchment degradation, the government has put in place policy, legal and institutional mechanism to mitigate the impacts. These include EMCA (1999), the Water Act (2002), establishment and operationalization of NEMA and (WRMA) Water Resources `management Authority.

5.4 HUMAN HEALTH

5.4.1. Water Borne and Water Related Diseases

Waterborne and water related diseases are among the top ten causes of outpatient morbidity in Kenya. These are diarrhoea, skin and intestinal worms related diseases, eye infections and malaria. The factors giving rise to these diseases include poor sanitation, inadequate coverage of safe and clean water supplies in the country, poor hygiene practices, poor food handling practices, poverty, socio-cultural practices and taboos.

Impacts associated with these pressures are increased mortality, reduced economic productivity, decreases in tourism and other income generating activities. These constraints should be corrected by enforcing the Food, Drugs and Chemical Substances Act, the Public Health Act, Kenya Standards Act, the Water Act 2002, Local Government Act and EMCA (1999), and implementation of the recently developed environmental sanitation and health policy.

5.4.2. Vector-borne Diseases

Malaria is endemic in many districts of Nyanza, Western and Coast provinces. It is a leading cause of outpatient morbidity in the country. In 1999, it accounted for 32% of the total cases reported. Annual outpatient morbidity during the period 1996-1999 ranged from 4,146,026 to 4,662,752.

Poor sanitation and drainage, poor management of solid waste, climatic and other conditions, which favour the breeding of mosquitoes as well as poverty gave rise to this situation. Other water related diseases and vector borne diseases occur sporadically in the country. These include typhoid, cholera, dysentery, amoebiasis, bilharzias and filariasis.

The consequences of these diseases include deaths and low income and productivity. Policy and programme intervention measures include the integrated water resources management strategy, the malaria control programme, the Public Health Act, the Physical Planning Act and the Local Government Act.

5.4.3. Respiratory Diseases

The number of all forms of TB cases increased from 49,386 in 1988 to 57,686 in 1999. The number of pulmonary TB (PTB+) cases rose from 24,029 in 1988 to 27,197 in 1999. HIV/Aids is responsible for about 40% of reported TB cases. Increased levels of poverty and increases in informal settlements are some of the pressures responsible for the current states. TB accelerates the onset of AIDS in HIV positive persons.

Some of the government's responses include the development of guidelines for prevention and management of opportunistic infections, phasing out the use of streptomycin in 1999, enforcement of Public Health Act (Cap 242) and the adoption in 1994 of the Kenya Health Policy and environmental sanitation and health policy. Currently, the government is preparing to implement a comprehensive National Health Service Programme, to ensure that all people have access to affordable health care services.

5.4.4. HIV/AIDS

Kenya is faced with high rates of HIV infections. HIV prevalence rates have been on the increase over the last two decades. The rates rose from 4.8% in 1990 to 13.0% in the year 2000. Prevalence rates in urban areas in the year 2000 stood at 17.5% compared to 13.0% in the rural areas (Table 5.7). Currently, 700 Kenyans die of Aids-related ailments daily or approximately a quarter of a million annually. Due to the concerted efforts of the government, the HIV/AIDS prevalence rates have now dropped to about 10.6%. The factors responsible for HIV/AIDS cases include socio-economic and cultural lifestyles, drug abuse, multiple sexual partners, illiteracy and ignorance.

Table 5.7. HIV/AIDS prevalence rates between 1997 and 2001

Prevalence	1997	1998	1999	2000	2001	2002	2003
Urban	10.9	18.1	17.8	17.5	17.0		
Rural	11.9	13.9	13.0	13.0	13.0		
National	12.8	13.9	13.5	13.5	13.0	13.0	11.2

Source: National Aids Control Council (NACC)

In response to the HIV/AIDS pandemic, the government has established the National Aids and Sexually Transmitted Diseases Control Programme (NASCOP) and the National Aids Control Council. Further, the HIV/AIDS pandemic was declared a national disaster in 2000. The government has since developed a strategic paper on HIV/AIDS pandemic. The implementation of this strategy includes the provision of retroviral drugs to the sick and the setting-up of voluntary counselling and testing centres (VCTs) to identify and support the infected and the affected.

5.5. ENVIRONMENTAL HEALTH

5.5.1. Solid Waste

Solid waste has been categorised as trade, industrial, municipal, agricultural, institutional, domestic, construction debris and waste from military and mining operations. Unsuitable patterns of production and consumption are increasingly generating large-quantities and varieties of waste at unprecedented rates. Increased industrial production and urbanization has led to high consumption of natural resources and the consequent generation of substantial wastes.

Inadequate planning, and co-ordination of environmental activities and limited finances in towns and among the communities are some of the drivers and pressures giving rise to the current state. Inadequate education and awareness, lacklustre enforcement of environmental regulations, indifference among the local communities on waste management are responsible for the poor management of disposal sites.

The local authority by-laws that have a bearing on solid waste management are outdated and too weak in their penalty to deter offenders. Lack of information on waste management to the communities and inadequacy of disposal equipment are issues of concern. The high rate of urbanisation may be part of the problem, since insecurity to waste handling companies is caused by scavengers at disposal sites. Other constraints include unplanned dumping sites, insufficient management and co-ordination of the players, weak enforcement of legislation and regulations. There is also lack of a national land use policy in relation to land zoning to provide for landfills. Again, there is absence of waste sorting by type at the generation point and inadequate technology for processing wastes into useful by products in urban centres.

Nairobi generates over 2,000 tons/day of wastes, 68% of which is of domestic origin, while 14%, 8%, 2%, 1% and 7% is from industrial, roads, hospitals, markets and other sources respectively. Current approaches to waste management are neither effective nor sustainable. Most local authorities give priority to wastewater treatment and little attention to solid wastes. The authorities have been unable to collect, treat and dispose of solid waste due to inadequate capacity including financial constraints.

Hospitals are classified as large, medium and small with corresponding volumes of wastes. Some large hospitals have stock-yards of 1550m^3 of wastes.

Collection and Transportation of Solid Wastes: In low-income areas, the collection service is very poor. Uncollected waste is found strewn along streets, play fields and between houses. The collection of garbage from communal sites is not frequent. Priority is given to central business districts, industrial area and high-income residential areas. Least efforts are given to the middle and low-income areas, and slum settlements. The accumulated and scattered wastes emit awful smells and are the breeding ground for rodents, flies and mosquitoes.

Table 5.8. Types of municipal wastes

Types of wastes	Nairobi (%)
Food waste	51.50
Paper (recyclable & others)	17.30
Plastics (containers & others)	11.80
Textiles	2.60
Bones	0.70
Metal (containers & others)	2.60
Glass (containers & others)	2.30
Grass/wood	6.11
Rubber	0.30
Leather	1.39
Others	3.40

Only 37% of the waste generated in Nairobi residential areas is collected and taken to approved dumpsites. Local authorities collect and transport wastes using various types of trucks. These trucks and related machinery are inadequate, and their efficiency very low. Most trucks are old and thus breakdown often. The trucks are usually open and spill refuse along the route. The desirable bulk compactor trucks are very few.

Disposal of Solid Wastes: Solid wastes in most urban areas are disposed off in open dumps or crude sanitary landfills, burned or composted (Plate 5.2). There is a scarcity of disposal sites in many municipalities, which results in vehicles criss-crossing town centres to the few available disposal sites. Some local authorities do not have designated disposal sites and often rely on individuals using the waste as manure. There is general lack of proper planning and zoning. Composting and burning is generally practised in estates that have large compounds and within the rural areas. Generally, most urban waste is collected in bins at the household level and in bulk containers at the institutional level. The recent widespread use of polythene bags has created an additional disposal problem.

Incineration: Most hospitals and some research institutions incinerate some of their solid wastes. However, some of the new clinical centres, especially in the urban areas lack the technology and consequently dispose of their wastes in the dumpsite. Incineration is expensive threat and quality and not affordable by many municipalities.

Impacts and Responses: Impacts of poor solid wastes management include pollution of water resources, adverse health effects and habitat modification. The Public Health Act and the Local Government Act and EMCA (1999) provide legislative direction in the maintenance of clean and sanitary services in all areas. Most local authorities are reviewing their policies to involve the private sector in solid waste management. The ongoing reforms will make local authorities regulators rather than operators. It will ensure the integration of environmental concerns into all planning and development in accordance with EMCA (1999) and Public Health Act.

In pursuance of the implementation of these measures, industries and other players are being encouraged to adopt the 4Rs concept – recover, re-use, reduce and re-cycle. There are also new approaches of treating wastes with effective microbes (EMs). EMs are naturally occurring benign microorganisms with positive effects on the environment and can be used to treat contaminated water, soil and even foodstuff.

Plate 5.2. Disposal of solid waste, Dandora site (photo by NEMA staff)

5.5.2. Onsite Sanitation in Human Settlements

Current levels of access to improved sanitation are 49% in rural areas and 65% in urban areas, giving a national average of 57%. The services offered in the covered areas are of poor quality. Pit latrines built using local materials and skills are the commonest onsite sanitation systems in Kenya, especially in the rural settlements, urban slums, peri-urban settlements and small towns. There is no uniform technology applicable throughout the country. However, widely used technologies include the ventilated improved pits (VIPs), twin pits, and vault toilets. Wet onsite sanitation facilities in use include the pour-flush toilets, septic tank and soak pits.

Low-income households account for about half the urban population depending on the city or town. It is the fastest growing segment of the urban population. These people live in informal settlements where water and sanitation utilities are not provided. Nearly 70% of slum dwellers pay to use the communal toilets. The 'flying toilet', where faeces is wrapped into a polythene paper and flung into the river or in the open, is a common feature in urban slums. VIP are few and found only in areas that have external support.

Few schools have enough sanitary facilities to meet the recommended ratio for toilets to the population of girls or boys. The national ratio of people per toilet was 55:1 in 1999 and 64:1 in 2003 against the recommended ratios of 25:1 for girls and 30:1 for boys. The impacts are poor human health caused by sanitation related diseases, increased health costs and polluted environment.

The Water Act (2002) has provisions for institutional water supply and control of water-borne, sanitation-related diseases, while EMCA (1999) regulates environmental issues including onsite sanitation. The Building Code has provisions for water and sanitation as does Public Health Act (Cap.242). The Ministry of Health is developing an environmental sanitation and health (ESH) policy as well as a school health programme.

A number of organisations are promoting the ecological sanitation (ECOSAN) technology. The private sector and others have played a role in the development and disposal and conservancy, septic tanks and pit latrines on demand basis. Agencies involved in the direct service provision and lobbying for better sanitary facilities include the UN agencies, the World Bank (Water and Sanitation Programme), development partners, CBOs and NGOs.

5.5.3. Radiation

Radionuclides are commonly used in industries, hospitals, schools, road construction, oil exploration and research institutions. These are mainly sealed (shielded) sources and unsealed radionuclides. There are no isotope production, research reactor, nuclear power or nuclear fuel facilities in Kenya. Unsealed sources imported annually range from tens to thousands of Mega Becquerels (MBq) of H-3, C-14, P-32, S-35, Ca-45, Cr-51, Fe-59, I-131 and In-111 and Kr -85. In hospitals, solid wastes are stored to decay and are disposed of as ordinary waste after monitoring. Excretions of patients (cancer diagnosis and therapy), which contain radionuclides, are discharged into the sewer system.

Liquid effluents from research institutions using unsealed sources are passed through a lagoon system with a total residence time of about three months before being discharged into the environment. Incinerators are also used for burning inactive and decayed wastes. Radioactive carcasses are buried deep or incinerated depending on the levels of activity. Further, the situation in the country in regard to the acquisition, handling and disposal of radioactive materials is as follows:

- Many diagnostic and therapeutic x-ray machines, Magnetic Resonance Imaging (MRI) and ultra-sound equipment are imported into Kenya without being subjected to any standards.
- The country does not have a comprehensive policy on radioactive waste management.
- There are reported cases of trafficking of radioactive materials.
- A number of studies on the background radiation mappings have been undertaken in a few areas in the republic (Kwale and Kerio Valley).
- No published regulations for a national Radiological Emergency Response (RER) Plan and procedures.
- Currently there exists neither standards nor the regulatory practice for non-ionising radiation (NIR).
- The Board does not have land to operate a radioactive waste repository or a central facility for treatment, conditioning and interim storage of sealed sources and radioactive waste.
- A register of radioactive substances imported since 1986 is available.
- A number of sealed sources have been conditioned into 200 litre drums at the Material Testing and Research Department, Ministry of Roads and Public Works. In principle, the department has been appointed as an agency for the treatment, conditioning and interim storage of radioactive wastes by the regulator.

However, specific regulations on the management of radioactive wastes have been prepared and are awaiting gazettement. Since 1990, purchasing contracts of sealed sources were required to include a clause assuring the return to the supplier once it has reached the end of its useful lifetime. The Radiation Protection Board (RPB) carries out annual calibration tests on x-ray equipment countrywide. However, the law does not mandate it to check and calibrate MRI and ultrasound equipment. Draft regulations for the safety of transport materials (class 7 dangerous goods) based on the IAEA regulations for the safe transport of radioactive materials, 2002 (TS-R 1, revised) have been prepared. The board has set up a surveillance system at the ports of entry (mainly at Kilindini in Mombasa and Jomo Kenyatta International Airport (JKIA) in Nairobi) to monitor food and other substances imported for radiation levels and radioactive contamination. A Radiological Emergency Response (RER) team exists in the regulatory authority.

Substandard equipment increases the dose to the population and could lead to higher incidences of clinical effects related to ionizing radiation. While the presence of radioactive materials can generate a state of panic in the people because of the mystery associated with it, the radionuclides released to the environment from research, medical and industrial applications cause only ambient environmental contamination. This may result in the contamination of food. Uptake of the radionuclides by all pathways will result in both internal and external irradiation of organs.

Some of the emerging pressures in this sector include concerns regarding the radiation from mobile phones, television transmission masts, base transmitting stations (BTS), MRI and ultrasound, Radionuclides enter ecosystems by many pathways and become widely dispersed. Ionizing radiation has a negative impact on biota and both terrestrial and aquatic ecosystems. The main pathways of radiation exposure include external irradiation, plant uptake from the soil, folia absorption, inhalation of suspended material and gaseous radionuclides, ingestion of plant, animal and microbial material, soil and water.

The country's policy responses include membership to the International Atomic Energy Agency (IAEA) since 1965, a party to the nuclear non-proliferation treaty (NPT) and a signatory to several agreements with the IAEA. RPB was established by the Radiation Protection Act (Cap 243) to protect patients, radiation workers, the public and the environment from the harmful effects of ionizing radiation. National regulations have been set up which cover the exemption, notification and authorization, dose limits and control of medical exposure. These regulations are based upon the International Basic Safety Standards series No. 115, published by the IAEA. Kenya will participate in an IAEA project on nuclear safety and security. This will entail the acquisition of equipment and training opportunities for the customs and police officers to complement the work of RPB.

5.5.4. Chemical Pollutants of Health Significance

Nitrates and Nitrites: Nitrate levels in groundwater have increased since the 1960s due to many factors. The factors include changing land uses, the increased use of nitrogenous fertilizers and recycling of sewage effluent. Limit for nitrate in drinking water is based on its effect on methaemoglobinaemia blood disease in bottle-fed infants. There is also concern about possible effects on the incidence of stomach cancer. WHO desired limits are 50 mg/l (as NO_3) but up to 100 mg/l is acceptable if medical authorities are warned about the possible danger of infantile methaemoglobinaemia. Treatment techniques based on ion exchange or biological denitrification have been developed but have not been extensively used.

Polychlorinated biphenyls (PCBs): PCBs are chemicals, used as coolants for electrical transformers. They are carcinogenic and mutagenic and therefore pose serious health concerns. Vandalism of transformers for these coolants, which are illegally used to treat wounds, exposes the user to chances of cancer.

Dioxins: The use of chlorine in the paper making industry introduces dioxins and furans into the environment. These compounds are known to be endocrine disruptors in addition to other adverse properties.

The tobacco industry promotes cigarette smoking, an activity that is associated with increasing incidents of lung cancer. Advertisements depicting smoking as a trendy way of life are luring the youth. The increasing incidents of smoking amongst our youth have generated concern and led to the establishment of the National Committee on Alcohol and Drug Abuse (NACADA).

5.5.5. Pesticides

Pesticides formulated to control notorious pests that attack crops, animals and people may also cause water pollution. Equally, substances known to be carcinogenic, teratogenic and mutagenic are not easily biodegradable. These are also being controlled locally through the licensing and scrutiny of the Pest Control Products Board (PCPB).

Driving forces include the increased demand for food resulting into increased use of pesticides. PCPB is charged with the registration of pesticides. Assessment of pesticide residues in soil and water systems has

been done, while pesticide residue monitoring programme for drinking water, sediment and fish is continually being carried out. EMCA (1999) provides for a strengthened coordinative approach in the monitoring of the effects of pesticides and compliance to the law.

5.5.6. Dichlorodiphenyl trichloroethane (DDT)

DDT is probably carcinogenic to man with effects on the nervous system. It travels long distances from the source of use, release or emission. DDT degrades in three years in temperate land and three months in tropical lands. Exposure to DDE (a metabolite of DDT) has also been linked to precocious puberty and shortened lactation period in breastfeeding mothers.

DDT is one of the so called "dirty dozen" (12) persistent organic pollutants (POPs) governed under the Stockholm Convention. The convention allows for the use of DDT for vector control until safe, affordable and effective alternatives are in place. Kenya is in the process of developing a national implementation plan (NIP) for implementing provisions of the convention. NIP includes regulatory measures and institutional framework as well as a strategy to reduce or eliminate releases of POPs.

Kenya is also a signatory to the Rotterdam and Basel Conventions, which cover DDT. The Rotterdam Convention is based on the "Prior Informed Consent" (PIC) procedure, in which importing and exporting countries share responsibility for ensuring that trade in the chemicals is in line with the convention. The Basel Convention limits "toxic trade" in hazardous wastes and ensures their proper disposal. The international community will evaluate at least after every three years whether DDT is still needed for this purpose.

DDT was introduced in Kenya in 1956 for use in agriculture and public health. However in 1986 its use in agriculture was banned. Currently, its use is restricted to public health for the control of disease vectors. Concern over its use arose over its toxicity and persistence in the environment. DDT has not been imported into the country for the last 14 years. However, there may be cases of stocks getting into the country illegally. DDT and other organochlorines are highly bio-accumulative in the fatty tissues with consequent magnification of environmental concentrations through the food chain. In addition, they have been found in significant quantities in humans, commonly in breast milk.

When re-introducing the use of DDT, the factors to be considered are the violation of the MEAs to which Kenya is a signatory and human safety. Additionally, an important concern is the quality of fish and horticultural produce since detection of DDT traces may exclude such produce from the international market.

Kenya is a signatory to the Stockholm convention, which seeks the elimination or restriction of production and use of all internationally produced POPs. Use of less persistent/biodegradable pesticide is recommended for public health purposes only.

5.5.7. Mercury

Mercury occurs in the environment from natural emissions and from industrial activities such as artisanal mining, metal smelting, cement making, mercury paints, electrodes for certain electrolytic processes, thermometer manufacture, in dental amalgam, in laboratory processes and in cosmetics. There is no policy and proper regulations for mercury in Kenya.

Poverty among the small scale miners, ignorance on the risks and the ways of handling mercury compounds during gold processing, dumping of cheap mercury-containing goods and poor technology are some of the pressures related to the unhealthy use of mercury. Use of mercury has resulted in the pollution of the atmosphere, land and water resources and bioaccumulation in fish. Methyl mercury is the most toxic form of mercury that causes neurological disorders such as minamata disease, resulting in impaired walking and talking.

As a response, Kenya has ratified the Basel Convention. In addition, the country has made specifications on how mercury is used in industry, for example, dentistry alloys for amalgams mercury (not to exceed 50%). Furthermore, mercury use in both cosmetics and paints is banned.

5.5.8. Lead

Lead is a substance whose toxicity to human health has been established. It is associated with memory loss, reduced IQ and kidney damage. The major sources of lead into the environment include petroleum fuels and car batteries. Lead is released during the recycling process posing health hazards to the workers and the environment. WHO standards give an upper limit of lead in drinking water of 100 ug/l.

5.5.9. Food safety

At all stages of the food chain (from the farm to the consumer), the main issues of concern in food safety include basic food microbiology, food borne pathogens, and diseases. Use of contaminated equipment, infected food handlers, contaminated food ingredients, unhygienic food preparation and poor quality control are other issues of concern.

Food borne diseases are a serious threat to public health in Kenya as evidenced by the frequent outbreaks of cholera, typhoid and other diahorreal diseases in the country. Besides microbial concern in food safety, pesticide residues, veterinary drugs, lead, zinc and mercury have been found in foods. Food hawking has become a common feature in urban areas, thus posing danger to the health of the public.

Factors that contribute to poor food safety include poverty, inadequate enforcement of existing laws and regulations, inadequate inspection, storage facilities, poor hygiene practices and use of contaminated food. Deaths from food-borne diseases and reduced economic productivity are some of the impacts.

Sanitary and phytosanitary certification of foods is one effective response in addition to the application of existing regulations. Existing intervention measures include the Kenya Health Policy Framework of 1994, the Health Strategic Plan 1999-2004, Food, Drugs and Chemical Substances Act (Cap 254), the Meat Control Act (Cap 356), the Animal Diseases Act (Cap 364), the Dairy Act, (Cap 336), and the establishment of various analytical laboratories for monitoring of food and radionuclide contaminants and radiation levels monitoring at points of entry are other key policy responses.

BOX 3. FUTURE OUTLOOK FOR WATER, HUMAN AND ENVIRONMENTAL HEALTH

Water Resources: To achieve the millennium development goals, there is need to:

- Enhance the national water coverage.
- Enforce compliance to existing laws and regulations for water quality.

Wetlands: There is urgent need to protect wetlands by:

- Approving the national wetlands policy and gazetting the national wetlands regulations.
- Increasing financial resources and building capacity.
- Improving drought and flood emergency preparedness, assessment, response and mitigation.
- Developing a comprehensive policy, legal and institutional framework for monitoring and early warning on drought and flooding.

Human Health: The following measures should be implemented:

- Provide adequate, clean and safe water for all.
- Increase sanitation coverage in the country.
- Enhance and intensity capacity building measures.
- Develop a malaria vaccine.
- Destroy mosquito breeding places and intensive surveillance measures.
- Promote preventive measures and make malaria drugs affordable and accessible to all population groups
- Initiate early and accurate diagnosis of TB and extend free treatments to private health institutions and use of quality assured drugs.
- Make antiretroviral drugs affordable and accessible and provide nutritional foods as well as guidance and counselling for HIV/AIDS suffers.

Environmental Health: The following measures are needed:

- Enhance the development of programmes that promote reduction, recovery, recycling and reuse of waste taking into consideration the changing consumption and human settlement patterns.
- Hasten the adoption of environmental sanitation programmes that harmonize stakeholder involvement in environmental sanitation and health.
- Gazette standards and regulation for radiation equipment and protection of mine workers using radioactive material.
- Establish radioactive waste repositories under by the regulatory authority.
- Monitor the movement of DDT in the environment and in the food chains.
- Conduct baseline survey on the qualities and location of mercury in the environment.
- Develop and gazette regulations for the collection and disposal of mercury containing compounds.

Enforce laws governing food safety, enhance hygiene and education of the food handlers as well as a surveillance programme.

CHAPTER 6

ENERGY, POLLUTION AND WASTE MANAGEMENT

6.1. ENERGY RESOURCES AND POLLUTION

6.1.1. Introduction

The provision of energy services is essential for economic and social development and improved quality of life. Providing adequate, affordable energy is essential for eradicating poverty, improving human welfare, and raising living standards. Without economic growth, it is difficult to address environmental challenges, especially those associated with poverty. For energy to be of value to the society, the energy system must be designed to meet the demands of a variety of services such as cooking, illumination, comfortable indoor climate, refrigerated storage, transportation, information, and consumer goods.

The environment provides raw materials for the energy industry. These include wood fuel, fossil fuel, radioactive minerals, hydro-power, geothermal power, insolation and wind. On the other hand the environment is the recipient of the residues of thermal energy, solid, liquid and airborne waste produced by energy systems. Activities related to energy production, distribution and consumption are perhaps the largest single category of benign sources of adverse anthropogenic impacts on the environment.

The government recognizes that alternative renewable energy sources hold tremendous potential, especially for releasing pressure on woody biomass. They also create opportunities for income and employment generation, both of which would have a positive impact on improving the quality of life, while reducing poverty.

The control of emissions should be based on an efficient energy production, transmission, distribution and consumption. We must also develop environmentally sound energy systems, particularly new and renewable energy sources.

Pollution of the atmosphere, especially indoor air pollution, has been linked to acute respiratory tract infections. Among the causes of such infections are emission of sulphur and particulates from energy systems. Fossil fuels are the largest contributors to air pollution owing to the amount of emissions they release into the environment when they are burnt.

6.1.2. National Energy Consumption Patterns

Most biomass is used in the form of fuelwood especially firewood and charcoal. Other biomass energy resources include agricultural/crop residues and animal waste. Municipal waste, especially household and commercial waste, is mostly organic in the form of food, packaging and paper. These too can be converted into other useful energy resources (Figure 6.1)

Households, commerce and industry use a combination of fuels. Energy resources used include biomass, fossil fuels, hydro and geothermal (Tables 6.1 and 6.2). Biomass is by far the most predominant fuel, providing over 75% of energy consumed.

Other sources of energy in the country include hydroelectricity and geothermal power. Solar and wind energy has also been harnessed albeit at low levels. The latter are perceived to have less impact on the environment.

6.1.3. Hydropower

6.1.3.1. Large Scale Hydropower

Hydropower systems are classified according to their generating capacity. These classes are large, small, mini, micro and pico. The overall hydropower potential in Kenya for large systems is about 2263 MW,

while for the small, mini and pico hydro is about 3000 MW. By 2003, 677.2 MW had been developed and connected to the national grid. Another capacity of about 1 MW of mini and micro hydro has been developed for private use, mainly by institutions and commercial agricultural enterprises. The Sondu Miriu River hydropower project will contribute another 60 MW. The balance of about 4500MW remains undeveloped. The overall national energy consumption patterns are indicated on Table 6.2.

Table 6.1. Existing system generation installed and effective capacity

No.	Power Station	Capacity MW		Percentof Effective Capacity
		Installed	Effective	
1	**Hydro**			
	Tana	14.4	12.4	
	Wanjii	7.4	7.4	
	Kamburu	94.2	84	
	Gitaru	225	215	
	Kindaruma	40	40	
	Masinga	40	40	
	Kiambere	144	144	
	Small Stations	6.2	5.4	
	Turkwel	106	106	
	UETCL (Imported)	30	0	
	Total Hydro including Imports	***707.2***	***654.2***	***62.2%***
2	**Geothermal**			
	Olkaria I (KenGen)	45	45	
	Olkaria III (IPP)	12	12	
	Total Geothermal	***57***	***57***	***5.4%***
3	**KenGen Wind**			
	Ngong	0.35	0.3	
4	**KenGen Thermal**			
	Kipevu Steam	75.5	26	
	Kipevu I Diesel	75	70	
	Kipevu GT1 and GT2	60	60	
	Nairobi Gas Turbine	13.5	10	
5	**IPP Thermal**			
	Iberafrica Diesel	56.5	56.5	
	Westmont Barge GT	43	43	
	Tsavo Power Diesel	74	74	
	Total Thermal	***398***	***339.5***	***32.3%***
	Total Interconnected System	***1,162***	***1,051***	***100%***
	Isolated Stations			
	KenGen Diesel Stations	3.8	3.5	
	REF Diesel Stations	5.6	5.1	
	REF Wind	0.2	0.16	
	Total Isolated Stations	**9.6**	**8.8**	
	Gross Capacity	***1,172***	***1,060***	
	System Peak Demand		780	

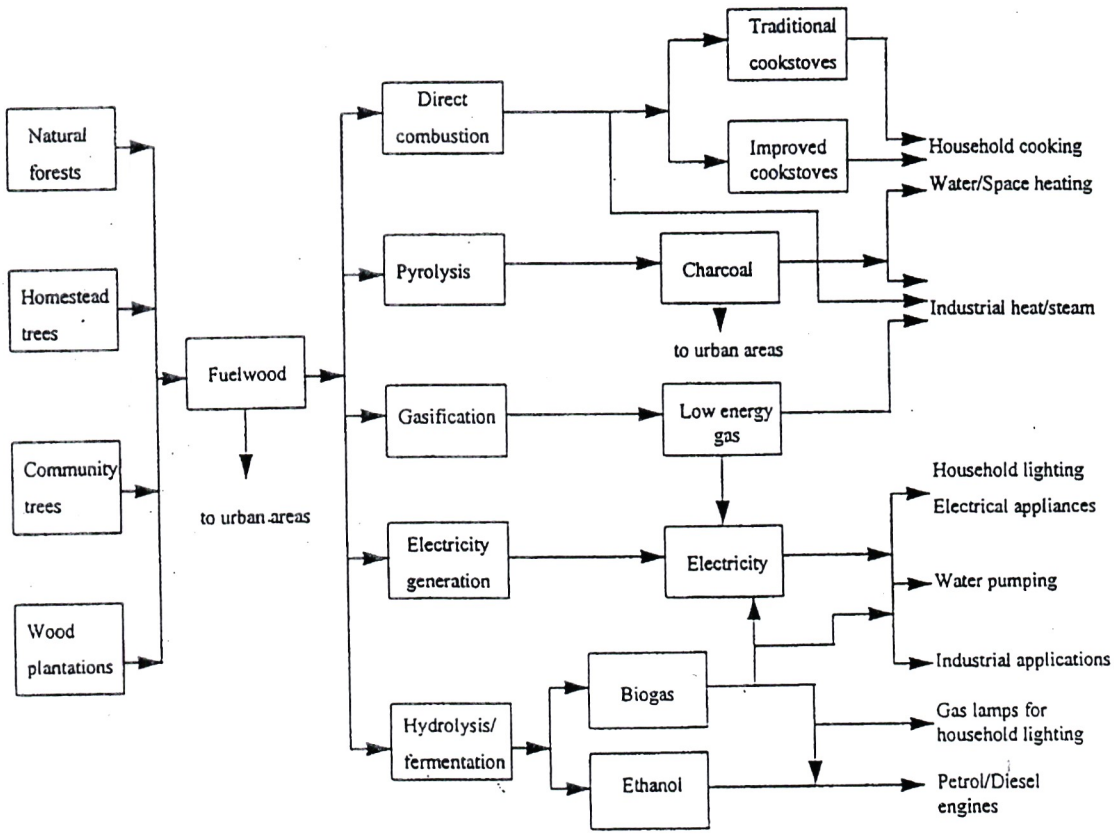
Source: Ministry of Energy records

Table 6.2. National energy consumption patterns in Gigajoules

Sector/Fuel	Agriculture	Industry	Transport	Households	Total
Woodfuels (75.2 %)	-	68421	-	452634	521055
Farm Residues (5.3 %)	-	-	-	37013	37013
Petroleum (18 %)	4496	61311	45678	13475	124960
Electricity (1.4 %)		6895	-	2939	9834
Total	4496	136627	45678	506061	692862
Per cent	0.6%	19.7%	6.6%	73%	

Source: GoK/KAMFOR Report (2002)

Figure 6.1. A model of a fuel wood energy chain



6.1.3.2. Small Scale Hydropower

Small hydro power stations are unique in their capacity to support isolated grid systems with flexibility to support rural market development and to provide power for multiple end uses. The total potential for such stations is about 3000 MW, of which only 8 MW has been developed, with 6.2 MW being connected to the national grid.

Hydropower resources provide the biggest share of the electricity consumed in Kenya. The demand for power has been estimated to grow by 5 % annually. The recent efforts by the state to exploit the Sondu Miriu River have raised a lot of concerns by the environmental agencies and civil society organisations. The cost of extending the grid has been a limiting factor to fully exploit the available power. The effective installed capacity is 1060 MW against a peak demand of 780 MW (Table 6.1). The harnessing of hydropower on large and medium scales involve the creation of artificial water reservoirs by denuding, dredging and flooding thousands of hectares of land. The creation of reservoirs modifies many environmental components, such as:

- Hydrologic regimes: affecting the flow of water upstream and downstream hence affecting the livelihoods on both sides;
- Sedimentation characteristics: drop in sediment load downstream affect the fertility of soils;
- Seismic activity: the weight of the impounded water and sediments exert forces on the geo-structures and may lead to earth movements;
- Climatic conditions: change in local weather conditions; and
- Water quality: stagnation of water results in eutrophication.

The impounding of water creates a conducive environment for colonization by alien species of fish, plants and disease vectors such as snails and mosquitoes. This may lead to the loss of indigenous plant and animal

species. The creation of power line corridors leads to the further loss of biodiversity. Socio-economic impacts include displacement of local communities, change of land use leading to loss of livelihood, creation of new lifestyles with new employment opportunities, increase in water-borne diseases such as malaria and bilharzias, and social conflicts due to influx of immigrants in search of opportunities. The government has addressed the above concerns by:

- Accelerating the rural electrification programme with the objective of reaching 20% of the rural population by 2010 and 50% by 2020;
- Supporting community-based energy systems through cost sharing arrangements and tax exemptions.
- Collecting hydrological data and undertaking pre-feasibility and feasibility studies on small hydro power projects;
- Formulating and enforcing standards and codes of practice to safeguard consumer interests and the environment.
- Packaging and disseminating information on renewable energy systems;
- Establishing of financing mechanisms especially for micro-credit for consumers and entrepreneurs.
- Enforcing the EIA provisions which minimizes environmental degradation.

Hydropower development is constrained by a number of factors, including: high cost of introducing efficient and cost effective technologies; lack of awareness on opportunities offered; inappropriate and limited credit and financing mechanisms; limitations imposed by the Electric Power Act (1997); and inadequate support for innovation and development, especially for micro-hydro applications.

6.1.4. Geothermal Energy

Geothermal prospects occur within the Kenyan Rift Valley where widespread volcanic activity and geothermal manifestations signify its viable existence. Potential for geothermal power generation is estimated at over 2000 MW. Of these 121 MW is already developed and connected to the national grid. Another 36 MW is currently under development, with the first 64 MW scheduled for commissioning during the financial year 2003/4. The extent of the geothermal field has not been quantified in terms of the area it covers but it runs from the Tanzania border to southern Sudan border in the Rift Valley.

The Olkaria geothermal field is particularly environmentally sensitive. It is situated in the Hell's Gate National Park, 5km from the fresh water Lake Naivasha, and adjacent to huge flower farms.

Geothermal wells produce hot water and steam in the ratio of 3:1. Amount of GHGs in steam is approximately 1 %, comprising hydrogen sulphide (H_2S)<10%, and the rest being carbon dioxide (CO_2)) with minor proportions of methane (CH_4). The hot water and steam are partially cooled before they are released into the atmosphere. Other impacts are:

- Hydrogen sulphide (H_2S) imparts an unpleasant and corrosive smell to the air. However, the maximum recorded in Olkaria, 4.4ppm, is far below the limit for hazardous occupational exposure.
- Carbon dioxide (CO_2)) and methane (CH_4) from geothermal power plant is negligible and currently of insignificant environmental exposure concern.
- The released hot water causes localized heating with increased levels of humidity. This has been known to cause fog at the Olkaria 1 power station, especially in the period June to August.
- Noise pollution results from the blasts from well testing and drilling.

There is a potential danger of land subsidizing, when large masses of water released from the earth are not replaced, thereby significantly reducing the underground pressure. Lowered pressure may also lead to depletion of hot springs and geysers within the same region.

To avoid thermal pollution of the atmosphere, Olkaria Geothermal Power plant is exploring the possibility of re-using hot water separated from steam to produce electricity using binary cycle technology. Meanwhile, the wastewater is re-injected into deep wells for disposal and also to maintain reservoir pressures. Under EMCA (1999), an EIA must be undertaken before the implementation of these geothermal projects to minimise environmental degradation.

6.1.5. Fossil Fuels

Currently, Kenya has no known reserves of fossil fuels and therefore relies on imports to meet her requirements. However, exploration activities undertaken so far show that nearly half of the country has potential for the occurrence of oil and gas. Traces of these resources have already been found. Liquified petroleum gas (LPG) and other liquefied products from natural gas are critical energy sources for both domestic and industrial use.

6.1.5.1. Petroleum

Petroleum fuels are the primary movers of the national economy in all its facets due to their convenience and flexibility in use. Over the last five years, consumption of petroleum products has averaged 2.3 million tonnes per annum, out of which the transport sector accounts for about 65%, power generation 9%, agriculture 5%, industrial and commercial sector 19% and other sectors 2%. The demand for petroleum fuels is projected to grow by 2% per annum in the next decade. Table 6.3 shows the demand patterns for petroleum products from 1997 to 2001.

Table 6.3. Petroleum supply and demand balance, 1997-2001 ('000 tonnes)

Demand	1997	1998	1999	2000	2001
Liquefied Petroleum Gas (LPG)	30.7	31.3	32.2	33.4	35.6
Motor Spirit (Premium and Regular)	390.6	395.8	384.6	365.7	374.3
Aviation Spirit	4.1	3.2	2.5	2.2	2.4
Jet/Turbo Fuel	431.9	419.4	418.7	432.2	417.3
Illuminating Kerosene	267.6	318.2	406.8	383.7	306.1
Light Diesel Oil	615.9	607.5	601.7	712.8	663.7
Heavy Diesel Oil	47.6	26.4	25.7	28.1	27.7
Fuel Oil	386.9	397.3	439.4	490.0	558.1
Total	2,175.2	2,199.1	2,311.6	2,448.1	2,385.2
Refinery Usage	93.6	94.1	90.2	96.3	81.3
Total Domestic Demand	2,268.9	2,293.2	2,401.8	2,544.4	2,466.5
Exports of Petroleum Fuels	653.0	640.6	627.3	441.9	469.1
Total Demand	2,921.9	2,933.8	3,029.1	2,986.3	2,935.6
Supply					
Imports:					
Crude Oil	1,833.7	2,157.7	2,139.3	2,452.3	1,965.6
Petroleum Oils	895.7	1,387.8	1,250.9	874.9	1,208.3
Total	2,727.4	3,545.5	3,390.2	3,327.2	3,173.9
Adjustment	194.5	(611.7)	(361.1)	(340.9)	(238.3)
Total Supply	2,921.9	2,933.8	3,029.1	2,986.3	2,935.6

Source: Ministry of Energy records

6.1.5.2. Coal

Commercially viable coal deposits have now been found in some parts of eastern and coastal areas of the country. However, the mining of these deposits has not yet commenced. Currently, all the coal consumed in the country is imported from southern Africa and consumption has averaged 130,000 metric tonnes per annum. Coal is primarily used as process energy in cement manufacturing.

Fossil fuels are the largest contributor to air pollution and have been rightly blamed for global warming. The demand for fossil fuels for industries and the transport sector is growing at a rate of 2% per annum. The use of kerosene for domestic purposes is also growing. Given that all petroleum products are imported, the economy has a very high import bill.

Emissions from fossil fuels, especially carbon dioxide, methane, nitrogen and sulphur oxides — are responsible for changes in the atmosphere that are affecting the global climate. Nitrogen and sulphur oxides are precursors to acid rain. They are also involved in the formation of smog, which affects human health and impairs visibility.

The use of leaded petroleum in vehicles has resulted in the spread of lead in the atmosphere as well as deposits on roadside vegetation. Vegetables grown and sold along roadsides have been shown to contain some concentrations of lead which end up in animal and human food chains. Lead is known to cause mental impairments, interference in metabolic activities and related ailments.

Oil exploration results in the disturbance of ecosystems and loss of biodiversity. Table 6.4 shows relative emissions of carbon dioxide and sulphur oxides from different fuel plants.

Table 6.4. Carbon dioxide and sulphur emissions from some power plant types

Energy resource	Energy type	CO_2 emission g/kWh	Sulphur emission g/kWh
Fossil Fuel	Coal	1000	11
	Oil	850	11
	Gas	550	0.005
Geothermal	Steam	96	6
	HDR	0	0
Solar	SEGs	140	0
	Battery	0	0
Nuclear	-	<1	0
Hydropower	-	0	0

Source Armannsson, 1997

The transport sector consumes about two-thirds of all petroleum fuels used in the country. However, this sector has opportunities for achieving savings on these imported fuels through energy conservation and fuel substitution. The government is reviving the Kisumu Molasses Factory to produce ethanol, which will be blended with petrol/diesel to forestall the need for additives in petroleum products. EMCA (1999) has provisions for controlling air pollution from motor vehicles and other conveyances using petroleum fuel. In addition, KEBS requires that vehicles imported into the country meet stringent emission levels to avoid undue environmental pollution [KS 1515: 2000].

Industry and commerce consume about 25% of petroleum products in Kenya. The following mitigation measures are helping achieve energy efficiency and conservation in this sector:

- The Kenya Association of Manufacturers (KAM) energy efficiency project is helping instil a culture of energy efficiency and conservation in industry;
- Kenya Cleaner Production Centre (KCPC) and Civil Society Organisations are acquiring and packaging energy efficiency and conservation information for dissemination to the public, commerce and industries;
- Ongoing efforts to encourage the use of LPG by packaging in affordable quantities.
- Exploration ventures in areas showing oil-bearing rocks.
- Ongoing efforts to harmonize standards for gas cylinder regulators by the Ministry of Energy, Civil Society, Private Sector and the KEBS.

The barriers to energy conservation and efficiency have been identified to include high cost of introducing efficient and cost effective technologies; inappropriate and limited credit and financing mechanisms; and ineffectual regulatory mechanisms for enforcement of standards and codes of practice.

6.1.6. Biomass

Biomass is any material of plant or animal origin. These include woody materials such as stems, branches and twigs. Non-woody ones include stalks, leaves, grass and agricultural residues such as rice husk, coconut shell, and animal and human wastes. The energy can be converted through a variety of processes to produce a solid, liquid or gaseous fuel. Biomass use is an environmental threat in terms of harvesting of the resource as well as the emissions from biomass energy consumption (Tables 6.4 and 6.5). Biomass burning is a major source of indoor pollution and contributes to poor health of mothers and young children through eye and

respiratory tract diseases. Charcoal production has resulted in deforestation, loss of biodiversity and soil erosion.

Table 6.5. Approximate carbon emissions from sample biomass and conventional technologies

Fuel and Technology	Generation Efficiency	Grams of CO_2 per kWh
Diesel generator	20 %	1320
Coal steam cycle	33 %	1000
Natural gas combined cycle	45 %	410
Biogas digester and diesel generator (with 15% diesel pilot fuel)	18 %	220
Biomass steam cycle (biomass energy ratio [a] = 12)	22 %	100
Biomass gasifier and gas turbine (biomass energy ratio [a] = 12)	35 %	60
[a] The energy of the biomass produced divided by the energy of the fossil fuel consumed to produce the biomass.		

Source: Records of the National Environment Secretariat

About 67% of all households in Kenya use firewood, while 46% use charcoal. Apart from households, the cottage industry as well as coffee, tea, tobacco, dairy and sugar industries also use significant amounts of biomass energy. The resource base for woodfuels is estimated at a standing stock of 33.4 million cubic metres.

Biomass can be a renewable resource if managed appropriately. In Kenya, efforts made over the past 20 years to improve biomass energy management have yielded much (Figure 6.1). Twenty years ago the share of on-farm contribution to biomass energy was about 47%. Today, over 80% of firewood used is from renewable stock of agro-forestry and other on-farm systems, with only 16% derived from trust lands and gazetted forests. Indeed, in 1981, a biomass deficit of 32.6 million tonnes was projected for the year 2000. However, with the interventions in energy use efficiency, and promotion of on-farm production, the deficit for 2000 was 20.1 million tonnes. Charcoal on the other hand continues to be drawn clandestinely from trust lands and gazetted forests, representing an annual business worth Ksh.17 billion. Improved charcoal production technology has had minimal impact on recovery and production.

Bagasse is used today in sugar mills as fuel for combined heat and power (CHP) generation. Bagasse burning for electricity production or cogeneration as it is often referred to is practiced by Mumias Sugar factory among other sugar factories in western Kenya. There is potential for the seven sugar factories in western Kenya to generate over 50 MW of electricity.

Biomass resources have experienced the highest pressures in the recent times. High levels of poverty means that a greater proportion of Kenyans cannot afford alternative fuels and have to depend on natural biomass for their energy needs. The demand for charcoal by the urban population continues to grow. Charcoal burning is a significant contributor to the depletion of forests and biodiversity loss.

Biomass is a renewable energy source with the following positive impacts: cuts down on waste in the sugar, tea, coffee and sawmills. It is a cheap and accessible source of energy for most communities. However, harvesting of tree crops has the following negative impacts: reduces the natural sinks for carbon dioxide, exposes soils to agents of erosion, and accelerates loss of soil nutrients.

Removal of agricultural crop residues for energy use breaks the natural nutrient recycling process, impoverishes soils leading to erosion, and causes ecological imbalances. The direct burning of biomass releases particulate matter, which causes air pollution resulting in particulate-induced diseases.

A number of programmes, plans, and strategies have been initiated in response to the above challenges. These include:

- Community-based energy systems should be supported through cost sharing arrangements and tax exemptions.

- Formulation and enforcement of standards and codes of practice on renewable technologies to safeguard consumer interests and the environment.
- Packaging and dissemination of information on renewable energy systems to create awareness among investors and consumers;
- Conducting feasibility studies on biomass waste energy;
- Establishing financing mechanisms especially for micro-credit for consumers and entrepreneurs.
- Support for improved biomass energy technologies including biogas systems, improved stoves, kilns, gas fires, combined heat and power generation in industry.
- Promoting the planting of multipurpose trees.
- Building capacity of communities and institutions.

Implementation of the above initiatives may be frustrated by the following challenges:

- High cost of introducing efficient and cost effective technologies;
- Resource distribution and availability;
- Lack of recognition of biomass as an important energy component in the national energy balance;
- Contradictory policy and environment regulations on the production, distribution and use of charcoal.
- Socio-cultural constraints relating to the use of biomass;
- Low consumer awareness of available technologies and the potential economic benefits;
- Inadequate support for innovation and development in modern biomass technologies
- Introduction of alien tree species whose environmental effects are not yet fully understood; and
- International agreements, which consider forests as a global common, thus interfering with the management of our own forest resources.

6.1.7. Solar Energy

The potential for solar energy in Kenya is estimated at 4 to 6 kWh per square metre per day of insolation, which translates to about 250 million tonnes of oil-equivalent per day. However, only a minute fraction of this resource is harnessed for a host of activities including crop and animal products drying, water heating and electricity generation. It has been estimated that at the current electricity tariffs for water heating, it is feasible to harness economically up to 100 MW of equivalent solar water heating.

Tax and duties have been waived on most of the imported components of solar energy technologies. There are also efforts from civil society and private sector to popularise solar energy. This has resulted in high demand for solar panels. Installation and operation of solar energy projects have significant impacts. The impacts include:

- Disposal of batteries, solar modules, bulbs and fluorescent tubes pose a health hazard, which should be addressed as a matter of urgency.
- The use of solar energy substitutes such as kerosene and other gas-emitting fuels.

The above impacts have led to the development of the following interventions:

- Community-based energy systems are being supported through cost sharing arrangements and tax exemptions.
- Compilation of insolation and wind maps;
- Formulation and enforcement of standards and codes of practice on renewable technologies to safeguard consumer interests and the environment. This process has already been initiated in collaboration with the KEBS.
- Packaging and dissemination of information on renewable energy systems for investors and consumers;
- Enhancing and integrating rural energy development by involving universities, research institutions and the private sector in conducting research, development and demonstration in the manufacture of cost-effective renewable energy technologies;
- Provision of tax relief to renewable energy enterprises, and removal of duty on importation of renewable energy hardware.
- Establishing financing mechanisms, especially for micro-credit for renewable energy consumers and entrepreneurs.

The above responses have the following implications: high upfront cost of renewable energy technologies; lack of technical backup and after sales services; limited credit and financing mechanisms; weak regulatory mechanisms for the enforcement of standards and codes of practice, especially in countering importation of counterfeits; and lack of support for local innovations to bring down the cost of components.

6.1.8. Wind Energy

Wind energy is a cheap source of electricity, which has remained largely unexploited except in very isolated cases for water lifting and electricity generation. An attempt is being made to quantify the economically exploitable resource through compilation of data on wind regimes in different parts of the country.

The exploitation of wind for electricity generation requires large wind turbines that change the landscape scenery, make noise and can interfere with migration patterns of birds. The following interventions have been initiated:

- Compilation of insolation and wind maps;
- Formulation and enforcement of standards and codes of practice on renewable technologies to safeguard consumer interests and the environment. This process has already been initiated in collaboration with lead agencies.
- Packaging and dissemination of information on renewable energy systems to attract investors and consumers;
- Review the Electric Power Act of 1997 to facilitate rural electrification based on supply on a limited scale using renewable energy technologies;
- Enhancing and integrating rural energy development by involving public universities in conducting research, development and demonstration in the manufacture of cost-effective renewable energy technologies;
- Provision of tax relief to renewable energy enterprises and removal of duty on importation of renewable energy hardware.
- Establish financing mechanisms, especially for micro-credit for renewable energy consumers and entrepreneurs.

6.1.9. Municipal Waste as Fuel

Urban centres have continued to experience serious refuse collection problems due to critical governance deficiencies. It has been established in other countries that it is possible to generate revenue to cover operating costs for collection of refuse and treatment of raw sewage through energy generation and sale.

There are efforts to use waste-derived fuels on small scale through making briquette from charcoal dust and direct burning of household waste. When burnt directly, particulates are released as well as noxious gases including carbon monoxide, carbon dioxide and sulphur dioxide.

Use of municipal waste as a source of energy is a waste management option that gets rid of solid waste and associated pathogens. It also prevents the production of methane and hydrogen sulphide, products of decomposing matter. Certain management interventions have been instituted for the above impacts. They are:

- Packaging and dissemination of information on alternative energy systems to create awareness among investors and consumers;
- Establishment of waste management associations in urban centres through civil societies.

These interventions pose the following challenges:

- High cost of introducing modern energy conversion technologies;
- Lack of awareness on economic opportunities offered;
- Lack of standards and codes of practice including regulatory mechanisms for their enforcement;
- Inadequate planning for land use in urban areas;
- Socio-cultural constraints;

- Incompatible waste management systems and poor separation hindering harnessing of landfill gas as well as incineration with energy recovery;
- Improving garbage collection and delivery to appropriate site, introduction of waste separation at source through change and acceptance, and mobilization of funds to undertake feasibility studies and packaging the projects for development by the private sector; and
- Conflicting by-laws on the responsibilities and modes of waste management.

6.2. INDUSTRIAL POLLUTION AND WASTE MANAGEMENT

6.2.1. Introduction

The manufacturing industry in Kenya plays a crucial role in the transformation of raw materials into high value goods. Consequently, it generates incomes and revenue and creates jobs, all of which contribute to the eradication of poverty and creation of wealth. However, industrial processes are associated with the exploitation of natural resources. This often depletes resource bases at rates beyond the ability of nature to replenish them, destroying habitats, generating wastes and discharging pollutants into the environment.

The pollutants comprising of gaseous emissions, obnoxious smells, particulate matter, liquid effluents, solid wastes, thermal heat and noise emanate from agro-processes, chemical and pharmaceutical plants, mining and metallurgical industry. However, some industries recycle their wastes and use them for new products, which are less costly. Other factories stockpile their wastes while others burn them in the open. None has solid waste treatment systems.

The impacts of the manufacturing industry will be felt in greater magnitude as the country enters the momentous phase in her industrial transformation, aimed at attaining an industrialized country status by the year 2020. It is imperative therefore, that judicious and timely application of appropriate measures geared towards mitigating negative environmental impacts be adopted. This will guarantee the best of the two worlds – development and environmental conservation.

6.2.2. The Petroleum Industry

6.2.2.1. The Petroleum Refinery

Kenya has only one oil refinery based at Changamwe, Mombasa. The oil imported from the Middle East is refined and supplied to Burundi, Eritrea, Ethiopia, Djibouti, Kenya, Malawi, Rwanda, Somalia, Sudan, Tanzania and Uganda. Together with imports of refined petroleum product, the average annual consumption of petroleum products amounts to 2.3 million tonnes.

The Mombasa petroleum refinery relies on lead as an additive to boost octane performance of petrol blends. It has not invested in new processes and technologies that have kept pace with environmental regulations. Discussions on the modernization of the refinery have been going on since the Mid 1970s. This would give more value to its users and to make environmentally cleaner products. However, no initiative has yet been made to upgrade the refinery.

The Mombasa refinery is jointly owned by the government and three international companies (BP, Caltex and Shell). The refinery turnover is protected by a *Kenya Gazette* Notice that requires dealers to obtain up to 70 per cent of their requirements from the refinery. The local refinery operates more or less on the principle of guaranteed profitability and as such it is a strong source of income for the Treasury by way of dividends and taxes. The government will most likely find itself facing a conflict of interests as a shareholder of this refinery and as a regulator of environmental standards.

Resultant pressures call for measures to tackle the following issues:

Lead phasing out. Lead is eventually being outlawed in most markets in the world as a way of cleaning up the atmosphere, especially in cities with high traffic volumes. Countries were supposed to bring the average

lead content from 0.8g/l g to 0.4 g/l by 2002 and to 0.2g/l by 2003. In June 2001, sub-Saharan governments resolved in the Dakar Declaration to phase out leaded gasoline latest by 2005.
Conflict of interests. There is need to resolve the existing conflict of interests by some shareholders in the petroleum industry in order to pave way for a modern refinery.
Acceptability of unleaded gasoline. There is need to address the uncertainty by motorists over the use of unleaded fuel.

Lead is a highly poisonous heavy metal. Studies have shown that there is a direct correlation between the use of leaded gasoline and its level of presence in blood. Lead compounds are known to cause neurological disorders, brain injury, learning disabilities, damage to kidneys, liver reproductive systems and to impair blood formation. The impacts of the widespread use of unleaded include:

- Delays in phasing out leaded oil have frustrated efforts to maintain clean air in cities. The importation of vehicles should be restricted to those fitted with catalytic converters. This device reduces the emission of carbon monoxide, nitrous oxides and unburned hydrocarbons by about 90 per cent.
- Sludge from tanks requires special treatment, which is unavailable.
- Flaring results in release of carbon dioxide, GHGs, sulphur dioxide emissions due to high sulphur crude oils.

The government has initiated some response mechanisms. A deadline of 1st March 1999 has been agreed for the elimination of leaded super petroleum imports. It was set in standard KS 113-275 Part II, which addressed petrol and spirits products. Lead, sulphur and octane maximum levels were stipulated. This, however, excluded oil refined at the refinery. Kenya is a signatory to the Dakar declaration, which resolved to phase out leaded gasoline by 2005. The following legislative instruments guide operations in the sector: The petroleum Bill 2002; Factories and Other Places of Work Act; Cap 514; and EMCA (1999), which has provisions on the discharge of oils into the environment.

6.2.2.2. The Transport Sector

The transport sector in Kenya comprises of five major types: road, rail, air, sea/lake and pipeline with road dominating. Transport plays a crucial role in the country's development and integration. Motorized transport is by far the most dominant and is a major source of pollution and emitter of GHGs, especially in the urban areas.

The sector accounts for 65% of the fossil fuels consumed nationally. This is likely to rise in future due to the rapidly rising demand for motorized transport. The main GHG from the sector is carbon dioxide (CO_2); other gases with indirect effects include non-methane volatile organic compounds (NMVOC) and nitrogenous oxides (Table 6.6). Efforts are being made to identify measures that will lead to the improvement in transportation and control of GHG emission.

The port of Mombasa serves an extensive hinterland in Kenya, Uganda, Rwanda, Sudan, Ethiopia, Burundi and the Democratic Republic of Congo. The heavy commercial vehicles (predominantly diesel users) to these countries, transversing the country are responsible for heavy emissions of GHG and the destruction of roads.

Kenya has vast numbers of old and poorly maintained vehicles. Often many of these are seen emitting thick smoke and causing noise pollution as they trot around. The numerous cases of traffic jams emit enormous quantities of fumes from the combustion of leaded gasoline which are inhaled by inhabitants.

The transport sector, which is the largest consumer of petroleum products in Kenya emits more than 65% of the carbon dioxide gas in the country. The leaded gasoline commonly used in Kenya is the main source of lead emissions into the environment. The need to transport personnel and produce has exerted ever-increasing demand for motorable transport. When gasoline is combusted in the car engine, it emits fumes containing a wide range of pollutants including carbon dioxide and nitrogen oxides. Some of these pollutants are able to remain in the atmosphere for extended periods of time and even get transported and transformed

over the long distances they may travel. Some end up deposited in plants, soil and water bodies, occasioning negative impact on human health and those of other living organisms. Effluents from automobile garages such as paints, grease and waste oil is a great environmental hazard. There are also huge quantities of solid wastes comprising of worn out tyres, tubes and metal components removed from vehicles. Junkyards are also common phenomena in many parts of Kenya.

Table 6.6. Statistics on fuel consumption, vehicle population and CO_2 emissions between 1992 and 2001

Year	Fuel consumed by the transport sector (million tonnes)	Vehicle Population	Carbon dioxide emission (Gg)
1992	940,224	385,636	714
1993	925,536	398,056	1069
1994	963,498	389,141	1025
1995	967,027	431,344	1074
1996	1,015,138	464,457	1210
1997	1,066,463	482,459	1363
1998	1,124,690	501,062	1535
1999	1,183,031	520,382	1729
2000	1,245,144	540,447	1947
2001	1,311,305	561,286	2194

Use of leaded gasoline is the major mode of dispersing lead into the environment. When leaded gasoline is burned, extremely small particles of lead are emitted into the atmosphere, where they can persist for extended periods of time. These lead particles will eventually fall into soil and dust, creating a reservoir of lead to continue to poison generations unless covered or removed. With increased roadside and urban agriculture, a lot of our vegetables and fodder may contain lead from the combustion of gasoline and is ingested into our bodies when they are eaten. Lead compounds are known to cause neurological disorders, brain injury, learning disability, damage to kidneys, and liver, reproductive system and to impair blood formation. Other impacts include: Inappropriate vehicle maintenance leading to high GHGs emissions; oils and grease spillage and unethical management and disposal of wastes by open air garages; ineffective enforcement of vehicle maintenance/regulations and substandard spare parts and low quality grease and oils

To meet the environmental standards, the following measures are being implemented:

(i) Amendment of the Traffic Act (Cap 403).
(ii) Enforcement of the Vehicle Inspection Manual (July 1999).
(iii) Amendments made in 2000-2001 on pre- shipment inspection requirements for imported vehicles will be incorporated in the vehicle Inspection Manual.
(iv) A Code of Practice for Inspection of Road Vehicles [DSK 06 -1515 –1999] of the Kenya Bureau of Standards is expected to be adopted and implemented in due course.
(v) KEBS [K506 –849] "Road Vehicles -Measure of Smoke Opacity and [KS ISO 6718-2] "Road Vehicles - Ignition System is under review.
(vi) A permanent National Mobile Transport Vehicle Inspection Unit is operational.
(vii) The following legal instruments are operational: EMCA (1999) the Local Government Act (Cap. 265); the Public Health Act (Cap 242); the Finance Act of 1994/95; and the Petroleum Bill 2002.

A number of additional measures are already being implemented. These measures include: promotion of rail transport; extension of oil pipeline; taxation, and pollution control; rehabilitation of the section of the old oil pipeline.

6.2.3. Cement Production

Kenya has three cement factories and one clinker grinding plant with a combined production capacity of about 4 million tones per annum. Two plants, Bamburi and the Athi River Mining Cement plant are based in Bamburi and Kaloleni respectively. Bamburi has also a clinker grinding plant of capacity 1 million tonne at

the Athi River, Nairobi, close to the East African Portland Cement company (EAPCC). Except for the Bamburi Cement plant, the other cement producing facilities are modern. All the plants engage tunnel kilns for cement manufacture by dry process. The EAPCC has recently been up-graded and modernized to make it fuel efficient and environmentally friendly - a model plant for the region.

In 1994, carbon dioxide emissions were estimated by applying an emission factor in tonnes of carbon dioxide released per tonne of clinker to the total amount of clinker produced. The emission factor that was locally derived has a value of O.6121t CO/t clinker. Carbon dioxide emissions from cement manufacturing were estimated at 943.69 Gg of carbon dioxide.

Pressures include:

- Cement is an important building commodity whose availability in amble quantities and competitive cost is crucial for the building and construction industry. The demand for cement has progressively been on the increase. This demand corresponds to the vibrancy of the economy, and the trend is expected to grow over time. Alongside this paving of roads with cement has been proposed. This approach will definitely increase the demand for the commodity.
- Efforts to establish more cement plants at some strategic locations in the country, where raw material deposits exist are being pursued *(Shimoni in South Coast, and Serbit/Ortum in West Pokot).*
- Improved lifestyles are exerting increasing demand for quality housing hence increased demand for cement.

Environmental impacts arising from the cement subsector include:

- The cement industry is a heavy consumer of energy. EAPCC consumes about 4,350 litres of fuel per hour for firing the raw material mix (or consumes 7000 litres of fuel to fire 100 tonnes of materials);
- The quarrying activities destroys ecosystems and habitats;
- Dust and noise pollution from both the quarries and the crushing activities at the cement plant pose great environmental hazards;
- Bamburi's cement plant is at its obsolescence, which is partly a reason for its huge energy consumption and high maintenance costs.

Environmental concerns are considered in Sessional Paper No 2 of 1997 on the Industrial Transformation to the Year 2020. Some of the legislation which contributes to mitigation measures to be undertaken are: the Mining Act; (Cap 308), EMCA(1999), the Factories and Other Places of Work Act (Cap 514), the Local Government Act (Cap.265), Public Health Act (Cap.242), the Finance Act of 1994/95, the Petroleum Bill of 2002, and the Water Act (2002).

6.2.4. Lime Production

Lime production involves three main processes: quarrying the raw materials, crushing and sizing, and calcining at high temperatures of around 1100°C to produce lime and calcium hydroxide. Carbon dioxide is generated during the calcination stage, when calcium carbonate or a combination of calcium carbonate materials is roasted at high temperatures. Carbon dioxide is produced as a by-product of this process, just as CO_2 is released during clinker production.

Lime is used in pulp and paper industry, construction materials, effluent treatment, water softening, pH control and soil stabilization. Thus, increased demand for this product will increase with the thrust of the country's industrialization, the demand for soft water and agricultural activities. The environmental impacts of the lime subsector include:

- Destruction of ecosystems and habitat by excavation;
- Discharge of pollutants into the environment;
- Increased demand for energy

The following legislation govern the operations of this industry EMCA (1999), the Mining Act (Cap 308), the Factories and Other Places of Work Act, (Cap 514), the Local Government Act (Cap 265), the Public Health Act (Cap 242), the Finance Act of 1994/95, the Petroleum Bill 2002; and the Water Act of 2002.

6.2.5. Chemical Industries

Some of the major polluting chemical industries include: electroplating, chemical and biotechnological, pharmaceutical and agro-industries.

Some chemicals are imported while others are manufactured locally from imported raw materials. Pharmaceutical products are imported into the country, either in their finished form or as active ingredients for formulation locally. They are used for both human and veterinary needs. The above industries cause pollution through gaseous emissions due to solvent use, energy generation, servicing, maintenance and disposal of residues. Expired drugs have also been reported often in sales outlets in Kenya.

These products are at times overstocked due to poor procurement and management practices leading to disposal problems of the expired chemicals. Other issues include:

(i) Improper management of these chemical wastes result in environmental pollution;
(ii) Lack of awareness and inadequate technical information and know-how on the inherent dangers of chemicals;
(iii) Ineffective enforcement of relevant laws and regulations;
(iv) Lack of guidelines on proper use of chemicals and use of designated sites for disposal of expired chemicals and containers;
(v) Guidelines on disposal of chemical wastes;
(vi) Improper packaging, labelling and storage of chemicals;
(vii) Lack of inventories of types, compositions and volumes of hazardous wastes;
(viii) Lack of disposal facilities;
(ix) Poverty, illiteracy and lack of a legal framework are the cause of exploitative working conditions.

The environmental impacts arising from this sub-sector include:

- Exposure to harmful effects of chemicals resulting in deteriorating health and environmental damage;
- Presence of expired, adulterated, substandard and counterfeit chemicals and drugs in the market
- Persistence of occupational related diseases
- Expiry of chemicals before their shelf dates
- Use of harmful chemical containers for domestic purposes such as carrying milk and drinking water.

The legislation governing this sector include the Food, Drugs and Chemical Substances Act (Cap 254); the Public Health Act (Cap 242), the Agriculture Act (Cap 318); the Crop Production and Livestock Act (Cap. 321); the Mining Act (Cap 308); the Water Act (2002), the Factories and Other Places of Work Act (Cap 374), Sessional Paper No. 6 of 1999 on Environment and Development, the Pharmacy and Poisons Act (Cap 244), Pesticide Control Products Act (Cap 346), EMCA (1999), and Basel Convention on Trans-boundary movement of Hazardous wastes.

6.2.6. Steel and Iron Products

The iron and steel industry constitutes 13% of the manufacturing sector that in turn contributes 13% of the GDP. There are around 15 rolling units in the country, most of which have melting facilities. Most of these still use old technologies like ingot casting techniques, while others have adopted the more recent development of continuous billet casting, electric arc and induction furnace facilities.

The private sector has invested over Kshs.5 billion in fixed assets for the production of various products. This industry depends on imported raw materials and partly from recycled scrap.

The iron and steel industry is categorized according to the nature of economic activity and products manufactured. These included steel smelting and hot rolling; wire-rod and wire drawing; cold rolling and galvanizing; pipes and tubular products; and metal fabrication and general contractors. All these production

activities result in adverse impacts on the environment due to solid wastes, effluents and emissions. Emissions from rolling mills include: -

- Emissions of volatile organics and oil mists from the rolling oils and acid aerosols from the pickling process.

- Effluents consisting of suspended solids and oil emulsions from cold rolling stages and acidic wastewater from pickling process.

- Solid wastes consist of by-products such as off-cuts, pickling tank sludge, acid regeneration sludge and effluent pretreatment sludge, various types of heavy metal dross.

The main environmental pressures from this subsector include erratic exports potential, dependent on aid programmes in neighbouring countries; stiff competition from developed countries; preferential tariffs dependent on source of raw materials; and the available scrap is usually of low quality and quantity. The resultant environmental impacts are inadequate treatment of effluents; lack of hazardous waste disposal facilities for the dross and lack of appropriate designated controlled disposal site.

Kenya's goal is to become a newly industrialized country (NIC) by the year 2020 according to Sessional paper No. 2 of 1997 on Industrial Transformation by the Year 2020. Other legislations in place, include the Factories and Other Places of Work Act (Cap 514) and EMCA (1999).

6.2.7. The Coffee Sector

Coffee is one of the leading cash crops in Kenya with 65% being produced by the smallholder farmers under the co-operative societies, while large estates produce 35%. The coffee co-operative factories are organized into a series of societies serving small-scale growers (1–5 acre plots) and privately owned estates that range in size from 5 – 1,000 acres. There are 937 co-operative coffee factories and 1,538 estate coffee factories distributed across 35 districts.

Production has been declining from 1,810,000 (60 kg bags) in 1995/96 to 917,000 (60kg bags) in 1998/1999. Processing is predominantly by the "wet method", which requires significant quantities of clean water ranging from $20m^3$ to $100m^3$ per tonne of parchment produced.

The following are the environmental pressures from effluents generated by the coffee sector:

- Re-circulation systems are inadequately designed to facilitate ease of operation;
- Poor maintenance and pump breakdown;
- Pre-circulation is not perceived by factory management as a method of reducing the production of effluent or of conserving water. Consequently, when water is abundantly available or small quantities of coffee are being processed there is a tendency for re-circulation systems not to be used;
- Location of coffee factories, which tend to be widely dispersed throughout rural areas;
- Seasonality of the coffee crop; and
- Inadequate treatment of effluents by use of soak pits.

The solid wastes produced are pulp and husks. A number of environmental pressures are associated with these wastes. Decomposing pulp generate obnoxious odours. When fresh pulp is stored in open piles, its sugars attract flies and it becomes home to vermin such as rodents. Husks have a direct fuel value and can be used to fire boilers in factories or pressed into briquettes known as Kahawa coal for domestic energy needs.

Environmental impacts in this subsector include: indiscriminate disposal of effluents into rivers causing oxygen depletion, affecting flora and fauna, and causing toxicity and diseases thus affecting human health. The complexity of the discharges militates against simple cost-effective alternatives thus compounding the problem of supplying adequate clean water for domestic and agricultural use.

Policy and legislative responses to the above environmental issues include: the Water Act of 2002, the Agriculture Act (Cap 318), EMCA (1999), the Coffee Act, the Cooperative Act, and the Pesticide Control Products Act (Cap 346).

6.2.8. The Tea Sector

There are 45 smallholder tea factories in operation and managed by the Kenya Tea Development Agency (KTDA). An additional 10 factories are waiting commissioning. Save for two, all factories have a processing capacity of 15 million kg of green leaf per year with a combined capacity in excess of 655 million kg per annum (Tables 6.7, 6.8, 6.9 and 6.10).

Table 6.7. Production o lfaves b the tea sector (k)g

Year	2002	2001	2000	1999	1998
Estate	111,196,801	112,905,523	90,739,810	94,962,650	118,537,242
Small holder	175,905,432	181,725,815	145,546,258	153,855,368	175,627,855
Total	287,102,233	294,631,338	236,286,068	248,818,018	294,165,097

Table 6.8. Green leaf production (kg)

Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total Upto June 2002
2001/2002	145,396,279.00	195,506,414.00	184,053,596.00	204,612,288.00	729,568,577.00
2000/2001	113,937,738.00	192,571,033.50	212,931,839.50	199,981,890.00	722,809,808.00
Difference	29,275,236.50	2,097,355.50	31,091,228.00	4,630,398.00	6,758,769.00

Table 6.9. Planted area by sector (ha)

Year	2002	2001	2000	1999	1998
Estate	44,399	38, 781	35,313	99,884	33,762
Small holder	95,577	92,800	90,890	90,317	84,657
Total	139,976	131,581	126,203	124,201	118,419

Table 6.10. Made tea (kg)

Year	Green Leaf	Made Tea	Out-Turn %
2001/2002	729,568,577.00	176,394,276.00	24.18
2000/2001	722,809,808.00	172,749,007.00	23.90
Difference	6,758,769.00	3,645,269.00	0.12

Source The Tea Board of Kenya

Environmental pressures of the tea sector include: smallholder factories use fossil fuel which is expensive and produce environmentally unfriendly carbon gases as opposed to large estates; some factories use modified old train engines with low energy efficiency; and the tea factories use wood fuel which causes deforestation. The following are the resultant environmental impacts: destruction of forest ecosystems; climate change; destruction of catchment areas; and increased land degradation.

Policy responses are covered by the following acts: the Tea Ordinance (1934); Sessional Paper no 2 of 1997 on Industrial Transformation to the Year 2020; EMCA (1999); the Factories and Other Places of Work Act (Cap 514); the Local Government Act (Cap 265); the Public Health Act (Cap 242); the Finance Act of 1994/95; and the Tea (Amendment) Act 1999.

The KTDA Limited Wood Energy is aimed at making the affiliated tea factories venture into commercial wood fuel production. This involves the planting of eucalyptus trees.

6.2.9. Tanning Sector

There were sixteen (16) tanneries in operation in the early 1990s, which are all privately owned and scattered around the country. Currently, only eight (8) are in operation. However, most of the tanneries process up to the wet blue stage. These tanneries are situated in urban centers and their environs.

Solid wastes vary from one process to another and will include trimmings, fleshings, chrome shavings, chrome split waste, buffing dust, finished trimmings and solids in the treatment sludge. These are generally disposed of at municipal dumpsites nearest the tannery.

Effluents emanating from tanning operations are characterized by high levels of BOD, COD, Chromium, chlorides and pH variance.

Gaseous emissions: Sulphide from de-hairing and waste treatment; ammonia from unhairing and deliming liquors; solvent vapours from finishing operations and gas from incineration of wastes; odours arising from poor control of beam house operations, poorly maintained treatment plants and from decomposing accumulated wastes. The reduction of odours from these sources is more a question of operational maintenance than technology.

The tanning subsector causes the following environmental pressures:

- The majority of tanneries discharge their effluents into surface water bodies. This causes heavy pollution characterized by very high oxygen demand and obnoxious odours that include hydrogen sulphide from de-hairing and waste treatment, ammonia from unhairing and deliming liquors as well as sulphur dioxide.
- Chromium from the tanning process is a problem in waste management as it is not usually exhausted. Most tanneries discharging effluent into municipal sewers do not meet the standards governing quality of discharge of industrial effluent into the sewers adopted by most local authorities.
- Those discharging into receiving water bodies in the country have not all met effluent discharge standards.
- Solid wastes accumulating at the tanneries awaiting collection and transportation to the disposal sites are unaesthetic.

Tanneries are responsible for the following environmental impacts:

Odours and Untreated Chemicals Discharge: The major public concern over tanneries has been bad odours and water pollution from untreated discharges. Inorganic salts cause salinity, while ammonia, chromium and sulphates are toxic. Nitrogenous compounds contribute to eutrophication of water bodies. Turbidity and colour restrict photosynthesis thus affecting primary production in the food chain.

Health and safety arise from increasing use of synthetic chemicals such as pesticides, solvents, dyes and finishing agents. These substances are frequently toxic and persistent and affect both human health and the environment into which they are being discharged. Pathogenic microorganisms such as *Bacillus anthraxes* may also occur. Other impacts are: Leather dust is now recognised as a potential carcinogen; the cross media impacts may include ground water pollution through seepage of wastewater and chemicals from unlined ponds, dumpsites and spills, and soil contamination, especially by chromium and high salt contents which may occur.

Interventional responses to these challenges include various policy and legislative frameworks such as EMCA (1999), the Water Act (2002), the Public Health Act (242), Hides and Skins Act (Cap 346) and the Science and Technology Act (Cap 250).

6.2.10. The Pulp and Paper Mills

Kenya has one pulp and paper mill located in Webuye town in Bungoma District. From initial production capacity of 45,000 tonnes per annum, the capacity has now risen to 126,000 tonnes. The mill is situated in an environmentally sensitive area right at the heart of Webuye town and on the bank of River Nzoia. The river drains into Lake Victoria and serves as an important source of water for local communities, livestock and industries along its entire length.

The Webuye plant uses about 35,000 m^3 of water in processes, which include steam/power generation. About 90% of this water is returned as effluent after undergoing various treatments. The chief sources of wastewater are the paper machines. Other sources include digesters, sandstone grinders, washings, bleaching, thickening, deinking, chemical plant operations and wastepaper pulpers.

Approximately 8,300 tonnes of solid wastes per year are generated from raw material handling, rejects from screening and scrubbers, paper residues, primary and secondary sludge from effluent treatment ponds and boiler ash from steam generation.

There are two pulp-making processes at Webuye namely mechanical and chemical using wood. Another source of pulp is the recycling of waste paper purchased from collectors. There are other six paper recyclers in the country.

Environmental pressures arising from pulp and paper mills include high demand for paper in view of the absence of any other paper mill in the country. There is also need to meet global requirements to modernize the paper processing from chlorine based bleaching to non-chlorine technology.

Solid waste disposal at Webuye has the potential of polluting the environment through leaching and runoff. There is also acid rain due to sulphur dioxide causing corrosion to buildings and other structures. The organic matter in the effluents discharged from the processes cause oxygen depletion thus affecting aquatic life and rendering it unfit for domestic and agricultural purposes. The Webuye plant is the highest consumer of energy and water in the country. The industry is also a heavy consumer of forest resources reducing carbon sinks.

Emissions include carbon, nitrogen and sulphur oxides. They constitute the greenhouse gases contributing to global warming. Methyl mercaptans, dimethyl sulphides, hydrogen sulphide are emissions that are responsible for the smell nuisance. The fuels used at Panpaper produce varying quantities of ash, soot, and smoke. Emission of chlorine gas into the atmosphere, an ozone depleting substance, also occurs. Wastewater from these processes contains large quantities of lignin and hemicellulose. The characteristics of the wastewater are their high quantities of BOD and COD.

There are various policy and legislative responses that can be applied to mitigate the above environmental impacts. These include the Local Government Act (Cap 265), the Public Health Act (Cap 242), the Water Act (2002), EMCA (1999), the Forest Act (Cap 385), the Chiefs Act (Cap 128) and the Agriculture Act (Cap 318). There is also the Factories and Other Places of Work Act (Cap 514).

There are also re-afforestation programmes spread across the four districts of Keiyo, Uasin Gishu, Lugari and Trans Nzoia. These forests are existing on 306,000 ha of government land and managed in conjunction with the paper industry.

6.2.11. The Sugar Industry

The Kenyan sugar industry is dominated by government-owned factories with very few private sector players. Out of a total of seven operational sugar companies, only one (West Kenya) is privately owned. The sugar factories operating in the country are Chemelil, Muhoroni, Mumias, Nzoia, South Nyanza, Miwani and West Kenya (Table 6.11)

Table 6.11. Company installed capacities.

Company	Year of commissioning	Installed capacity in tonnes of cane per day (TCD)
West Kenya	1980	900
Muhoroni	1966	2200
Mumias	1973	8000
Chemelil	1968	3850
Nzoia	1978	3000
Sony Sugar	1979	2800
Miwani	1923	2400

Source: Kenya Sugar Board, Year book of Sugar Statistics, 2001

The domestic demand for sugar has steadily risen from 217,462 tones in 1973 to 600,000 tonnes in 2001. Production has increased from 137,808 to 377,438 tonnes in the same period. Total sugar production from the seven operational sugar factories for the year 2001 was 377,438 tones, down from 401,934, in the year 2000, representing a decrease of over 6%. Sugar sales also declined following massive importations of the commodity. The industry ended the year with sugar stocks of the magnitude of 55,000 tonnes, up from 1,291 tonnes in the same period in 2000.

The country has a sugar deficit of about 200,000 tonnes that must be met by imports. The bulk of this sugar should be industrial sugar that is not processed locally. The volume of sugar imports from the Common Market for Eastern and Southern Africa (COMESA) countries increased in the year 2001. Total sugar imports for the year 2001 were 182,459 tonnes up from 118,011 tonnes in 2000, a 55% increase in importations. Sugar imports constituted the following: refined white sugar 56%, Mill White 11% and raw sugar 33%.

In 2000, 3,907,835 tonnes of cane were crushed at a sugar recovery of 10.48% (TC/TS of 9.54). A total of 3,689,571 tonnes of cane were crushed to make 378,277 tonnes of sugar, representing the sugar recovery of 10.25% [tonnes cane (TC)/tonnes Sugar (TS) of 9.75].

The Kenyan sugar industry is characterized by the following operational shortcomings:

Cane Crushed/Sugar Made: Low recoveries are normally attributed to the harvesting of underage cane for crushing. Table 6.12 gives the quantities of cane production in tonnes, cane to sugar ratio, and sugar production in tonnes for six sugar factories.

Table 6.12. Sugar production for six sugar factories.

	Cane production in Tonnes		Tone of Cane to Tonne Sugar Ratio (TC/TS)		Sugar Production in Tonnes	
Factory Zone	2000	2001	2000	2001	2000	2001
Chemelil	493965	315104	9.02	11.39	54763	27665
Muhoroni	179281	14382	14.67	12.43	12221	1157
Mumias	1765313	1900341	8.76	9.13	201520	208142
Nzoia	415373	424105	10.06	10.42	41290	40701
South Nyanza	463167	382773	10.02	9.70	46224	39461
Miwani	147478	8346	17.09	31.55	8629	265
Overall	3464577	3045051	9.54	9.66	363163	315,223

Source: Kenya Sugar Board (KSB) 2001: Year Book of Sugar Statistics

In the year 2000, Mumias produced 1 tonne of sugar from 8.76 tonnes of cane. Miwani needed 17 tonnes of cane to produce the same 1 tonne of sugar. Similarly, in the year 2001, Miwani needed 32 tonnes of cane to produce 1 tonne of sugar whereas Mumias was producing a tonne of sugar from 9 tonnes of cane. Naturally, these two companies should sell their sugar at different prices if they have to both remain economically solvent. However, the price of sugar is uniform in the country, a reality that favours those companies that have better recovery ratios. The disadvantaged companies should invest in cleaner production as a way of improving on their recovery ratios. Mumias has installed an efficient diffuser technology.

Bagasse Management: The overall bagasse production for the entire country since 1992 is as indicated in Table 6.13. Out of the bagasse produced, only 54 % is utilized per year as fuel for the generation of steam for the milling processes. The rest is heaped in 'mountains which constitute a fire risk for the entire establishment. Boilers in most of the factories are operated inefficiently hence leading to wastage of energy. The power sector is not fully liberalized so as to attract investments in power generation by sugar companies as profitable venture (Table 6.14). Only independent power producers are allowed to generate electricity and sell it to KPLC. It will be necessary to change the current legal framework to allow the sugar companies to invest in power generation.

Table 6.13. Bagasse production in Kenya, 1992 - 2001

Year	Generated Quantities (tonnes)
1992	1,320,140
1993	1,390,307
1994	1,140,833
1995	1,465,692
1996	1,503,445
1997	1,578,511
1998	1,079,552
1999	1,802,143
2000	1,439,838
2001	1,290,646

Source: Kenya Sugar Board (KSB) 2001:Year Book of Sugar Statistics

Table 6.14. Model calculations of surplus electricity production potential

Company Name	Bagasse Percent	Net Calorific Value of Bagasse (KJ/Kg)	Specific Steam Consumption (Tone steam/tone cane)	Steam to Bagasse Ratio (tone steam/tone bagasse)	Excess Bagasse (tones/year)	Surplus Electricity Potential (KWh/ton e Cane)	Annual Electricity Productio n (GWh)	Surplus Power Productio n Capacity (MW).
Mumias	40	7493	0.5	2.2	332086	79	163	22
Chemelil	37	7290	0.5	2.2	75823	58	33	7
Nzoia	42	7493	0.5	2.2	79800	92	41	10
South Nyanza	37	7493	0.5	2.2	84556	60	39	7
Miwani	40	7493	0.5	2.2	33983	79	17	4
Muhoroni	43	7493	0.5	2.2	54653	99	28	7
West Kenya	37	7493	0.5	2.2	27954	60	13	1

Source: Common Fund for Commodities (CFC) 2001: Sugar Factories Surplus Bagasse Utilization for Co-generation Processes for Sugar Industries in Eastern Africa, Technical Paper No.12.

Management of Filter Cake or Mud: All the sugar companies, except Mumias generate a filter cake or mud at the rate of 4% of the cane crushed. This translates into 146,177 tonnes of mud annually. This filter cake constitutes a direct fertilizer that is applied as a soil conditioner. The sugar factories have not yet set up adequate mechanisms for the packaging and transportation of the generated filter cake to composting areas or those ones of immediate application. Innovative companies are using it as a binder material for filling up potholes on their feeder roads. Composting of the filter cake, unused bagasse, and sugarcane that drops by the roadside and dry sugarcane leaves is a worthwhile venture that can promote organic farming. Given that sugarcane is a heavy feeder, this intervention of returning the acquired biomass back to the soil is welcome. For this to be successful, issues such as capacity building, quality control, transportation and proper packaging need to be addressed.

Management of Boiler Ash: Overall, boiler ash is generated by all the companies as they use boilers fired by bagasse to generate steam. The ash is generated at the rate of 2% of the amount of cane crushed. This translates to 80,000 tones of boiler ash per year. Currently, this ash is returned to the field together with the filter cake as a soil conditioner. The practice should be expanded in the spirit of promoting organic farming in the sugar belt region.

Management of Fly Ash: Approximately five kilogram of fly ash is generated per metric tonne of cane processed. This translates into an annual fly ash emission of 2000 tones by all the seven operational sugar factories. This fly ash that emanates from the combustion of bagasse in boilers causes both indoor and

outdoor pollution. First, boiler efficiencies need to be upgraded so as to arrest the problem at source. The inevitable particulates can be filtered out with filter bags and mixed with other composting materials.

Management of Molasses: Molasses, a residual mother liquor from which little or no additional sugars can be obtained economically, is a by-product common to all sugar factories (Table 6.15). Going by the production of the year 2001, 50% of the molasses in Kenya becomes a raw material for the Agrochemical and Food Company (ACFC). The rest is dumped or sold as an animal feed. A small fraction is used for the manufacture of an illicit brew. ACFC uses the molasses for the manufacture of bakers yeast, rectified spirit, neutral alcohol, industrial methylated spirit, Kenya methylated spirit, active dry yeast and fodder yeast. Molasses is generated at an average rate of 4% of the cane crushed. The ACFC has an installed capacity of 18 million litres of alcohol and 1200 tonnes of active dry yeast.

Table 6.15. Quantities of molasses produced and their respective percentage recoveries in tonnes, 1997-2001

Years	Chemelil molasses recovery (%)		Muhoroni molasses recovery (%)		Mumias molasses recovery (%)		Nzoia molasses recovery (%)		South Nyanza molasses recovery (%)		Miwani molasses recovery (%)		West Kenya molasses recovery (%)	
1997	5.27	37123	5.06	12045	3.79	71430	3.66	18599	3.05	19346	3.32	7794	2.26	4296
1998	3.08	23201	3.90	11402	3.45	75879	2.97	13093	3.31	24226	3.52	7466	2.27	4826
1999	4.08	22909	4.37	14768	3.41	74962	3.13	16322	3.56	24101	3.48	5840	2.42	5026
2000	3.71	24747	4.75	8890	3.71	70769	3.50	14615	3.21	14955	2.99	4624	2.92	3108
2001	3.13	15741	0.29	45	3.59	74240	3.53	14902	3.42	171162	2.48	258	2.52	4257

Source: Kenya Sugar Board (KSB) 2001: Year Book of Sugar Statistics

The company's first project focused on the manufacture of gasohol (99.7% ethanol blended with 1% regular gasoline) whose production was abandoned in 1985 due to marketing complications created by the multinational oil companies. Out of its overall output of 18 million litres of alcohol, the company sells 3-5 million litres regionally, 8-10 million locally and 3-5 million is exported to Belgium, France and other European countries. ACFC needs to diversify and manufacture more products from molasses. It also needs to be expanded so that it can absorb the entire amount of molasses generated by all the factories. This will constitute a perfect industrial ecology system where the waste products of one company become perfect raw materials for the other. Table 6.15 indicates the amounts of molasses generated by the seven companies in tonnes since1997.

The Kenyan sugar industry is characterized by excessive water consumption. The resultant wastewater is normally treated using a series of waste stabilization ponds before being discharged into natural watercourses. Some of the sugar companies have incorporated natural wetlands in their tertiary treatment of their wastewater. Despite all these attempts, the sector's effluent is characterized by high organic loading that could easily interfere with aquatic life in natural watercourses. Adoption of waste minimization measures will drastically reduce the amount of effluent discharged into the lagoons; increase the effluent's retention time so as to reduce the level of organic loading.

Wastes consist of environmentally hazardous substances such as photographic and residual chemicals, metal hydroxide sludge, dyestuff and solvent residues, wiping material containing dyes and solvents and oil spills. There are also bulky wastes such as paper.

6.2.12. The Printing Industry

Emissions into the air mainly consist of organic solvents and other organic compounds. Some substances may cause unpleasant odors or affect health and the environment. Discharges to water bodies mainly consist of silver, copper, chromium, organic solvents and other toxic organic compounds. Noise pollution comes principally from fans, printing presses and transport.

Wastes consists of environmentally hazardous substances such as photographic and residual chemicals, metal hydroxide sludge, dyestuff, solvent residuals, wiping materials containing dyes and solvents and oil spills. These are also bulky wastes such as paper.

There is an increasing demand for reading materials occasioned by the free primary education programme and the liberalization of the education sector. There is also a vibrant print media and a growing photography industry. The improvement on literacy levels will also require more reading materials. A growing packaging sector is being fuelled by the increased industrialization.
Impacts result from the growing volumes of waste paper and hazardous wastes. Reading materials are now easily available and there is enhanced communication and information flow. Other impacts include noise pollution emanating from the printing machines, gaseous emissions from the solvents and surface water pollution by the emanating effluents.

Interventions to address the above impacts include the application of existing legislations such the Water Act of 2002; EMCA (1999), Industrial Bill and Factories and Other Places of Work Act (Cap 514).

6.2.13. The Textile Industry

The Kenyan textile industry is currently facing a number of challenges, particularly with respect to environmental legislation, the proliferation of the second-hand textile trade and international competition. The impacts of the industry on the environment include discharges of effluents containing dyestuffs and solvents. Other environmental issues arising from the textile industry include the increasing cost of energy, water and effluent treatment and disposal.

Activities in the textile industry generate the following other environmental and health impacts: pollution of water courses and other ecosystems and the escalation of contagious skin diseases perhaps from wearing used clothes.

6.2.14. Environmental Impacts of Various Industries

The environmental impacts of various industries are indicated in Tables 6.16, 6.17 and 6.18

Table 6.16. Characteristics of liquid wastes from selected industries

Industry	PH	Total Suspended solids Mg/l	BOD mg/l	COD mg/l	Other important Characteristics
Pulp & Paper (Kraft Process)	7.05–8.3	20 – 71	32-59	274-617	Lignin, colour, suspended fibre, (Cl 169 - 284)
Tannery			25.0 -7,200	186-11,350	Cr^{+3} 21mg/l max recorded, Sulphide 296.4 mg/l max. recorded, Cl, Tannin, Colour
Coffee				1390-3900 WtR 2000 -14,625 WR	TDS mg/l 3,600 - 5000 WTR 6,200-11,000 WTR

WTR-Without-Recirculation
WR- Recirculation

Table 6.17. Toxic chemicals in effluents from selected industries

Industry	Toxic Pollutants
• Electroplating	• Cyanides and heavy metals like Cr^6, Zn, Cd, Ni, etc.
• Metallurgical	• Heavy metals like Cu, Cd, Zn
• Caustic Chlorine	• Mercury
• Fertilizer	• Ammonia, arsenic, chromium
• Metallurgical coke	• Phenols, cyanide, thiocyanate, ammonia
• Resin	• Phenol formaldehyde
• Synthetic wool	• Cyanide, acrylo-and aceto-nitrile
• Pesticides	• BHC, DDT, 2,4-D-Malathion, Palathion, etc

• Dyes and Pigments • Petrochemicals	• Coloured bodies, oxalic acid, heavy metals like Pb, Zn, Cu. • Phenols, etc.

Table 6.18. An inventory of industrial GHGs emissions in Kenya

Industrial Process	Production (tones)	Emission Estimates				
		CO2	SO2	NOX	NMVOC	CO
Cement production		979.4	0 45	0	0	0
Lime Production	30.7	24.2	0	0	0	0
Soda Ash (trona) Production	181.3	17.6	0	0	0	0
Pulp & Paper Production	513.6	0	3.6	0.8	1.9	2.9
Bread Production	98.8	0	0	0	0.8	0
Sugar Production	371.8	0	0	0	3.7	0
Beer Production (hl)	3686000	0	0	0	0.13	0
Spirits (hl)	14803	0	0	0	0.12	0

6.2.15. Medium and Small Scale Enterprises (Jua Kali) Sector

The medium and small scale enterprises (MSE) sector has more than one million enterprises employing over 2.4 million people. Most players in the sector lack the appropriate skills, finances and technology needed to enhance its performance and further growth. This has resulted in vast amounts of wastes being generated and dumped into the environment untreated.

Ease of entry into the informal sector activities has been the major force behind the sector's expansion. Demand for a cheap alternative source of implements offered by the sector has also spawned the associated activities. Some of the environmental challenges arising from the sector's activities include informal business settlements, inefficient solid waste collection and effluent disposal. Workers are exposed to dangerous chemicals and other toxic substances and emissions.

Congestion in the working areas are fertile grounds for the spread of diseases and serve as dens for robbers and other criminals. Vandalism of aluminium power cables and transformers for use in making aluminium items and coolant for Jua Kali fabricated transformers respectively are common.

In major towns, the government has established Jua Kali sheds for the sector's activities. The government has also developed a Sessional Paper on the Jua Kali industrial sector.

6.3. AGROCHEMICALS

6.3.1. Introduction

Agrochemicals comprises of pesticides and fertilizers. Pesticides include insecticides, fungicides, herbicides, acaricides, nematicides, soil sterilants, rodenticides, hormones and insect repellants and attractants. Fertilizers include nitrogenous, phosphates, potassic and compound fertilizers, trace elements, foliar feeds and soil improvers. Being an agricultural country, Kenya imports a lot of these products (Tables 6.19, 6.20 and 6.21) but lacks proper facilities for the disposal of the resulting wastes. Agrochemicals have been extensively used for agricultural production with limited skills for their safe handling which has led to negative impacts to human and animal health and the environment. Agrochemical wastes are also generated at farm level but have attracted little attention until recently when their inherent dangers came to light.

6.3.2. Pests Control Products (Pesticides)

Inadequate disposal facilities affects the management of pesticides. There have been attempts to collect and store these pesticides at the Kitengela Goat and Sheep Project Site. Further, there are pesticide wastes in several government institutions, cooperative unions and societies and other places totalling about 400 metric tons throughout the country awaiting disposal. There are five identified sites in the country with suspected

POPs contaminated soils estimated at 700 tones awaiting excavation and disposal. The suspected sites are located at Gaitu in Meru Central, Naivasha in Nakuru, Ngurumani in Kajiado, Wajir and Mandera. Most pesticide containers do not have clear guidelines and techniques on their disposal, especially with those of metal and glass containers. Measures on the regulation and of pests control products should provide standards for their disposal and also address the issue of illegally imported unregistered pesticides.
The site at Kitengela, with an estimated 200 metric tonns of POPs, needs careful management. It is suspected that there is seepage of these chemicals to the underground water and thereby finding their way into the nearby Athi River. There is also a strong smell from the site that may affect human and animal health within the vicinity. In Wajir, there are high chances of pesticides finding their way into the underground water which is the main source of water in the town. In Mandera and Wajir the contaminated sites in the army camps pose high human health risks. Most firms and farms are disposing of their dilute pesticide waste through soak pits. There is only one manufacturer of pesticides with an incinerator that can dispose of pesticide waste. Most pesticide manufacturers and/or formulators are situated in Nairobi and Nakuru.

The above activities generate the following pressure in relation to the manufacture, use and disposal of pesticides. Increased population requires more food as more people come into contact with pesticides. Stringent regulations on pesticides should be formulated. High costs of pesticides render them unavailable to the farmers who need them most. Due to health and environmental concerns, developed countries are insisting on pest and disease free produce. There is therefore need for more research on more effective but cheaper and safe pesticides.

Table 6.19. Value (in Ksh million) of pesticide imports (C+F)

Year	Insecticides	Acaricides	Herbicides	Fungicides	Others	Total
2002	2030		492	1012	110	3644
2001	1677	524	324	957	713	4185
2000	1114 1		298.6	713 9	74.7	2201.3
1999	1178		259	891	181	2509
1998	1196.9		521.3	1358 5	37.7	3114.4
1997	1164		301.5	827.2	113	2405.7
1996	1405 4		389 9	1049 1	102.1	46 5
1995	707		312.1	682.6	74.4	1776.1
1994	479.3		286.5	432.8	84.5	1283.1

Table 6.20. Quantity of pesticides imports in metric tons

Year	Insecticides	Acaricides	Herbicides	Fungicides	Others	Total
2002	2747		1064	2138	434	6383
2001	1664	656	1398	1779	154	5651
2000 1762		633 4	1665.9	370 6	4431.9	
1999	2186		593	2284	1116	6179
1998	1814.4		1407.84	4225. 4	158.8	7606.4
1997	2077 8		703 1	2391.0	655 6	5827.5
1996	1876.2		997 9	3469.8	602.5	6946.4
1995	1413 3		870.6	2323.0	501.9	5108.8
1994	1049.9		747.4	1671 8	563 3	4032.4

Table 6.21. Percentage of pesticides imports in monetary value

Year	Insecticides	Acaricides	Herbicides	Fungicides	Others	Total
2002	55		14	28	3	100
2001	40.1	12 4	7 6	22.9	17 0	100
2000	50.6		13.7	32.4	3.3	100
1999	47		10.3	35.5	7.2	100

1998	38.43		16.73	43.6	21.21	100
1997	48.4		12.5	34.4	4.7	100
1996	47.7		13.2	35.6	3.5	100
1995	39.8		17.6	38.4	4.2	100
1994	37.4		22.3	33.7	6.6	100

Tables 6.19, 6.20 and 6.26 denote figures for the years 1994 - 2002. Note that pesticides imports vary from year to year depending on the prevailing weather conditions

The following are the resultant impacts associated with pests control products:

a) Migration to semi-arid lands with fragile ecosystems for food production.
b) Land fragmentation.
c) Increased use of pesticides in order to increase production per unit area.
d) Few people can comply with the stringent regulations on pesticides leading to increased counterfeit products; crop loss / low productivity; increased environmental degradation; health and occupational risks; and resistance of pests and diseases to pesticides.
e) Misuse of pesticides to control pests and diseases, which leads to crop rejection at international markets.
f) Proliferation of flower farms.
g) Workers exploitation and exposures to poisonous chemicals.
h) Inadequate knowledge on inherent dangers of pesticides leading to poisoning.
i) Aerial spraying that pollutes non-targets sites.
j) Dumping of pest control products that would persist in the environment and contaminate water courses and environment.
k) Dumping of pests control products that would persist in the environment and lead to poisoning through food chain.
l) Inadequate protective gear that would lead to poisoning to the applicators of these chemicals.

6.3.3. Statutory and Voluntary Controls

There are statutory and non statutory responses to address the above impacts. Statutory controls are contained in the Pest Control Products Act (Cap 346). The law regulates the manufacturing, distribution, importation and use of pesticides. Registration of agro-chemicals is intended to ensure before the importation of any agrochemicals is allowed into the country, there is registration that ensure efficacy, quality and safety to the environment. There exists legislation on importation of pesticides that ensures that only registered products are allowed into the country. The law also regulates formulation, repackaging and use of all pest control products that ensures that the above processes do not pollute the environment.

There are guidelines in place for small-scale disposal of waste generated at farm level. Although there is no legal framework or subsidiary legislation for the control and disposal of pesticide wastes, the Agrochemicals Association of Kenya (AAK) in collaboration with the Government of Kenya through the Ministry of Agriculture and PCPB has put in place procedures that would ensure that all wastes are disposed of in an environmentally sound manner.

Any chemical (pesticide) waste generated at farm level should be safely disposed of either through AAK for large quantities of obsolete pesticides or soak pits for washings from contaminated floor or application equipment. Empty containers should be burnt at farm level while some plastic and metallic containers are buried. The Kenya Flower Council (KFC) has special equipment for disposing these containers. The efficiency of the process needs to be evaluated.

Information on the manner and time a pesticide should be applied is normally on the label. AAK, PCPB and Ministry of Agriculture have been conducting trainings, which cover aspects on the safe use of pesticides. Currently, several organizations are involved in ensuring that human health is safeguarded, especially in flower farms and factories. It is a requirement that all workers be provided with adequate protective clothing, which they are required to wear. In order to ensure this is followed, the PCPB inspectors carry out impromptu inspections upon which a decision is made on whether to issue an operational license or not.

There are codes of practices, which are voluntarily followed by members of AAK Fresh Produce Exporters Association of Kenya (FPEAK), the Kenya Flower Council (KFC), Lake Naivasha Riparian Association (LNRA) and Lake Naivasha Growers Group (LNGG) which ensures protection of workers and the environment. Additionally, the agrochemical industry subscribes to the FAO/WHO code of conduct on the distribution and sale of pest control products which ensures that products are used and disposed of without polluting the environment. Kenya, being a signatory to the United Nations convention on pest control products movement works to prevent the dumping of expired and banned products.

At the farm level, most large-scale growers have wetlands where most washings are channelled. These are normally away from water bodies. Bio-indicators are incorporated in some treatment systems for monitoring their efficiency. Some solid wastes generated at farm level are normally decomposed to form manure, which is later used in the farm. Workers are subjected to blood tests every three-six months. If found to have been overexposed they are assigned alternative jobs.

The challenges facing the pests control products subsector include:

- The need to isolate and eliminate unregistered and counterfeit pesticides in the market.
- Production should meet the markets' requirements on the maximum residue limits in the produce.
- Increased research in agriculture will provide better quality varieties with high pests and disease resistance.
- The need to gazette sites for the disposal of obsolete pesticides.

6.3.4. Fertilizers

Fertilizers are chemical formulations used to boost crop production. Presently, fertilizers used locally are all imported. Fertilizer use poses environmental problems, which include, change of soil pH, availability of nutrients, pollution of water courses and animal and human health.

The management of fertilizers is also affected by adulteration and faking of fertilizers and inadequate surveillance systems. Importation of fertilizer is controlled under the Agriculture Act (Cap 318), while quality is controlled by KEBS and KEPHIS.

Pressures in this sub-sector include:-

- Population increase leading to high demand for increased food production per unit area.
- Insufficient control mechanism on manufacture, import and distribution of fertilizers.
- High cost of fertilizers.
- High market demand for quality agricultural produce.
- Poverty and unemployment.

The resultant impacts include the following:

- Overdependence on use of chemical fertilizers in order to increase production per unit area.
- Lack of sufficient control mechanism
- Increased counterfeit fertilizers
- Low productivity
- Increased environmental degradation
- Risks of supply of fertilizer with radioactive materials.
- Discharge of fertilizer to water bodies leading to eutrophication

Fertilizer issues are regulated by various policies and legislations, which include: the Agriculture Act (Cap 318), the Factories and Other Places of Work Act (Cap 514), the Public Health Act (Cap 242), EMCA (1999), and Sessional Paper No. 6, 1999 on Environment and Development.

NEMA will supervise the fertilizers sub-sector by identifying and coordinating relevant institutions that are involved in the control of manufacture and distribution of fertilizers; encouraging and facilitating partnerships and networking among lead agencies and other relevant institutions; identifying and building capacity in key relevant analytical laboratories to address environmental issues.

The challenges facing the fertilisers subsector include: isolating and eliminating adulterated and counterfeit fertilizers in the market; meeting the high demand for fresh produce; and reducing the cost of fertilizers.

BOX 4. FUTURE OUTLOOK FOR THE ENERGY, POLLUTION AND WASTE MANAGEMENT

EMCA (1999) has provisions for comprehensive management of the environmental issues.

Energy: Measures which need to be undertaken to streamline the sector include:

- Incorporate energy conservation and efficiency in all industrial and commercial establishments
- Create incentives/disincentives for cleaner and modern technologies.
- Increase research and development funds for development of affordable biomass energy technologies for the poor, especially those in the rural areas.
- Increase access to affordable electricity by importing from the regional grid/power pool and rehabilitation existing plants with a view to increasing their output.
- Explore alternative sources of energy.
- Build capacities through training and motivation.
- Incorporate EIA in all new projects and EA in old energy generation and consumption plants.

Industrial Pollution: To achieve the target of NIC, the following measures need to be implemented:

- Strengthen legislation on packaging, labelling and proper storage of chemicals and their products.
- Ensure that all industries incorporate treatment of wastes in their production systems. The treatment plants should be frequently monitored to enhance compliance.
- Encourage cleaner production technologies by providing incentives.
- Reduce GHGs emissions by industries by minimizing consumption of fossil fuels and promoting afforestations and reafforestation programmes.
- Promote research and development of value-added products from wastes.
- Implement the Kyoto Protocol with a view to accessing the Clean Development Mechanism (CDM) funds.

Municipal/Household Waste: The management of the municipal and household solid wastes call for the following measures:

- Conduct studies on solid wastes management in the country
- Develop national land use policy to zone areas for landfills
- Provide adequate financial and technical resources for the sector, including funds for research and development.
- Enforce the existing legislation.
- Institute rigorous capacity building in the sector.
- Enhance environmental education and public awareness programmes and promote consultative and collaborative approaches.
- Implement the national sectoral regulations, standards, and guidelines.

Sewage: Measures to manage sewage wastes will involve public and private players as follows:

- Make MWRMD the policy maker, while the local authorities, private entities, communities and NGOs should provide the services.
- Government should support local authorities and communities in the development of sewerage systems.
- Review the current charges with a view to reflect the costs incurred in sewage management.
- Apply appropriate technologies that are acceptable in the management of sewage.
- Complete and implement regulations, standards and guidelines relevant to the sector.

Agrochemicals: The following measures need to be undertaken in order to regulate the agrochemicals sector:

- Identify/designate disposal sites for obsolete pesticides.
- Enhance awareness on safe use and disposal of pesticides and chemicals.
- Review and strengthen existing laws on the manufacture, export, import, formulation, use and disposal of fertilizers and pesticides.

CHAPTER 7

TOURISM, TRADE, INDUSTRY AND MINING

7.1. TOURISM

7.1.1. Introduction

Kenya is a mega diverse country with high quality tourism products. It has remained one of the most popular tourist destinations in Africa ranking sixth in Africa after Morocco, Tunisia, South Africa, Algeria and Zimbabwe. The country has 66 conservation areas covering almost 8% of the country's land area with a large variety of animals, plants and unique land forms. Tourism in Kenya generated an estimated Ksh.23.9 billion in 2001/2002, making this economic activity the third largest foreign exchange earner after tea and horticulture. It contributed about 8.7% of the country's GDP, 6.8% of total employment and 19.2% of total export earnings in 2002.

Tourism was for many years viewed as environmentally benign. However, it is now widely recognized that there is no 'zero-impact' tourism. In fact, wildlife and white-sand beaches which attract about 780,000 tourists to Kenya annually, has had tremendous impact on the environment. The unique attractions of wildlife and wilderness have been destroyed through overcrowding and environmental degradation.

The Kenyan tourism industry has in the recent past implemented some mitigation measures recommended at the global level, including minimizing resource use and treating wastes, recycling wastewater and rehabilitating degraded sites. Ecotourism has been adopted and implemented through partnership programmes involving the government, the private and local communities — such as the Kenya Wildlife Service (KWS) and the Beach Management Programme. Ecotourism operations aim to minimize negative impacts on the environment.

7.1.2. Tourism Destinations, Activities and Preferences

Kenya's stunning topography ranges from the snow capped peaks on Mt Kenya (5,199m), the Great Rift Valley, alpine highlands, rolling savannah plains, wilderness semi deserts to some of the best palms-fringed beaches in Africa. Traditionally established as a beach and wildlife safari destination, these are likely to remain the core products. Kenya also offers a range of adventure and diversity of other activities. The richness and variety of Kenya's heritage, beaches and wildlife safaris make the country an important tourist destination (Table 7.1).

Kenya's highland farms have rich British historical connections that are interesting to visitors. Farm stays and visits to tea and coffee plantations have become popular tourists destinations. Other attractions on offer include: mountaineering, rock climbing, ballooning, hang gliding, skydiving, para-gliding, parachuting, mountain biking, white water rafting, canoeing, snorkelling, windsurfing and bungee jumping. Other opportunities are horse riding and camel treks. Lake and deep sea fishing for big game species such as blue marlin attract high yield niche segments. Scuba diving is now a major high yield adventure activity (Box 1).

The infrastructure in the national parks and reserves in terms of roads, lodges and hotels have risen over the years. These facilities and the associated infrastructure have caused the loss of habitat and naturalness.

The tourism sector was on a recovery path during year 2000 (Table 7.3). The data on hotel-bed night occupancy rate shows an upward trend from 35.3% in 1998 to 42% in 2002. However, the mushrooming of unclassified hotels and restaurants in the major urban centres has negatively impacted on the environment due to improper disposal of wastes generated from these facilities. Some of the facilities have also become health hazards due to unavailability of running water.

Table 7.1. Major tourist destinations in Kenya

Coast	Northern	Central and eastern Kenya	Western
Post beach destinations Tsavo East National Park Tsavo West National Park Amboseli, National Park Arabuko sokoke Forest Reserve Shimba Hills – National Park Beach destinations Marine parks Marine reserves Sacred site destination (Kaya forests, Mathebo) Kenya's historical sites	Meru National Park Samburu National Reserve Marsabit National Reserve L.Turkana	Masai Mara N Reserve Aberdares National. Park Nairobi National Park Samburu N. Reserve L. Nakuru National Park L. Lake Bogoria National Reserve Mt. Kenya National Park Hells Gate National Park Mt. Longonot National Park	Mt Elgon National Park Kakamega Forest National Reserve Saiwa National Park Ndere Island National Park Ruma National Park. Lake Victoria

Table 7.2. Types of tourism activities and their locations

Types of tourism activities	Locations
Mountaineering	Mt. Kenya, Longonot and Hells Gate).
Game viewing	Masai Mara, Amboseli
Forest Nature Walking	Kakamega
Diving, swimming and snorkelling	Marine parks
Hiking, Camping trails cave exploration and Bird Watching	Saiwa Swamp
Sport fishing, yachting	Marine parks
Private Ranches Tourism	Laikipia
Waterfall viewing	14 falls, Nyahururu falls (formerly Thomson falls)
Wildlife Safaris	Masai Mara National Reserve
Cultural Tourism	Masai Mara National Reserve
Conference Tourism	Nairobi, Mombasa, Nyeri, Kisumu
Agro Tourism: Coffee. Tea, cattle	Central Province, Kericho, and Nandi districts

The Maasai Mara National Reserve and Lake Nakuru received over 193,000 tourists each in 2000. In the same year, visitors to Lake Nakuru, Maasai Mara, Animal Orphanage, Tsavo East National Park, and Amboseli National Park accounted for about 61% of visitors to all game parks and reserves.

Table 7 3 International arrivals via - Cruise, Moi International Airport- Mombasa and Jomo Kenyatta International Airport.

	July	August	September	October	November	December	Total
2002 (02/03)	50,765	53,067	41,989	50,554	42,343	48,527*	287,245
% change (over 01)	*+13%*	*+16%*	*+6%*	*+32%*	*+24%*	*+20%*	*+18%*
2001 (01/ 02)	44,806	45,786	39,500	38,319	34,100	40,372	242,883
2000 (00/ 01)	52,747	49,909	44,770	42,973	46,563	56,682	293,644

Source: Kenya Tourist Board (KTB)

Tourism in Kenya is almost exclusively centred within the coastline ecosystems and a handful of national parks and game reserves. The adverse impacts of mass tourism in Kenya have been aggravated by overconcentration of tourist activities in some areas of the country, notably the beaches of the north and south Coast, and some national parks and game reserves (Maasai Mara, Amboseli, Nairobi, and Nakuru). The six most popular parks (out of 57) alone accommodated 70.2% of all park visitors in 1995, while the top 15 accommodated 96.1% of all visitors. Within the popular parks, moreover, visitation is also concentrated.

Table 7.4. Impacts of tourism on the environment

Positive Impacts on Environment	Negative Impacts on Environment
• Economic value motivates wildlife protection and conservation through funding for national parks and other conservation areas. In Amboseli National Park each lion or elephant herd is worth US$ 27,000 or US$ 610,000 per year, respectively, in tourism revenue. • Ecotourism promotes environmental health by providing environmental education to the local people and by building consumer demand for environment-friendly products and services. • Tourism contributes to environmental conservation through improved environmental management and planning, for example through control of tourism activities and use of environment-friendly technology. • Tourism industry is estimated to employ 180,000 Kenyans directly and another 320,000 are indirectly employed. This draws labour away from environmentally destructive activities,. Wildlife tourism industry was estimated to employ 55,000 people in 1994. • A significant portion of tourism expenditure benefits businesses and industries outside the core tourist sector. The suppliers to hotels and restaurants such as farmers, vegetable growers, breweries, others include the banks and foreign exchange dealers, motor and fuel suppliers, builders, furniture makers and airport staff.	• Deforestation Cutting down trees or shrubs for firewood, particularly while hiking or camping • Destruction of forests and mangrove swamps to obtain construction material for lodges and hotels • Destruction of coral reefs at the Coast • Soil erosion; air, noise and water pollution, littering; decreased diversity of flora and fauna; and aesthetic degradation • Improper disposal of garbage by campers in areas like Mt. Longonot and Mt. Kenya leading to pollution that affects wildlife feeding behaviour. • Pollution as a result of improper disposal of solid waste from tourist facilities • Transportation emissions, especially from tour vans and noise affecting the feeding, movement and mating behaviour of wild animals. • At global level, Ozone-depleting substances generated by some of the equipment and products widely used in the tourism industry such as refrigerators, air conditioning have detrimental impacts on the environment. • Animal harassment caused by off road driving. • There have been cases of human/wildlife conflicts in certain destination areas. This has been occasioned by the fact that most communities in tourism areas do not benefit from the wildlife. • Cultural erosion. • Biopiracy.

Kenya has 27 terrestrial national parks, four marine reserves and four sanctuaries. The national parks are managed by KWS, while some of the national reserves are managed by the county councils. Apart from the national parks and national reserves there also exist conservancies in individual and communal ranches. Some of the community conservancies are managed by wildlife forums, for example the Laikipia Wildlife Forum. A range of community-based initiatives on group ranches is already attracting interest as eco-tourism models such as Il'Ngwesi, Namunyak and Mwaluganje wildlife sanctuaries.

7.1.3. Challenges

The impact of tourism on the environment is largest where visitation is concentrated. Maasai Mara and Lake Nakuru received slightly more than 193,000 tourists each in every year (Table 7.4).

A number of policy documents have been formulated to guide efforts to protect the environment against adverse human activities. The policy initiatives outlined the long-term plans for preserving the beauty of the country and minimising pollution, traffic congestion and the destruction of the environment. Sessional Paper No.8 of 1969 and the1994 –1996 national development plan outline mechanisms to allocate each piece of land to its best use.

Today's markets are environmentally conscious and aware, and feel good about contributing directly to community benefits. There are opportunities for show casing "conservation in action", wildlife research projects and innovative resource management solutions such as the Lewa Wildlife Conservancy. These would have to be specially controlled and planned for tourism so that their ecological objectives are not compromised.

The mitigation efforts for minimizing the adverse impacts of tourism activities on environment need to address the following issues: most tour operators routinely ignore environmental regulations, inadequate coordination of institutions dealing with tourism; inadequate political and administrative capacity; policy

failure, including the lack of an effective land-use policy; inadequate incentives to stimulate interest of local people in conservation; inadequate marketing resources; insecurity and rampant poaching; and the high cost of changing these practices.

The tourism reform policy focuses on the development of new sustainable tourism products, the upgrading of existing products, the repositioning of Kenya as a tourism destination and the development of domestic tourism. The National Tourism Development Master Plan of 1995 sets out a development strategy up to the year 2010. The principal goals in the plan are stated as: to secure the sustainable use of tourism resources; to optimize the sector's contribution to the national economy and rural development and to ensure the maximization of tourist satisfaction.

7.2. TRADE

7.2.1. Introduction

Kenya's general trade policy objectives are articulated in Sessional Paper No. 1 of 1986 and elaborated in the 8th National Development Plan. The country's general policy objectives include moving towards a more open regime, strengthening and increasing market access and integrating Kenya into the world economy. Towards this end, the role of the government has changed over the years from control and regulation to that of facilitation. However, a number of factors have adversely affected the domestic, regional, bilateral and multilateral trade. These factors are: influx of imports in the domestic market, non-competitiveness of local products, limited negotiation capacity of private and public sectors, poor infrastructure, high cost of utilities, narrow product export base, finance, effects of liberalization, and high cost of inputs for the locally manufactured goods.

7.2.2. Domestic trade

A 1999 baseline survey counted over 1.3million medium and small enterprises (MSEs) which, employ close to 3.7 million people and accounted for over 43% of Kenya's total export earnings in 2002. The sector also contributed 18% of the gross domestic product.

However, the cumulative and collective impact of 1.3 million enterprises on the environment can equal or even surpass, that of formal and bigger establishments which are normally subjected to environmental audit (EA). Some of the trading activities with notable impact on the environment are hawking, motor vehicle garages, hides and skins, charcoal and woodfuel, carvings and timber, agricultural produce markets, fish and general trade.

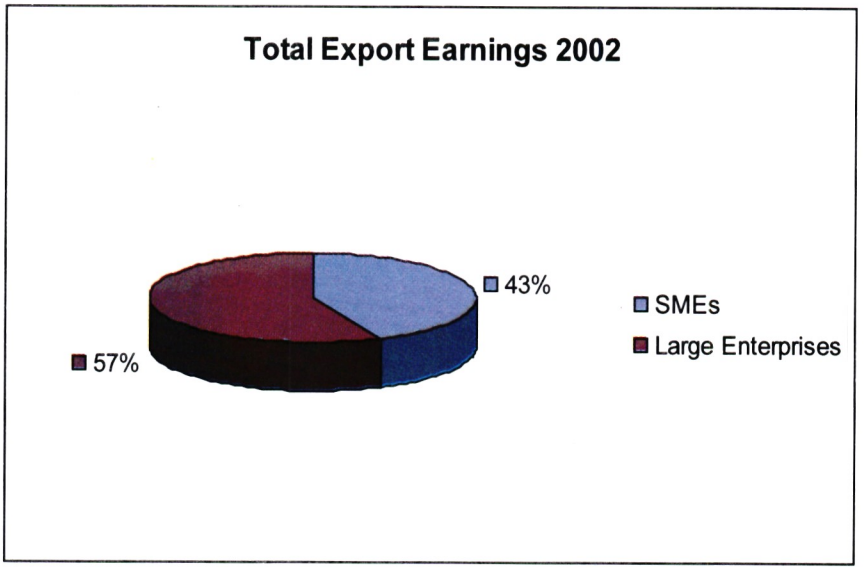
Hawking: Since Kenya liberalized her economy in the 1980s, hawking has increased significantly in all the urban centres. The increase has also been contributed by the high rate of unemployment. Although this activity's contribution to the economy is immense, it impacts negatively on the environment, as the hawkers do not clean the mess they create when undertaking the activity. Various local authorities are in the process of relocating these hawkers, with a view to controlling and regulating the trade.

Garages: The wastes generated from garages are mostly oil based, scrap metal and others that are non-biodegradable. Those wastes contaminate the air, soil, water and at times block the sewage systems. The perception that these enterprises support the very poor in the society, makes it difficult for authorities to monitor and properly regulate them.

Hides and Skins: Some leather processors use chrome and other toxic agents considered environmentally unfriendly. An increase in demand for processed leather will therefore accelerate the release of some of these latent and toxic chemicals into the environment.

Timber: Trading in timber and timber products is a major business in urban centres. However, sale of timber decreased from 197,200 m^3 in 2001 to 162.000m^3 in 2002 as a result of the logging ban.

Figure 7.1. Contribution of SMEs and large enterprises to Kenya's exports



Agriculture and Produce Market: This sector's contribution to the GDP has progressively declined from 37% in the early 1970s to about 25% in 2000. Growth in agriculture and improved rural incomes has a significant and direct impact in reducing poverty. The sector also provides raw materials to the manufacturing sector. The sector covers all the crops including horticultural (crops) which is currently the third most important foreign exchange earner.

Fish Exports: Kenya is one of the largest exporters of filleted Nile Perch. In the recent past, Kenya's filleted fish was rejected by some markets due to environmental issues, mainly centred on landing beaches and the processing plants.

Trade: Over the years, wholesale and retail trade has continued to grow both in rural and urban areas. However, there has been poor planning, which has led to mushrooming of shops and kiosks, which have generated enormous amounts of waste. These wastes include polythene bags, which end up clogging the sewerage system and littering the environment.

7.2.3. International Trade

The amount of imports fell significantly in 2002 while exports grew substantially. The trade deficit which has been widening since 1996 fell by 38.0% in 2002. Total exports increased by 4.7%, while imports declined by 11.2%. As a result, the volume of trade declined by 2.4% per cent in 2002 compared with growths of 16.2 per cent and 14.2 per cent registered in 2000 and 2001 respectively.

However, there is need to urgently build capacity to monitor international trade malpractices in order to effectively apply anti-dumping and countervailing measures so as to ensure that Kenya is not used as a dumping ground and that our products are not unfairly driven out of the international markets. There is also need to check the influx of counterfeits, as they are unfairly competitive to locally manufactured products.
Imports: The value of imported crude petroleum and petroleum products dropped by 23.2% and 15.2% respectively. The import bill for iron and steel and industrial machinery decreased by 7.1% and 32.8% respectively. However, import values for animal/vegetables fats and oils rose by 41.6 per cent. Other increases in import values were recorded in medicinal and pharmaceutical products, essential oil and perfumes, hand and machine tools, agricultural machinery and tractors. The import values of industrial

machinery, crude petroleum, and petroleum products recorded the largest declines of 32.8%, 23.2% and 15.2% respectively.
The share of non-food industrial supplies increased from 29.5% in 2001 to 32.4% in 2002 and remains the dominant import category. The value of imported food and beverages dropped by almost one half. As a result, its import share dropped from 10.5% in 2001 to 6.0% in 2002.

Exports: The leading export earners are tea, horticulture and coffee. They jointly earned 52.7 % of the total export earnings in 2002, compared with 50.9% in 2001. Export earnings from tea almost remained at 2001 levels, while those from coffee fell by 12.3%. Earnings from horticulture, which declined by 6.5% in 2001 expanded by 42.8% in 2002. Other notable increases in export earnings were in fish, cement, tobacco products, articles of plastics, sugar confectionery and animals and vegetable oils. The share of export earnings from food and beverages, was 49.2% in 2001 and increased slightly to 51.9% in 2002. The share of non-food industrial supplies increased from 22.7% in 2001 to 24.7% in 2002.

In 2002, the value of re-exports grew by 44.9% compared to 77.2% in 2001, while the value of imports declined by 11.2% in 2002. Consequently, the trade deficit, narrowed by 38.0%, from Kshs.142,518 million in 2001 to Kshs.88,427 million in 2002 (Table 7.5). The export/import ratio reversed its downward trend and stood at 65.7% in 2002 compared with 50.9% per cent in 2001.

Table 7.5. Balance of trade. 1998 - 2002 (KShs Million)

Description	1998	1999	2000	2001	2002*
Export (FOB)					
Domestic Export	114,448	115,406	119,764	121,434	131,394
Re-export	6,735	7,153	14,763	26,156	37,889
TOTAL	121,181	122,559	134,527	147,590	169,283
Imports (CIF)					
Commercial	190,538	199,808	240,473	285,107	254,006
Government	7,251	6,592	7,331	5,001	3,704
TOTAL	197,789	205,400	206,401	290,108	257,710
Balance of Trade	-76,608	-83,742	-113,277	142,518	88,427
Total Trade	318,969	328,960	382,331	437,698	426,993

Source: Government of Kenya, Economic Survey 2003, Nairobi: Government Press

African region continued to be the dominant export market followed by the European Union. Exports to the African region in 2002 was 48.9% of total exports; a decrease of about 0.3 percentage points compared with 2001. However, export earnings from the African region went up to Ksh 82,750 million in 2002 from Ksh.72,513 million in 2001, a 14.1 percent increase. The growth was attributed to significant increase in the value of export to other African countries. Exports to the United Kingdom increased substantially by 19.8 per cent, while to German fell by 14.8 per cent. Exports of all types of vegetables to UK increased remarkably. Exports to the Netherlands continued to rise steadily by 11 per cent in 2002 mainly due to the increases in export of fish and vegetables.

Over the last two decades, the interlinkage between trade and environment has become an increasingly important issue in international trade relations. There are about 200 international agreements (outside WTO) dealing with various environmental issues. Some of the MEAs have provisions that can affect trade in certain circumstances (Table 7.6). Kenya is a keen proponent of environmental conservation.

Further, Kenya wants developing countries to be engaged in the debate on the linkages between MEAs and other trade related organizations. Such collaboration would lead to an all inclusive final stand in terms of where to draw the line between trade and environment and the responsibilities of each party.

Table 7.6. Some of the multilateral environmental agreements to which Kenya is a party

The Convention on International Trade in Endangered Species (CITES)	This convention seeks to control trade in endangered species and their parts, as well as products made from such species. It also establishes trade controls, ranging from a complete ban to a partial licensing system.
The Vienna Convention on substances that Deplete the Stratospheric Ozone Layer, with the Montreal Protocol	This convention establishes a regime of control for several classes of industrial chemicals now known to harm the stratospheric ozone layer. The result has been a ban on the production and use of several of them together with sphere limitations on others.
The Basel-Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal.	This particular convention resulted from the concern of developing countries, particularly in Africa, that they could become the dumping ground for hazardous wastes that could no longer be disposed of in the developed world. The Convention has been marked by disputes over the most appropriate strategy for controlling the movement of hazardous wastes, regional bans versus prior informed consent) and the technical difficulty in establishing unambiguous distinctions between wastes and materials for recycling. Parties have adopted amendments banning the export of hazardous wastes from mainly OECD to non-OECE countries.
Cartagena Protocol on Bio safety	This is a Protocol to the CBD, covering trade in most forms of living genetically modified organisms and the risks it may present to biodiversity. Kenya has ratified the Cartagena Protocol which came into force at the end of 2003. Also the Government has developed the biosafety bill which is expected to address trade on GMOs. Trade on GMOs is currently controlled by KEPHIS in conjunction with Kenya Revenue Authority.
United Nations Framework Convention on Climate Change (UNFCCC)	This convention grapples with the most complex of all environmental issues and the one with the greatest potential for economic impacts. Since greenhouse gas emissions can rarely be limited with technical, end-of-pipe" technologies, the principle strategy of the UNFCCC is to be able to change the pattern of future investment in favour of activities that generate less green house gases.
Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for certain Hazardous Chemicals and Pesticides in International Trade	There is need to offer adequate assurance that information would be provided quickly, but also that it would reach the relevant authorities when needed. And it needed to create a system that permitted developing countries to stop the import of certain substances if they felt a need to do so. This goal has been served by the Rotterdam Convention.
Convention on Biological Diversity (CBD)	Opened for signature at the Rio Conference in 1992, the Convention's objective is conserving biological diversity the sustainable use of its components and the fair and equitable sharing of the benefits.

7.3. INDUSTRY

7.3.1. Introduction

Kenya's industrial sector is one of the largest in Sub Saharan Africa. Manufacturing accounts for 13% of the gross domestic product (GDP), a share that has remained constant since 1998. The sector accounted for over 27 per cent of Kenya's total export earnings in 2001. The sector had about 700 medium sized and large-scale enterprises and 1.3 million micro and small enterprises in 2000 employing about 300,000 and 3.7 million people respectively. The sector registered a positive growth of 1.2 per cent in 2002. Despite this small gain, the sector still performs at less than its optimal capacity due to high costs of energy, poor infrastructure and increased dynamism of the customer needs and demands.

The cumulative and collective impact of over 1.3 million micro and small scale enterprises (MSEs) on the environment may even surpass that of large industrial establishments. This is because:

- The enterprises are small, numerous and geographically dispersed thereby making monitoring of their activities difficult and enforcement of any laws costly.
- Due to their size and the fact that they are regarded as sustaining the poor in the society, they become less attractive targets for regulation measures than the large-scale firms.
- SMEs operate on sites that have inadequate infrastructure or lack properly rights. This reduces their commitment to long-term investment to improve the environment in which they operate.

Plate 7.1. Site of the proposed titanium mining in Kwale district (Photo by L. K. Biwott)

Current industrial production are associated with both the wasteful use of natural resources as well as the unmonitored release of emissions into the environment. The increasing pressures of globalization and liberalization require Kenyan industrial establishments, particularly MSEs to continuously improve their competitiveness and environmental performance. Successful adoption of cleaner production (CP) strategies can provide a single answer to both these problems. CP has potential to help MSEs and large industries to meet their environmental challenges by reducing the generation of pollution at source and quite often with enhanced profitability. The other benefits of CP include better working environments, improvements in

product quality, and ease compliance with environmental regulations, enhanced company image and creation of new market and employment opportunities.

7.3.2. Key Issues of Industrial Growth

7.3.2.1. High Cost of Production

The most pressing challenge for Kenyan industrialists is the high cost of manufacturing at a time when globalization is subjecting them to intense competition. Kenyan manufacturers pay 80 US$ per Megawatt hour while their Egyptian counterparts pay 27 US$ per Megawatt hour. The international cost averages 30 US$ per Megawatt hour. Kenyan industrialists pay 180 US$ per tonne fuel oil as opposed to 42 US$ per tonne for Egyptian industrialists. This high cost of energy is putting Kenyan goods out of regional and international competition. This has resulted in some entrepreneurs being forced to switch to environmentally damaging energy sources such as firewood, saw dust, tree barks and other forms of combustible biomass. At times, the supply of these energy sources is very unreliable in the country.

Unreliable water supply compounded with its increasing costs has forced some Kenyan entrepreneurs to exploit underground water resources. This exploitation is happening without proper water abstraction guidelines based on hydro geological surveys.

7.3.2.2. The Impact of ISO 9000 and 14000 Series of Environmental Standards

All organizational activities, products and services will interact with and have an effect on the environment. Consequently, there is need for an effective environmental management system (EMS) to manage, measure and improve environmental performance. If properly implemented, EMS increases efficiency and compliance with environmental requirements. So far, there are approximately 7 large Kenyan companies that have been forced by foreign market demands to adopt ISO14001 Certification. About 50 others have adopted ISO 9000 series of total quality management. These management systems are considered too costly by MSEs. These MSEs should therefore be encouraged and supported to adopt the cost effective cleaner production or waste minimization approaches that can enable them to cut down on their costs of production and remain competitive. Although there are numerous benefits to a company that implements ISO 14000/9000 series of environmental management/quality management standards, there are a number of concerns by MSEs. They consider implementation of ISO Standards as too expensive. These Standards can act as a possible tariff barrier if they are adopted as a pre-requisite for imports.

7.3.3. Types of Industries

Kenya's industrial establishments are concentrated around Nairobi, Mombasa, Kisumu, Nakuru, Eldoret, Nyeri, Thika, and Athi River with the sugar belt being predominantly located in western Kenya. The sector is dominated by agro-based industries. The industry sub sectors include: manufacturing, service, construction and building and informal.

Manufacturing Sector: The manufacturing sector contributes about 13% of GDP. Among the factors that have contributed to the good manufacturing performance have been the stable macro-economic environment, the reduction in import duty to zero rate for the majority of industrial intermediate inputs, the government interventions in promoting export of manufactured goods, enactment of anti-dumping and countervailing duty legislation to curb restrictive practices that disadvantage local manufacturers. Overall, most industries recorded positive growth with highest growth in sugar and confectionary sub-sectors. Other major industries that recorded real output increase were in beverages, clothing, printing and publishing, plastic and cement production. The steepest declines were in the wood and cork products, furniture and fixtures, rubber products and metal industries.

The Flower Industry: Methyl bromide is one of the most important ozone depleting substances that is still being used in the Kenyan agricultural sector. Its current consumption is mainly in cut-flowers' fumigation. Current imports stand at 400 metric tonnes.

Sugar Industry: The domestic demand for sugar has steadily risen from 217,462 tonnes in 1973 to 600,000 tonnes in 2001, while production has increased from 137,808 to 377,438 tonnes in the same period. Sugar industries are mostly located in the Lake Victoria Basin. The main sugar factories are Mumias, Sony, Nzoia, Chemelil, Muhoroni (under receivership), West Kenya, Miwani (under receivership), Busia (proposed), Ramisi (for revival) and the Agrochemical Food Corporation. They are located near permanent rivers. Water drawn from these rivers is returned back after treatment. Mumias has six stabilization ponds with a total volume of 76,450 m^3 that discharges a BOD^5 of 120mg/l. Sony Sugar has a V-Notch for flow measurement, four oxidation ponds, uses bacteria to speed up biodegradation, has an aerator, sludge beds and a clarifier and discharges a final BOD_5 of 90mg/l.

Nzoia has sedimentation ponds, primary ponds with aerators, and secondary ponds for its wastewater treatment and achieves a BOD_5 discharge of 120mg/l. Chemelil has 12 oxidation ponds with a total capacity of 10,500 m^3 each with all basic requirements for effluent treatment that discharges a BOD^5 of 110mg/l. All these sugar factories are required to use facultative ponds for the tertiary oxidation of their wastewaters, while some have already adopted constructed wetlands for their secondary and tertiary wastewater treatment.

Additional environmental problems facing Kenyan sugar factories include:

- About 54% of the generated bagasse is used in steam generation. The rest is left as bagasse mountains in the sugar factories (constituting a fire hazard). However, it could be used in the co-generation of electricity up to the tune of 58MW. Mumias sugar factory is co-generating over 14 MW of electricity.
- The filter mud is generated at the rate of 4% of the cane crushed. This translates to 150,000 tonnes per year. This filter cake can be composted to promote organic farming in the Kenyan sugar belt. Its accumulation on site can cause disposal complications.
- All Kenyan operational sugar factories generate a total of 80,000 tonnes of boiler ash per year. This boiler ash can be used as a soil conditioner in combination with the composted filter mud.
- Kenyan sugar factories generate 5 kg of fly ash per tonne of processed cane. This causes both indoor and outdoor air pollution. Sugar factories need to install filtering bags that will filter the fly ash from the boiler flue gas. This trapped fly ash can be composted into a soil conditioner.

The Coffee Industry: Coffee is one of the leading cash crops in Kenya. Most (65%) coffee is produced by small holder farmers under the co-operative societies, while 35% is produced by large estates. The coffee co-operative factories are organized into a series of societies serving small-scale growers (1 – 5 acre plots) and privately owned estates that range in size from 5 – 1,000 acres. There are 937 co-operative coffee factories and 1,538 estate coffee factories distributed across approximately 35 districts. There are about 100,000 hectares under coffee in Kenya of which 30,888 hectares are estates and the rest under cooperatives

Processing is predominantly by the "wet method" which requires significant quantities of clean water ranging from 20m^3 to 100m^3 per ton of parchment produced. Wastewater from coffee factories is normally discharged into watercourses after pre-treatment, or directly through seepage pits; and in some cases, it is used for irrigation. Coffee factories generate two types of wastewaters, namely the pulping water with a high content of quickly fermenting sugars using enzymes from bacteria on the coffee cherries and thick effluents from the mechanical mucilage removers.

The organic and acetic acids from the fermentation of sugars in the mucilage makes the wastewater very acidic (pH down to 3.8). Under these acid conditions, higher plants and animals will hardly survive. BOD_5 levels of 150 mg/l are registered. The pH of the wastewater has to be lifted to at least pH 6 or 7 before discharge into natural waterways in order not to threaten aquatic life. Natural limestone is the best-suited buffer solution for neutralizing coffee wastewater.

Coffee wastewater has high biological oxygen demand (BOD) that interferes with aquatic life. Solid wastes from coffee factories are used as mulch for grass, coffee and soil conditioning. The use of pesticides and fungicides in preventing coffee diseases also constitutes an environmental problem. The Kenya Planters

Cooperative Union (KPCU), under the trade name of Kahawa Coal, makes Charcoal briquettes (for use as fuel) from pulp and parchment.

Slaughter Houses: Municipalities and urban centers have slaughterhouses that have serious environmental problems with respect to the management of their solid waste, effluents and gaseous emissions. Based on existing practices, the following environmental liability factors should be addressed:

- Hygiene standards for treating, handling and storage of animals and meat in all stages of the production process.
- Regular hygiene and animal health checks should be carried out before slaughter.
- Collection of residues arising from the slaughter of animals.
- Burning of waste and recovering fats and oils.

Slaughterhouses use large quantities of water for washing meat and cleaning of the process areas. Effluent produced during the slaughtering process may generate pollution problems due to the high content of animal fat, waste, blood and cleaning agents. The effluent from slaughterhouses may need to be treated and usually requires hot water spraying to dislodge fats that have accumulated in the on-site drainage system. The main sources of atmospheric odour are animal wastes (skin, hides, hooves), unprocessed material and other solid waste. Odour control may be significant, particularly when the slaughterhouse is located near a residential area.

There are 19 registered tanneries, but only 8 are operational. The tanning process is usually accomplished in three distinct phases: the preparation of hides in a beam house; the actual tanning to make leather in the tan yard; and finishing the leather (in the post tanning area) phase.

During the tanning process, hides and skins are treated to remove non-structured proteins and fat, leaving an essentially collagen matrix that is preserved by tanning. This involves the impregnation of hides and skins with minerals, synthetics or vegetable tanning agents. The potential impacts of tanning can be significant. The industry produces toxic gases (hydrogen sulphide and solvent vapours), putrefying solid waste (responsible for the bad smell) and copious volumes of wastewater containing high concentrations of inorganic salts, heavy metals and organic substances in solution or suspension.

Tanning chemicals used include lime, sodium sulphide, and chromium salts. Large quantities of hair, flesh, blood clots and dirt are generated during soaking, dehairing, liming and fleshing. Generally, only 20% of the raw material used is transformed into the final product. Adoption of waste minimization practices will help alleviate pollution problems associated with tanneries. Wastewater treatment at the leather industries involves screening, grit removal and treatment in aeration lagoons and filtering beds. The quality of the effluents varies from factory to factory and depends on the level of treatment. It is possible to recover chrome, compost raw leather trimmings and use the lime liquor for neutralizing soil acidity. Odour from tanneries has been a major cause of complaints from residents near such factories. The Kenya Medical Research Institute (KEMRI) is currently promoting a microbe for reducing the obnoxious smell from tannery effluents.

Pulp and Paper Industry: Pan Paper Mills is the only large-scale pulp and paper factory in Kenya. It is in Webuye town of western Kenya. There are a few small industries involved in paper recycling. Pan Paper is responsible for 70% of Kenya's paper production and is involved in pulp and paper manufacturing using wood (pine, cyprus and eucalyptus) from forests that are within a radius of about 100 km from the mill. On average, Pan Paper consumes 45-50,000 m^3 of water per day, 80% of which leaves as wastewater (36-40,000 m^3 per day). The effluent characteristics from the factory is shown in table 7.7.

The key pollutants are suspended solids (fine fibres from paper manufacturing processes) of up to 2000 t/yr; organic loads including wood juices, cellulose and suspended matter; wood residual substances including lignin material, cellulose, tannins and sugars; volatile suspended solids; and process additives including sulphides, sulphates, sulphites, chlorides, soda, sizing materials and glues.

There are four wastewater stabilization ponds (with partial aeration) covering over 28 acres of land. The combined retention time is 30 days. The clarifiers removes up to 80% of suspended solids and the recovered sludge is used in boilers as fuel.

Rubber and Rubber Products: The rubber and rubber products sub-sector declined by 5.6% in 2002. Production of motor vehicles tyres dropped to 331,359 units in 2002 compared to 369,346 units in 2001. However, production of rubber shoes, bicycle tyres and the tubes is growing.

Table 7.7. Effluents from the Pan Paper pulp and paper factory in Webuye

Pollutant	Load (mg/l)	Total Daily Load (kg)
BOD_5	40	1,400
COD	209	7,300
Suspended Solids	39	1,300
SO_4	82	2,800
PO_4	0.17	6
Cl	150	5,200

Source: Lake Victoria Environment Management Programme (LVEMP) records.

Printing and Packaging: Printing and publishing sub-sector grew by 4.9% in 2002, while the production of the locally made paper remained relatively unchanged.

Cement: Kenya has three cement factories and one clinker grinding plant with a combined production capacity of about 4 million tonnes per annum. Two plants, Bamburi and the Athi River Mining Cement plant are based in Bamburi and Kaloleni respectively. Bamburi has also a clinker grinding plant of one million tonne capacity at Athi River, close to the East African Portland Cement Company (EAPCC) plant. All the plants use Tunnel Kilns for cement manufacture by dry process. The EAPCC has recently been upgraded and modernized to make it fuel efficient and environmentally friendly.

Cement production in 2002 registered a significant growth of 10.9 per cent to stand at 1,462.5 thousand tonnes from 1388.6 thousand tonnes in 2001. Production of roofing tiles in 2002 went up by 8.2% above the 2001 production. Carbon dioxide emissions from cement manufacturing were estimated as 943.69 Gg of CO_2 in 1994.

Petroleum: This is one of the dominant movers of the energy sector in Kenya. In 2001, it accounted for 25% of the total energy consumption, out of which kerosene accounted for 13% of the overall household energy consumption, while liquified petroleum gas accounted for 0.20%.

Tobacco and Beverages: Cigarette production recorded a growth rate of 1.7 per cent in 2002. Beverages recorded a growth rate of 4.9%, while production of soft drinks grew by 7.0% in 2002.

Industrial Chemicals: In 2002, production of wattle bark extract was 2848 tonnes down from 5123 tonnes in 1998. Production of pyrethrum extract also fell from 138 tonnes in 2001 to 122 in 2002. Production of oxygen, nitrogen, hydrogen and pyrethrum powder also fell. Production of insecticides, herbicides and vaccines rose by 4.1 per cent, 9.2 percent and 5.4 percent respectively.

Transport: Kenya's transport system comprises of five (5) major modes, namely: road, railway, marine, air and pipeline. The transport modes integrate the various production, population centres and facilitate mobility in both rural and urban centres. Air transport recorded 22.5% increase in output value. Road transport recorded a significant growth of 41%, while the number of ships docking grew by 54.8% between 2001 and 2002. The railway services went further in depression in services by 10.9%.

Vehicular pollution has become a significant environmental problem in Kenya over the years. The main vehicular pollutants are lead and by-products of fuel combustion, which include both the visible (smoke) and the invisible emissions. The main emissions are hydrocarbons, carbon monoxide, oxides of nitrogen and

particulate matter. The particulate matter consists of soot due to incomplete combustion, oxides of sulphur and phosphorus, soluble organic fractions arising from the thermocracking of fuels and lubricants and lead oxide from the combustion of leaded gasoline.

Telephone: Telecommunications is important in facilitating the integration of the domestic economy and contribute to promotion of trade and economic development. The number of telephone exchange connection have been increasing steadily at 3% annually. The exchange capacity is expected to increase from 446,302 in 2001 to increase to 943,000 in 2008. The mobile phone industry has been growing very fast. However, there is need to manage disposal of the mobile phone scratch cards and safe disposal of rechargeable batteries. Demand for mobile phones increased by 69.6% in 2002.

Information and Communication Technologies (ICT): Information and Communication Technologies is one of the fastest growing and dynamic sub-sectors in Kenya. Significant progress has been made in the expansion and modernization of the country's information sector. However, the demand for basic ICT services remains unmet and the disparity in the distribution of communications facilities between the rural and urban areas continues to widen.

Carvings: The largest value and volume of African carvings in the international trade comes from Kenya. About 60,000 carvers produce commercial carvings for export valued at U$20 million annually. Growth in the industry is projected to continue as will pressure on the preferred species with serious consequences for the environment, and the livelihood of hundreds of thousands who depend on the industry for their livelihoods.

The Charcoal Burning Industry: Approximately 80% of the total quantity of energy consumed in Kenya is provided by the woody biomass. In 1999, the Kenyan wood requirements were 7,992.9 m^3 for firewood and 5,087.7 m^3 for charcoal. The amount is set to double by the year 2020, assuming that the annual per capita consumption of $0.5x10^3$ may not change.

The importance of wood to air pollution cannot be underestimated. For households, dispersion of combustion gases is not controlled. Carbon monoxide is widely generated indoors by heating and cooking appliances in poorly ventilated rooms. Its affinity for the haemoglobin makes it a very toxic gas. Over reliance on both charcoal and firewood is mainly responsible for the deforestation of most Kenyan forests with serious consequences on flooding and soil erosion. The practice of charcoal burning has led to serious deforestation in the ASAL.

Whereas charcoal burning is illegal, its sale is legal and is done in the open. There is need therefore for the government to remove the apparent conflict between the two activities, while at the same time finding an alternative and affordable energy sources for the rural and urban poor. A solution to this problem is very urgent because of increasing demand as evidenced by the 47.3% increase in fuelwood/charcoal demand in 2003 compared to 2001.

7.3.4. Enabling Policies, Legal and Institutional Measures

As Kenya aspires to join the ranks of newly industrialized countries (NICs) by the year 2020, its major challenge will be to promote industrialization without compromising the ability of the resource base to meet the needs of future generations. Increased industrialization will mean increased pollution levels of our water courses, soils and the atmosphere. Whereas solid and liquid wastes from industrial plants can be contained and treated on site, in landfills and effluent treatment plants, gaseous emissions are problematic with respect to human health and the environment.

EMCA (1999) requires all new projects to be subjected to environmental impact assessment, while ongoing ones must be subjected to environmental audits (EA). Environmental regulations, standards and guidelines are being developed to fully enforce compliance with EMCA. The Kenya National Cleaner Production Center (KNCPC) which was established in July 2000 has been involved in training, setting up of demonstration projects, information dissemination and policy advice. So far, there are over 25 demonstration

projects in the country that have ably demonstrated both the economic and environmental benefits of cleaner production.

Additionally, the Kenya Industrial Property Institute (KIPI) was created by the Industrial Property Act (2001) to enforce industrial property rights, screen technology transfer agreements and promote innovativeness in Kenya.

Kenya is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. This convention grapples with some of the most complex environmental issues, with the greatest potential for economic impacts. Since greenhouse gas emissions can rarely be limited with technical, end-of-pipe" technologies, the principle strategy of the UNFCCC is to change the pattern of future investment in favour of activities that generate less greenhouse gases.

Corporate environmental reporting is a voluntary method of communicating environmental performance internally and externally. Meaningful environmental reporting should be part of an effective communication strategy and not just a public relations exercise. Reporting can enhance an organization's reputation as a responsible employer, improving staff retention, loyalty and recruitment. Some industries are now striving to return something to the communities that enable them to stay in business and post profits by getting involved in the provision of social amenities to their immediate neighbourhoods.

A Pollutant Release and Transfer Register (PRTR) is a tool that can augment government efforts to achieve integrated environmental management and promote pollution prevention. PRTRs are part of a new corporative approach to environmental management involving governments, industry and the public. It is an environmental data base or inventory of potentially harmful releases to air, water, and soil, as well as of wastes transported to treatment and disposal sites. Facilities releasing one or more of the substances must report periodically on what was released, the quantities involved, and to which environmental media. Nakuru Municipal Council (MCN), the Directorate of Occupational Health and Safety (DOHS) in Nakuru and the World Wide Fund for Nature (WWF) developed a PRTR for Nakuru based industrial establishments in 1998. Consumer groups could promote a locally nurtured eco-labelling scheme.

Companies should be encouraged by industry associations such as the Kenya Association of Manufacturers and the National Chamber of Commerce and Industry to practice Corporate Social Responsibility. With respect to plastics, manufacturers and distributors should be involved in the collection, recycling and safe disposal of plastic waste. An organized plastic return scheme is critical to the success of this strategy. The proliferation of the fast foods industry together with the take away culture is also contributing to pollution problems in the Kenyan urban centers.

7.4. MINING

7.4.1. Introduction

Mining is an activity that involves excavation of the earth's surface and subsurface for the purpose of exploiting and processing minerals for economic and industrial development. Types of mining include underground and open cast methods. In the former, vertical, inclined or horizontal methods of excavation and extraction are involved. The open cast method involves open quarries, pits or trenches.

Some of the minerals currently being mined in the country are carbon dioxide gas, Magadi soda/ash, vermiculite, gypsum, limestone, fluorspar, diatomite, gold, titanium, lead, iron ore, quartz, feldspar, magnetite, and various gemstones including tsavolite, green garnet, sapphire and ruby (Table 7.8). Amongst unexploited minerals are the deposit of gypsum in the El Wak area that is estimated to be more than 2 billion tonnes, radioactive minerals of Mrima hills of Coast Province, Ruri hills of Kericho and Homa hills of Nyanza Province and the graphite of Ol Donyo Nyiro.

Exploration for coal in the Mui Basin of Kitui/Mwingi districts has already yielded encouraging results, while exploration for petroleum is ongoing in the off shore areas of Kenya. More exploration for oil is expected to pick up on the mainland.

Several companies are involved in quarrying and sand harvesting. Quarried materials are used for ballast, aggregate and building stone. Materials/minerals being exploited include granite, marble, dolomite, sand and limestone.

The mining industry is not significantly developed in Kenya. Until the discovery of titanium at the coast in the mid-1990s, this sector had no noticeable possibility of impacts on the economy and by extension on the environment.

Table 7.8. Quantity and value (in Kshs '000) of minerals for the period 2000-2002

Specification		2000		2001		2002	
Mineral	**Unit**	**Quantity**	**Value**	**Quantity**	**Value**	**Quantity**	**Value**
Soda ash (Trona)	MT	238,190	1,955,500	297,780	2,716,000	304,110	2,729,113
Flourspar	MT	100,102	627,860	118,850	727,000	85,015	632,829
Refined Soda	MT	382,556	2,179,100	207,647	2,836,000	474,014	2,664,909
CommonSalt	MT	16,359	51,740	5,664	99,000	18,848	61,388
Carbondioxide	MT	7,744	34,920	5,645	37,000	5,662	54,297
Diatomite	MT	448	10,040	441	19,000	1,333	46,234
Gold	Kgs	1,243	791,508	1,545	1,016,000	1,477	1,132,607
Green garnet	Kgs	20	700	25	440	20	940
Ruby Corrundum	Kgs	5,896	94,840	5,863	117,000	3,043	39,563
Grand total		-	5,777,808	-	7,567,440	-	7,361,880
GDP Contribution		-	0.14 %	-	0.20%	-	0.2%

Source: Mines and Geological Department, 2003.
MT = metric tonne

7.4.2. Types of Mining Activities

Mining is a non-renewable resource activity that can have significant and often irreversible environmental impacts.

Sand harvesting and quarrying: Sand harvesting is carried out under the authority and permission of various local government authorities. It pays little respect to environmental aspects. Quarrying for dimension stones, aggregates, ballast and other soft minerals like limestone, dolomite, and kaolin fall into similar situation. The activity continues to expand due to increased demand for construction raw materials. Disused quarries and mines are often left unrehabilitated, and thus are unsafe, to inhabitants and animals living around. They have also become hiding places for criminals and breeding place for disease vectors. In peri-urban areas, some of the holes are used as dumping sites for industrial waste that affects the underground water resources.

Explosives are used in quarrying and mining activities. Their detonations produce noise pollution and affect building foundations and structures through vibrations. This has brought about conflict between residents and miners.

Sand and gravel harvesting along rivers has degraded the environment by lowering the riverbed, steepening and destabilizing riverbanks thereby causing erosion and river channel widening. Besides, it is expected that the environmental degradation in the form of sediment bed load and suspension have consequences that include elimination of organisms, destruction of fish spawning and nursery areas. These may change composition of the aquatic community.

Artisanal Mining: Gold prospecting by small miners is undertaken in Lolgorien, Migori, MacAlder, Ndori, Asembo and Kakamega in western Kenya. Uncoordinated operations have left many pits and holes open without rehabilitation. Many people and animals have lost their lives due to accidents at these places. Miners also lack adequate knowledge on use of dangerous chemicals like cyanides and mercury used in gold

extraction. This has led to poisoning of humans and livestock as well as water bodies and ambient air. Mining equipments such as diesel engines emit soot and poisonous gasses that pose serious safety hazards to workers. Self regulations by artisanal gold miners and prospectors through co-operative societies failed when cooperatives collapsed due to poor management.
Mining in the Kenyan game parks is banned by Kenya Gazette notice of 1978 and remains so unless authorized by the Kenya Wildlife Service. There are a few companies still mining gemstones in national parks. These were already in operation before the mining was banned but were left continue. However, mining conflicts arise from the fact that while the Mines and Geological Department oversees the licensing of prospectors and miners, KWS oversees the national parks against prospecting or mining.

Gypsum mining in Kajiado has also led to proliferation of artisanal miners who have dug pits all over the area. Some organized small scale miners have fairly well managed operations but activities of middlemen have led to 'poaching' of minerals from licensed operators. The inefficient extraction of gypsum is also noticeable. Waste rock used to make roads are acidic, while a lot of dusts is produced during excavation, screening, loading and truck transportation.

Some impacts of mining activities in Kenya are given in table 7.9. Kenya is yet to take advantage of its enormous mineral resources. However, expansion of industrial and commercial activities are inevitable (Table 7.10).

7.4.3. Intervention Measures

Mining activities are regulated by the Mining Act (1987), the Forest Act (Cap 385), the Wildlife Conservation and Management Act, and EMCA (1999). The Mining Act is silent on what should be done with abandoned mines. However, it is expected that the Mines and Geological Department will realign its operations in line with EMCA (1999). Under EMCA, various regulations are being prepared to harmonize conflicting issues on management of natural resources, with a view to minimizing negative impacts. In addition, the government is formulating a comprehensive mineral policy, as well as reviewing the Mining Act.

Table 7.9. Impacts of certain mining operations

Mining Operation	Impacts
Bamburi Portland Cement factory, East African Cement factory and Athi River mining Company are major producers of cements in Kenya.	Put pressure of higher energy and water consumption. There is also loss of cultural and archaeological heritage sites due to coral reef mining. Losses of biodiversity are apparent and littering due to abandoned equipments is common. There is noise and airborne dust pollution both at mining and plant processing site. Loss of land occurs Possibility of increased solid waste has been there now
Magadi Soda Company mines trona and common salt.	Pressure on water consumption and energy requirement. It also releases significant amount of carbon dioxide to the atmosphere. Noise pollution and Dust emission is also considerable. Concentration of unwanted minerals increases in process discharges. There is also influx of population to seek better opportunities around plant operations increasing various environmental concerns.
E.A. Diatomite mines diatomite near Gilgil in Rift Valley province.	Airborne dust pollution, land scars, soil and water contamination from mined area, increased soil erosion, diversion of watercourses, and dumps of wastes.
Tiomin is new Canadian mining company, which was licensed to carry out its operation in Kwale to mine titanium-based minerals.	Loss of fauna and flora, ground water fluctuation, surface disruption, acid drainage, erosion, coral disruption, pollution due to ground waters etc.
Fluorspar Kenya Limited is another mining company, which extracts fluorspar for export.	Its activities has contributed to acid mine drainage, increase of sediment loading in the basin rivers, disruption of ground surface, airborne dust, soil and water contamination etc.

Table 7.10. Potential impacts of mining activities on the environment

Sector	Impact	Time Frame
General	Climate change	Permanent
	Loss of cultural and historical heritage	Permanent
	Abandoned infrastructure	Long term
	Effects on indigenous population	Long term/ permanent
	Damage to Wild-life conservation	Permanent
	Hydrological resources disturbance	Long term / Permanent
Coal / Graphite	Removal of vegetation	Life of mine
	Blasting vibration	Life of mine
	Solid waste	Life of mine
	Dark Dusts	Life of mine
	Disposal of mine water	Syn Mine
Iron / Chromite	Acid Mine Drainage	Permanent
	Soil & water contamination	Long term / permanent
	SO2 , NOx ,emission pollution	Life of mine
		Life of mine
Heavy /noble metals	Air borne dusts	Life of mine
	Radio-activity	Long term / Permanent
	Poisoning by hazardous chemicals	Life of mine

BOX 5: FUTURE OUTLOOK FOR TOURISM, TRADE, INDUSTRY AND MINING

Tourism

- Eco-tourism incorporates strong commitment to conservation of nature and creates a sense of social responsibility. If properly managed in an environmentally sound manner, eco-tourism can be a powerful force for sustainable conservation of our natural and cultural heritage.
- In order to achieve the objectives of tourism while conserving our natural heritage there is need to encourage wider participation from the local community so as to share the benefits, control new developments in ecologically fragile parks and reserves, protect and develop cultural attractions, carry out mass education, promote eco-tourism as a tool for conservation, and put in place a proper mechanism for sharing benefits from tourism industry with the land owners.
- The ASAL hosts most of the country's game reserves and national parks. One of the major problems in the past has been little involvement of the local communities in these areas. There is need therefore to strengthen community-based conservation and other approaches through which pastoralists can benefit directly and consequently be motivated to conserve and accommodate wildlife in their production systems.

Trade and Industry

- The trade and industry sectors need support with regard to promoting environment-friendly packaging, styling, design, competitiveness and product development.
- In order to minimize the adverse environmental impacts of the medium and small-scale enterprises (MSEs), there is need to promote adoption of cleaner technologies as they incorporate environmental concerns in the planning, production, and distribution processes. It is recommended, therefore that a suitable framework/mechanism should be developed to ensure that MSEs are subjected to EIAs and regular environmental auditing.
- There is need to devise a system for rewarding those enterprises that practise sound environmental practices such as recycling geared towards reducing pollution.
- Other environmental management approaches, which should be promoted are development and implementation of standards with participation of stakeholders; certification of products; harmonization of standards within the East African Community; accreditation of laboratories; and harmonized proficiency testing scheme (HPTS).

Mining

- All new mining projects should be subjected to environmental impact assessments (EIAs), while ongoing projects should undergo environmental audit (EA).
- Local authorities and municipal councils should be involved in enforcing safe sand harvesting, quarrying of building and dimension stones, dolomite, limestone and all minerals or materials covered by their licenses. They should ensure that the local communities benefit from these activities.
- Efficient mining technologies should be promoted.
- Relocation of quarrying and mining activities within urban areas to safer areas is necessary.

CHAPTER 8

ENVIRONMENTAL GOVERNANCE, INFORMATION, EMERGING AND CROSS-CUTTING ISSUES

8.1. ENVIRONMENTAL GOVERNANCE

8.1.1. Introduction

Environmental governance entails the formulation of comprehensive environmental policies, and the enactment of supportive legislative regimes. These should be complemented by strong and well-coordinated environmental institutions. The institutions would then draw up, and enforce environmental regulations and standards, to ensure sound environmental management. The public and civil society organizations should also be facilitated to access and use information on environmental policies and legislations. An informed society will have an enhanced ability to make decisions and fully participate in sustainable development issues. For developing countries that rely mainly on natural resources, the achievement of sustainable development will depend on the empowerment and capacity of the public and civil society to complement the government's efforts in environmental management. And lastly, full environmental governance will be achieved where individual countries have the capacity to domesticate and take advantage of the technical and financial facilities provided for in various MEAs.

The increasing human population and associated consumption patterns have threatened the environment and natural resources. Population has also impacted on the quality of environment especially in aspects related to settlement and urbanization. This has generated wastes and sewage with deleterious consequences on the environment. Similarly, application of increasingly complex packaging of consumption goods have increased the pressure on the environment and the natural resources. Particularly acute has been the uncontrolled industrial discharges, which have adverse impacts on the environment and natural resources. These trends have necessitated policy and legal interventions.

The Kenyan environmental governance consists of the legislation, standards, regulations, and institutions to control activities damaging the environment. The enactment of EMCA (1999) and the current national policies on the environment have been influenced by a series of developments both at the national and international level, key among which are:

a) The United Nations Conference on Human Environment held in Stockholm, Sweden in 1972 whose main outcome was the establishment of the United Nations Environment Programme (UNEP) in Nairobi.

b) The World Commission on Environment and Development (UNCED) which published the *Our Common Future* in 1987, commonly referred to as the "Brundtland Report".

c) The United Nations Conference on Environment and Development (UNCED) or The Earth Summit held in Rio de Janeiro, Brazil in 1992 whose main outcomes included: the Rio Declaration on Environment and Development; Agenda 21 (or the Global Plan of Action) addressed the pressing problems of the 21st Century.

After Rio, Kenya embarked on translating Agenda 21 into a national development agenda. The National Environment Action Plan (NEAP) was developed with a view to enhancing integration of environmental concerns into the national planning and development process. The NEAP was a major policy breakthrough for the country. Various sectoral plans and strategies aimed at implementing

Agenda 21 and other related outcomes of UNCED have also been developed within the broad framework of sustainable development.

8.1.2. Environment Management and Coordination Act (EMCA) of 1999

To ensure implementation of the NEAP, the Environment and Development Policy (1999) was formulated. It was followed by the enactment of the *Environmental Management and Coordination Act* (EMCA) the same year. EMCA provides an appropriate legal and institutional framework for the management of the environment. It is also an umbrella legislation that provides guidance, coordination and harmonization of all environmental laws of the country. Kenya's 77 statutes relating to the management and conservation of the environment were hitherto sector specific.

EMCA (1999) created the following institutions to implement the provisions of the Act:

a) **National Environment Council (NEC),** which is responsible for policy formulation, setting national goals and objectives and determining priorities for the protection of the environment, including promoting cooperation among public departments, local authorities, private sector, non-governmental organizations, and such other organization engaged in environmental protection programmes.

b) **National Environment Management Authority** (NEMA), which is the principal instrument of government in the supervision, coordination and the implementation of all policies relating to the environment. .

c) **NEMA Management Board:** It is mandated to control, supervise and administer the assets of the authority; provide for capital and recurrent expenditure and for reserves of the Authority. Receive any grants, gifts, donations or endowments and make legitimate disbursements therefrom; enter into association with other bodies or organizations; for which the Authority is established. Open a banking account or banking accounts for the funds of the Authority; and invest any funds of the Authority.

d) **Provincial and District Environment Committees (PECs and DECs):** Responsible for the proper management of the environment within the province or district in respect of which they are appointed.

e) **Standards and Enforcement Review Committee (SERC)**: Advise the Authority on how to establish criteria, procedures and standards for water quality; conditions for discharge of effluents into the environment; guidelines or regulations for the preservation of fishing areas, aquatic areas, water sources, and reservoirs and other areas where water may need special protection; and collect, maintain and interpret data from industries and local authorities on the pretreatment, nature and levels of effluents.

f) **National Environment Action Plan (NEAP) Committees**: The NEAP committees facilitates the integration of environmental considerations into policies, plans, programmes and projects. It prepares a national environment action plan every five years for consideration and adoption by the National Assembly. The NEAP committee was launched in June 2003 and is in the process of preparing its first Report.

g) **EIA Technical Advisory Committee (TAC)**: It reviews/assesses and advises on EIA documents/reports/requests/comments received by the Authority.

h) **Public Complaints Committee (PCC):** To investigate any allegations against any person or against the Authority in relation to the condition of the environment in Kenya; on its own motion, investigate any suspected case of environmental degradation, and to make a report of its findings together with its recommendations thereon to NEC. PCC also facilitates the public to have access

to the environmental information they need. Access to information is a powerful tool in ensuring compliance and public participation.

i) **National Environment Tribunal (NET):** The Tribunal shall, upon an appeal made to it in writing by any party or a referral made to it by the Authority on any matter relating to EMCA inquire into the matter and make an award, give directions, make orders or make decisions thereon. Every award, direction, order or decision made shall be notified by the Tribunal to the parties concerned, or any relevant committee. NET has prepared Rules of Procedure.

It is worth noting that EMCA does not replace hitherto existing laws, which deal with specific sectors or components of the environment. It is applied alongside the existing legislation governing the different sectors of the environment. Therefore, such laws as the Water Act, the Wildlife Management Act, the Forestry Act, the Fisheries Act and the Physical Planning Act, will continue to apply and the law expects that the technical directors of the respective departments will assume a major role as lead agencies of NEMA. However, where any previous legislation has provisions that conflict with EMCA, the provisions of the EMCA will override that other law to the extent of that conflict. For instance, where a law did not provide for the public to be consulted, that is now mandatory under the EMCA. These sectoral laws are coordinated by lead agencies who work in partnership with NEMA.

8.1.3. Other Sector Policies and Legislation

Currently, a number of policy changes are at various stages of consultation and or approval. These include the Forestry Bill, and the Wildlife Management Bill, all of which when implemented, will have important implications for environmental conservation.

The Water Act was amended in order to accommodate appropriate resource management principles. The Act provides for a legal mechanism for active community participation in the water sector and facilitates creation of partnerships between the public and the private sector in the management and development of water resources. It further provides guidance on the management of transboundary water resources.

Legislative reforms continue to be undertaken alongside institutional reforms in order to facilitate implementation of the policies. Environmental conservation and management will be better coordinated under this enabling environment.

Kenya has endorsed poverty reduction as a priority goal. The foundation of this is sound macroeconomic policies and strategies, ensuring both sustainable broad-based economic growth and macroeconomic stability and environmental resources management. Other approaches include social policies that have significant effect on environmental management.

Family planning and other population growth control strategies, better and free universal education for the young are some of the policies that are yielding positive results. Removing unhealthy environmental conditions such as improving accessibility to safe water can contribute to reducing vulnerability to disease.

8.1.4. Decentralization of Environmental Management

Policy responses relating to environmental governance include the decentralization of management responsibilities from central to lower levels of government. They also include involvement of communities in the planning and management of environmental resources. In this respect, EMCA provides for decentralized environmental management and planning through PECs and DECs. These will facilitate implementation of environmental policies and sectoral action plans at lower levels. Moreover, the coordinating and supervisory role of NEMA will provide for consultation with lead agencies and thereby integrate environmental concerns in all policies, programmes, plans and projects. Kenya has an active civil society participation in environmental management. They complement government efforts in environment and natural resources management and advocacy. The civil societies also promote public participation. The capacities however, of lower levels of government

and community based organizations will have to be built to equip them for their new roles as environmental planners and managers. The government also works in partnership with the private sector to promote a clean and healthy environment. Currently, there is strong political support for better management of the environment.

8.1.5. Multilateral Environmental Agreements (MEAs)

MEAs are legal instruments to enhance the global responsibility in the management of the environment and natural resources. It was not until the Earth Summit held in Rio de Janeiro, Brazil in 1992 that a number of global MEAs of great environmental importance were negotiated. These include the United Nations. Framework Convention on Climate Change (UNFCCC), the UN Convention on Biological Diversity (UNCBD) and the UN Convention to Combat Desertification (UNCCD).

The Nairobi and Abidjan Conventions advocated the Protection of the Oceans, including enclosed and semi-enclosed areas and the protection, rational use and development of their living resources. The geographical coverage of this convention applies to the Eastern Africa region without inclusion of the international waters of the contracting parties. Kenya has taken appropriate measures and is in the process of harmonizing its policies in this regard.

8.1.5.1. The Vienna Convention (1985) and the Montreal Protocol (1987)

Kenya signed the 1985 Vienna Convention and ratified the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer on 9th November 1988. Subsequently, Kenya ratified both the London Amendment (1990) and Copenhagen Amendment (1992) on 27th September 1994 and the Montreal Amendment (1997) on 12th July 2000. The Beijing Amendments (1999) are currently being drafted by the National Environment Management Authority (NEMA) for subsequent approval by Parliament.

A detailed Kenya Country Programme for phasing out ozone depleting substance (ODS) has been prepared to ensure that the phase out of ODS is according to the national development strategy. Kenya also has put in place comprehensive draft regulations on ODS phase out. These regulations are in the process of being finalised for gazettement. Furthermore, Kenya has regularly been reporting on ODS consumption, export and import under Article 7 of the Montreal Protocol.

8.1.5.2. United Nations Framework Convention on Climate Change (UNFCCC)

Kenya signed the Convention on 4th June 1992 in Rio de Janeiro and ratified on 30th August 1994. The Convention then entered into force on 27th November 1994. The 1st National Communication to the Conference of Parties was prepared in 2002. Mitigation measures against climate change are being pursued along the project concepts outlined in the first National Communication report.

8.1.5.3. Kyoto Protocol

Kenya has signed but not ratified the Kyoto Protocol. NEMA is the focal point to the Protocol and of the Clean Development Mechanism.

8.1.5.5. Stockholm Convention on Persistent Organic Pollutants (POPs)

Kenya has signed but not ratified the POPs. Plans are underway for the ratification of the Convention.

8.1.5.6. Rotterdam Convention on Prior Informed Consent (PIC)

Kenya signed the Convention in 1998 but has not ratified it. However, the country has established a list of banned and restricted chemicals and severely hazardous formulations.

8.1.5.7. Basel Convention on Transboundary Movement of Hazardous Waste and their Disposal

Kenya signed and assented to the Convention in September 2000.

8.1.5.8. Convention on Wetlands of International Importance (RAMSAR)

Kenya has ratified and is implementing the Ramsar Convention. Integratetd management plans for several lakes like Lake Naivasha have been prepared. Kenya has already prepared a national wetland policy. Further, in conformity with the requirements of the Convention, Kenya has designated Ramsar sites at Lakes Nakuru, Naivasha, Bogoria and Baringo.

8.1.5.9. United Nations Convention to Combat Desertification (UNCCD)

Kenya signed the convention in 1994 and ratified it in 1997. It has since prepared a National Action Plan to Combat Desertification. Programmes are being implemented in line with this plan.

8.1.5.10. Convention on Biological Diversity (CBD)

Kenya signed CBD in Rio in 1992 and ratified it in June 1994. Kenya has prepared a National Biodiversity Strategy and Action Plan. Programmes are being implemented in line with the Strategy and Action Plan.

8.1.6. Institutional Arrangements

The implementation of the provisions of various conventions is coordinated by designated focal institutions. These are located in specialized lead agencies. The focal institutions have established a national steering committee comprising of the relevant government institutions, non-governmental organizations, international organizations, private sector and research and academic organizations. The committees meet regularly to prepare national position papers to the conference of the parties; translate the provisions of the convention to national development priorities through preparation of strategies and action plans; identify capacity building needs and resources mobilization.

In 2003, NEMA created a MEAs secretariat and a National MEAs Steering Committee. The committee has all convention focal points represented. Objectives of this national committee are to develop the MEAs National Register; enhance synergies; coordinate the development of regulations; mainstream conventions into plans and programmes and identify implementation strategies at the community levels. The committee has started working on the MEAs National Register.

8.1.7. Benefits Accruing from MEAs

Countries that sign up and ratify various MEAs can benefit by getting access to funding and technical know-how on MEAs or support for projects/programmes for capacity building in the preparation of enabling activities. Other benefit is being supported to build or enhance capacity in negotiation skills through participation in international and regional meetings. However,

Developing countries face the following constraints in domesticating the MEAs: inadequate capacity to implement the MEAs at all levels; inadequate institutional and legal frameworks to implement MEAs; inadequate financial resources; lack of cross-border cooperation; and lack of a national register.

8.1.8. Promotion of Regional Co-operation

Kenya is participating in various international initiatives aimed at developing collective responsibility for the environment. This includes participation in NEPAD, African Union and the East African Community. However, there are policy inadequacies in the management of trans-boundary resources, access to genetic resources and the management of indigenous knowledge. Tables 8.1 and 8.2 show some key policy responses and examples of failures and weaknesses in environmental management, respectively.

8.1.9. Millennium Development Goals (MDGs)

Kenya has joined the international community in taking steps to implement programmes that will ensure the achievement of the MDGs. MDGs were adopted at the 2000 UN Millennium Declaration that committed all countries represented to do all they can to eradicate poverty, promote human dignity and equality and achieve peace, democracy and environmental sustainability. During the

WSSD in Johannesburg in 2000, the Johannesburg Declaration on Sustainable Development and the Johannesburg Plan of Implementation were formulated to provide a framework for the achievement of the MDGs. Under the MDGs, countries must meet concrete targets to reduce inadequate incomes, widespread hunger, gender inequality, environmental deterioration and lack of education, health care and clean water.

Kenya as a country has taken the necessary measures to enable the country to achieve the MDGs in health and sanitary issues and environmental sustainability. The Poverty Reduction Strategy Paper (PRSP), the Poverty Eradication Programme (PEP), and the Economic Recovery Strategy for Wealth and Employment Creation (ERS) are in already in place to eradicate poverty. The government has also instituted the free primary education programme to achieve universal primary education for all Kenyans. Programmes to mainstream gender issues into all development activities are already being implemented. The Ministry of Health is formulating a comprehensive National Health Service that will ensure the availability of adequate and affordable health services to all Kenyans. Already the Ministry operates pre-post-natal clinical and maternal health services.

To attain environmental sustainability, the Kenya government has enacted the umbrella EMCA (1999) to bring the overall coordination of environmental matters under one statutory body, NEMA. Alongside, sectoral policies and legislation on land, water, forestry and wildlife are also being streamlined to reflect new realities and requirements. Lastly, Kenya has over the years conducted an open and friendly foreign policy. As such, Kenya has supported all regional and international initiatives to foster global partnerships on peace, security, environmental conservation and sustainable development. It is to this end that Kenya has embraced such regional and international initiatives as EAC, IGAD, NEPAD, WSSD, the Rio Declarations and Principles, and most UN resolutions. Kenya is a signatory, and participates, in the implementation of all the major MEAs.

Table 8.1. Summary of key policy responses by thematic area

Issue	Key policy responses
Poverty	• Preparation of PRSPs and poverty eradication action plans. • Economic Recovery Strategy for Wealth creation and employment. • Formulation of sustainable livelihood strategies. • Lobbying for greater access to developed country markets and in general, removal of trade barriers. • Strategy proper modernization of Agricultural and Rural Development.
Climate variability	• Kenya is party to the UN Framework Convention on Climatic Change (UNFCCC) and the Convention to Combat Desertification (UNCCD). • Establishment of early warning system. • Establishment of food reserve programs. • Crop research to identify drought resistant varieties. • Improving housing design and construction. • Urban planning to reduce vulnerability of human population.
Air pollution	• Upgrading public transport systems, imposition of age limit for private and commercial vehicles and the provision of subsidies for switching to unleaded fuels. • Preparations of plans for adoption of cleaner technologies to reduce industrial emissions.
Land degradation	• Formulation of land use policies, and plans including zoning. • Land reform e.g. (resettlement). • Capacity building. • Development of environmental management programs (provincial, district, national). • Promotion of community based natural resource management projects. • Development of erosion hazard mapping. • Reducing the rate of growth of the human population. • Environmental education programs. • Promotion of private sector involvement in land management uses. • Ratification of United Nations to Combat Desertification.

Habitat loss	• Increase in the number and extent of protected areas. • Ratification of conventions related to Convention on Biological Diversity (CBD) in particular and CITES. • Promoting community based natural resources management programs. • Development of national environmental action plans and conservation strategies.
Inadequate attention to indigenous knowledge	• Establishment of resource centres that focus on identification and dissemination of indigenous or traditional knowledge and practices using indigenous knowledge in the treatment of HIV/AIDS.
Species loss	• Ratification of convention related to Biodiversity in particular CBD & CITES. • Species reintroduction. • Ex-situ plant propagation in nurseries.
Limited access to water resources	• Construction of dams to provide water storage capacities, hydro-electric power and to supply domestic, industrial and agricultural users. • Revision of water policies and pricing mechanisms as measures to manage demand and encourage more conservative water use.
Poor water quality	• Revised Water Policy and Act. • Development of wetland policies and conservation strategies. • Establishment and enforcement of effluent water standards. • Rehabilitation of existing wastewater treatment facilities as measures to control water quality. • Incorporation of the polluter pays principle in many policies and legislation. • Schemes for improving drainage, purification and decontamination of fresh water systems and public awareness campaigns.
Coastal erosion	• Integrated environmental management particularly integrated coastal zone management. • Promulgation of laws and regulations requiring environmental impact studies to be carried out before development proceeds in the coastal zone. • Ratification of international conventions aimed at enhancing conservation of natural resources.
Poor urban conditions	• Increased production of low-cost housing for low-income groups. • Creation of the UN Commission for Human Settlements (Habitat) and Local Agenda 21. • Revision of constitution to promote right to adequate shelter. • Land reform. • Formulation of environment policies. • Development of integrated water policies and waste management strategies. • Privatization of municipal services in an effort to improve coverage and maintenance.
Vulnerability	• Establishment of department responsible for disaster preparedness, prevention and management. • Formulation of policies and action plans for disaster prevention and management. • Formulation and implementation of poverty reduction strategies. • Establishment of early warning systems. • Land use planning Act. • Disaster Management Strategy Paper.
Future outlook	• Preparation of long-term perspectives, strategic framework for national development (National Vision 2015). • Preparation of poverty reduction strategies.
Deforestation	• Improving forest-harvesting sustainability through removal of subsidies for commercial logging and privatization of state owned forests. • Ensuring greater stakeholder participation in forest management through partnerships between state or private and local communities. • Use of technologies e.g. remote sensing and geographic information systems to provide more accurate information. • Including forests in wildlife protected areas such as national parks to accord them greater conservation status.

Table 8.2: Examples of failures, weaknesses and gaps in environmental management by thematic area

Area	Failure , weaknesses and barriers for implementation
Toxic chemicals	• Lack of risk assessment and of dissemination of information • Labelling of chemicals not sufficiently understood by majority • Inadequate industry response to risk reduction programs • Inadequate national co-ordination mechanism for liaison between all parties involved in chemical safety activities • Weak enforcement mechanisms for prevention of illegal international traffic in toxic and dangerous products
Hazardous wastes	• Inadequate industry response to treat, recycles, reuses and dispose of wastes at source. • Inadequate information network and alert systems to assist with detection of illegal traffic in hazardous waste.
Solid waste and sewerage related issues	• Commitment to achieving certain benchmarks by year 2000 have not been met.
Land resources combating deforestation	• Inadequate of planning and management systems. • Little community involvement in information gathering. • Inadequate information base on state of resources and rates of deforestation. • Inadequate valuation of forest resources.
Combating desertification and drought	• Low capacity for drought preparedness and drought relief schemes. • Absence of comprehensive anti-desertification programs integrated into the national development plans and national environmental planning. • Inadequate popular participation and environmental education focusing on desertification control and management of effects of drought.
Conservation and biodiversity	• Biodiversity resources are poorly inventoried.
Sustainable development for mountainous areas	• Lack of database or information systems to facilitate integrated management and environmental assessment of mountain ecosystems
Sustainable agriculture and rural development	• Limited opportunities for non-farm employment. • Limited incentives to promote land conservation. • Inadequate attention given to indigenous knowledge in agriculture. • Both plan and animal genetic resources are poor inventoried or documented.
Environmental management on biotechnology	• The potential contribution of biotechnology to sustainable development is little known • National Biosafety policy. • Benefits accruing from biotechnology include production of human and livestock medicines and in industrial applications that ease pressure on natural resources. • Inadequate trained biotechnologists and inadequate funding and research facilities. • The environmental and human risks of biotechnology are still poorly understood.

8.2. DATA AND INFORMATION FOR ENVIRONMENTAL MANAGEMENT

8.2.1. Introduction

Environmental information refers to all forms of knowledge, which relates to the environment in one way or another needed to understand or manage the environment. These include industry, pollution, biodiversity, water, climate, health, soils, geology, the atmosphere, cultivation, cropping, animal husbandry, management, infrastructure, settlements, human activities, and rural development. These can be group into biological information, physical information, agricultural and land use and socio-economic and cultural (Table 8.3).

Main sources of environmental information include the international organizations, U.N bodies, government ministries, parastatals, private companies, research institutes and centres, educational institutions, and civil society organisations.

8.2.2. Data and Information Sourcing

The following problems lead to the prohibitive cost of data and information making it inaccessible to users.

- Funding for data collection is low and environmental databases are often not accessible to potential users.
- A lot of data/information is gathered by institutions and organizations through projects, research work, monitoring, publication and records.
- Existing data is spread over many organizations in the public and private sector, international and regional organizations. The collection process is inadequate due to the widely scattered sources without an established data/information collection infrastructure. In some cases there are restrictions on data access and use.
- Some institutions have data categorized as classified, confidential and restricted and these are usually inaccessible or in some cases released at a high price.

There is need to increased budget allocation for data collection and management as well as for establishing linkages and networking with data centres elsewhere. It is also necessary to establish mechanisms for identifying and filling data/information gaps. However, a priority action is formulation of a policy on information, which would facilitate modalities for easy access to information.

Table 8.3. Types and sources of environmental data and information

Data and information type	**Source**
1. **Socio-Economic and cultural**	
Human Population and Demographic	CBS, FAO, Nairobi Univ. NCPD, AMREF
Socio-Economic	CBS, LBDA, KARI, NGOs, MPND, Ministry of Culture and Social Services
Legislation	NEMA, AGs Chambers, Libraries
Commerce and industry	CBS, National chamber of Commerce, Banks, Financial institutions
Tourism	Min. of Tourism, CBS, KWS, Tour companies, KTDC, KATO, Moi University
Environmental Education	All public universities, Schools, Polytechnics, NMK, WCK
Health and Human diseases	MOH, KEMRI, ICIPE, NGOs, UNICEF, WHO, AMREF, NEMA, Nairobi University, Moi University
2. Agriculture and Land use	
Agriculture and forestry	Min. of Agric. KARI, Egerton University Nairobi University DRSRS, CBS
Vegetation and land use	DRSRS, KARI, NEMA, Forest Master Plan, Min. of Agric., KWS, NMK
3. **Physical Information**	
Hydrology/Climate	Min. of water, LBDA, KVDA,TARDA, KPLC, Geology and mines dept, public universities, Kenya Meterological Department
NOOA data on Climate	DRSRS, KMD, RCSSMRS, FAO, Min .of water, LBDA, TARDA
Soils	KARI, Min. of Agric., Public University NEMA
Pollution and Pollutants	Government Chemist, Ministry of Water Management and Development, CBS, Universities, Ministry of Transport and Communication, NEMA
Topography	Survey of Kenya, Tourism info. Centres, KWS, RCMRD, Public University
Geology and minerals	Geology and Mines Department Ministry of Energy, Universities, Oil companies, Mining companies, NOCK
Infrastructure Facilities	CBS, DRSRS, KARI, KPTC, KPLC, Min. of transport, physical planning dept, Local authorities
Energy	Min. of Energy, Oil companies, Power companies, Regional authorities, NOCK
Satellite Imagery	RCMRD, DRSRS, private companies, FEWS, ASK
4. Biological information	
Cattle Census data	DRSRS, ILRI, IGADD, ILCA, Min. of Agric.
Animal diseases vectors and pests	ICIPE, ILRI, UNEP, ILCA, KARI, Min. of Agric., KETRI, welcome, KSPCA, NMK, FAO, Nairobi University, Egerton University
Livestock	FAO, DRSRS, KWS, Min. of Agric., KARI, ASK, ILCA
Wildlife	DRSRS, KWS, NMK, Wildlife Clubs, EAWLS, Moi University
Marine and Fisheries	KEMFRI, MENR, KWS, KU, Univ. of Nairobi, Fish Dept, Moi. Univ.

8.2.3. Data Quality

Quality of data and information is critical in decision-making. It is therefore important that appropriate plans are developed for implementation. Lack of quality, timely and regular data/information usually leads to poor planning, monitoring and evaluation. There is therefore need to build capacity for data collection, archiving, analysis and retrieval.

8.2.4. Data Storage, Management, Networking, Access and Dissemination

Most information is stored in a variety of media and forms. These include bibliographies, reports, journals, computer database, microfiche and audiovisual. Computer-based databases have been established over the years by a number of government departments, research institutions, private companies, and NGOs. National institutions with these computer-based systems include DRSRS, KWS, LBDA, KARI, Ministry of Water Management and Development, CBS, NMK and FD. International bodies based in Kenya with various data sets include UNEP, ILRAD, WCI, ICRAF, ICIPE and RCMRD.

Some of the national data centres have inadequate physical facilities, obsolete systems, lack back-up systems and use incompatible data formats. There is therefore great need for institutional linkages and networking and to provide for access to data and information at affordable costs and within reasonable time.

Due to the underlying factors including poor data generation and weak policies, there is limited dissemination of information aimed at enhancing education, public awareness and participation.

The need for easy access to reliable data/information is to facilitate informed decision-making. The impacts include lack of timely application of data/information leading to poor or lack of appropriate corrective measures. There is often duplication of efforts in data collection and generation due to weak institutional linkage and networking. This eventually leads to ineffective planning, monitoring and evaluation of activities. With poor linkages, it is difficult to know what data types are archived in different institutions and this has impacted negatively in terms of hindering collaboration and in duplication of efforts.

To address the above problems in data collection, storage, management and access, there is need to establish linkages and networking with other national and internationally institutions. Despite the numerous data sources in various institutions, there exists weak co-ordination and linkages between the institutions and users of the information. Data entry points are many and there is inadequate networking between institutions. Therefore, there is limited use of information for planning and management of the environment.

However, these problems are being addressed currently through deliberate efforts to establish linkages and collaboration through protocols that facilitate sharing of data and information. Also, there is increased stakeholders involvement to develop the various data types held by different institutions. There is therefore need to establish a national environmental management information system (EMIS) and network to strengthen the lead agencies that have databases on environmental attributes.

8.2.5. Funding

Funding of environmental activities is inadequate, especially for data collection and management. This situation is as a result of limited finances due to poor economic growth. This has led to negative impacts including delayed implementation of environmental policies, stalled environmental initiatives, limited research activities and poor monitoring and assessment of natural resources.

To address these problems, there is need to establish partnerships with the private sector, including collaboration between governmental and research institutions. Also, there is need to develop economic incentives on research oriented activities. Table 8.4 summarizes data and information management by sectors

Table 8.4. Data and Information Management by Main Sectors

Sector	Data and Information Management Aspects
Wildlife	A major gap in wildlife information is little or lack of data on population dynamics- sex ratios and population growth potential. Equally data collection suffers from infrequent surveys due to inadequate human and financial resources as well as appropriate technology.
Tourism	Tourism is a rapidly expanding economic industry in Kenya. As an industry tourism is based mainly on wildlife and its natural habitat in addition to the natural attractions like beaches and landscapes. The growth of tourism will depend on good public relations, marketing efforts, political stability and world economy and politics. Financial base is a major constraint to the tourism industry. The budget provision is severely inadequate.
Forestry	A major gap in forestry data includes forestry characteristics, biodiversity, dynamism and economic value
Livestock	Information relating to livestock is far from adequate particularly on population dynamics, biodiversity policy/ legislation, human resources/ technology, networking/ marketing, quantity and socio-cultural aspects.
Marine and fisheries	There is general inconsistency and lack of periodicity in data collection. Main contributing factors is inadequate funding for human resource capacity building, and for purchase of equipments, and for surveys, analyses and storage.
Soils	Soil surveys are expensive to carryout due to intensive and demanding field checks. This has resulted to having only limited areas (30 per cent of the country covered to a scale of 1:100,000 in a span of 20 years). The only soil map covering the whole country is at a scale of 1:1,000,000,which is low in resolution and inappropriate for projects implementation. Inadequate funds have been major constraints to these efforts. Most soil surveys reports are written in a vocabulary, which is mainly understood by soil specialists. Such reports lack illustrations for the general public, particularly maps on the distribution of soil erosion hazards and soil loss amounts.
Water Resources	The water master plan comprise interrelated databases including the following: socio-economic conditions; potential water resources and demands, development plan for domestic and industrial water supply and livestock water supply, wildlife and fisheries, development plan for agriculture hydropower development and flood protection and drainage. It also contains a total of 151 various thematic maps and other illustrations on vegetation and land use, landforms, hydrology, groundwater quality, surface water, water resources This information has been digitized. Other government ministries also do collect data on water e.g. Health, Agriculture and Local Government. Universities, research centres, parastatals, NGOs, development authorities also collect water and wastewater samples for analysis by government and private laboratories. Public and private universities and researchers have data in the form of research reports. There is need to fill data /information gaps on aquatic environment; location and extent of acquirers in different areas and their potentials; cause of declining water levels in Rift Valley lakes; effects of pesticides, heavy metals and other substances on water quality.
Geology and Mining	Geological information collected can be used to assess and locate ground water resources, rock formations, hydrocarbons, geological hazards and mineral potential. Existing data bases are available in forms of; geological reports and maps; well information which includes well logs and cores; geo-chemical and petrol-physical samples; and geophysical data and accompanying reports but only for a part of the country. The National Oil Corporation of Kenya (NOCK) is digitizing existing databases. Data in the Mines and Geological Department are still in form of reports and maps. Enormous information exists in universities.
Energy	Four main sources of energy are wood-fuel, fossil fuel, hydro and geothermal electricity. Information is available but scattered in different institutions e.g. NOCK, Ministry of energy and Public works, private and NGOs.
Meteorological	Meteorological data is observed at 28 ground surface stations, 15 agro-met. Stations, 3 radiosonde, 18 pilot balloon and about 2000 rainfall stations. In collecting and disseminating met. Data, use is made of schools, hospitals, government offices, farmers, and interested individuals for observation of rainfall data. KMD provides them with rain gauges and maintain them. Missing data gaps are insufficient network of observation stations due to inadequate funding. Type of data collected; Rainfall, clouds, wind, temperature, visibility, pressure, evaporation, sunshine, radiation etc some data date-back to 1890. Most data are kept on magnetic tapes and observation registers. Processed data are microfilmed and stored. Other constraint that face quality of data radiation measurement is imprecise-type and intensity, which denies the scientist the chance of involvement in research of ozone depletion and global, warming.

Land use	Available information is of varying types, formats and scale and is held by various organizations. Collection analysis and management is expensive as it is multi-sectoral in nature requiring the participation of various institutions. Besides, funding has been inadequate, while technologies used have been largely inappropriate.
Agriculture	Information relating to agricultural activities and services are at the moment held by various organizations and Government departments. Information is stored in various forms ranging from monographs to digital information. The Ministry of agriculture publishes bulletins on agriculture and related services. It also has several information systems ranging from a library service to a documentation unit and computerized databases. Currently, uncoordinated institutions manage agricultural information services. Besides, the institutions lack clear, consistent guidelines for data collection, standardization and reporting. The public lack information on the availability and dissemination of information in the sector. There is inadequate funds to support information acquisition and management; absence of adequately trained personnel to undertake the tasks of information management and dissemination. Information collection, management and dissemination have not been accorded appropriate priority and funding. As a consequence, presentation of some information from agricultural research is sometimes difficult for the end users to understand.

8.3. CAPACITY BUILDING

Adequate capacity is essential for sustainable development. It comprises human, scientific, technological, organizational and institutional capabilities. Among others, the institutional capacities include laboratories, machinery and tools. This is critical for developing skills, knowledge, technical know-how, policy analysis, institutional building, technical cooperation and development management.

8.3.1. Institutional and Human Resources

Staff need to continuously upgrade their skills in the management of the environment and natural resources. Institutions offering training on environmental matters also exist. The institutions include the six public universities and the four national polytechnics. However, there is need for these institutions to offer appropriate courses. The major challenges in environmental education are:

a) Teachers take a theoretical approach to teaching instead of problem–solving approach.
b) Critical thinking and creativity are not fully developed as the Kenyan education system lays great emphasis on national examinations.
c) There is poor commitment in carrying out environmental projects in schools.

There is little research or follow-up to determine the impact of environmental education (EE) in the curricula. The current trainings in environmental management are not demand driven. The training and public awareness are always generalized such that they do not address specific environmental needs. The inadequate skills development and under utilization of trained personnel contribute to unchecked environmental degradation. There is need to upgrade skills at all levels on environmental management. Linkages among institutions dealing with environmental management should be strengthened and demand driven.

About 50 civil society organisations compliment government efforts in capacity building. The trainings for NGOs and CBOs are in the following areas: Problem and project identification skills using various tools such as Participatory Rural Appraisal (PRA); project proposal writing; community action plans; lobbying and leadership skills as well as fundraising and financial management skills.

Policy initiatives include:

- Agenda 21 which reiterates that education, public awareness and training are critical for promoting sustainable development, improving the capacity of people to address environment, and development issues and meet their basic needs as well as alleviate poverty.

- The National Environment Action Plan (NEAP) report of 1994 recommends various capacity building initiatives.

- The national policy on education recognizes the importance of environment education. Sessional Paper No.6 of 1988 on Education and Manpower's for the Next Decade and Beyond states that environmental education should be part and parcel of the education and training curricula and be taught at all levels of education.

- Sessional Paper No.6 of 1999 on Environment and Development recognizes the need to expand training programmes and strengthen institutional capacity.

8.3.2. Infrastructure

There are many organizations involved in environmental capacity building. These include the public and private sector, international, regional, sub-regional organizations, civil society organizations, academic institutions, research centres, and municipalities. There is need to improve the infrastructural facilities for capacity building activities, especially laboratories, equipment, machinery and tools, land and buildings.

EMCA (1999) has provisions aimed at enhancing environmental management capacity through creation of bodies, including:

- National Environmental Management Authority (NEMA).
- Provincial Environment Committees (PECs).
- Public Complaints Committee (PCC).
- National Environmental Action Plan Committee (NEAP).
- Environmental Impact Assessment Technical Advisory Committee (EI-TAC).
- National Environment Tribunal (NET).
- Standards and Enforcement Review Committee (SERC).

8.3.3. Environmental Education, Awareness and Public Participation

Environmental education, awareness and public participation among the population is critical for active involvement in conservation. Information technology has become a powerful tool for information dissemination.

Formal and non-formal education help to change peoples attitudes and behaviour. It imparts skills and knowledge that enabled people strive for sustainable development through effective public participation in decision.

Currently, there are several public awareness initiatives through the:-

- Print and electronic media, *barazas,* environmental commemoration days, workshops and seminars.
- Liberalization of the mass media is assisting greatly in reaching more targets. However, there are very few surveys are done to ascertain the impacts of public awareness initiatives. This is despite the fact that different actors from the different sectors prepare sensitisation materials and use different channels; radio programmes newspapers and national public days. The main drawback is that there is no strategy and guidelines on environmental awareness campaigns.

EMCA (1999) provides for the creation of public awareness on the importance of sustainable use of the environment and natural resources for national development. NEMA, in partnership with other stakeholders, is preparing a comprehensive environmental education (EE) strategy for formal, non-formal and informal education.

The EE strategy is expected to produce a well-informed public with appropriate skills for active participation in environment management (Plate 8.1). The EE curriculum will be reviewed by a stakeholder forum of lead agencies and other interested parties including curriculum developers in a programme called "Greening the Curriculum".

Plate 8.1. Public involvement in conservation

Previous efforts have incorporated EE in the formal education curriculum. In 1985, the 8-4-4 system incorporated EE into the curriculum by adopting an approach where relevant content was introduced in study areas and at different levels of the school systems. Later in 1998/99, the primary and secondary schools curricula were reviewed and EE was integrated in primary and secondary levels, as well as the early childhood level.

There are about 12 donor funded projects in NEMA, which seek to coordinate and empower the public, national institutions, NGOs, CBOs, private sector and industries with the tools, capacity, skills, and knowledge. This will address problems of environmental degradation by adopting strategies to protect, manage and utilize natural resources wisely and to attain sustainable development.

8.3.4. Private/Public Sector Partnership

Collaboration between the public and the private institutions on environmental matters is low. Some of the private sector institutions collaborating with the government are the Kenya Association of Manufacturers, the Federation of Kenya Employers, oil companies, hotels and tour companies, Kenya National Chamber of Commerce and Industry. However, issues of managing environmental degradation require the contribution of a larger set of stakeholders. Notwithstanding the current limited stakeholder participation, the collaboration between public and private sector is already beginning to bear fruits. The activities so far undertaken include planting of trees, improved scenery in rural and urban areas sponsorship of environmental events, seminars, workshop and trainings.

EMCA (1999) has provisions for encouraging collaboration with the private sector through partnerships, promotion of cleaner production technologies and best environmental practices through incentives such as tax rebates and duty waivers.

8.3.5. Environmental Management Tools

Various information systems have been put in place to facilitate informed decision-making in environmental management. These systems include early warning for better management of natural disasters, remote sensing and geographical information systems. Many of the interventions required to arrest environmental degradation call for elaborate organizational and management systems. Key among these is information management systems and databases. The government has introduced a number of tools that facilitate better management of the environment. These include environmental impact assessment (E.I.A), environmental monitoring, environmental audit, regulations and standards. However, existing capacities may be unable to effectively implement them.

8.4. FINANCING THE ENVIRONMENT

8.4.1. Introduction

The problem of funding environmental programmes was identified during the formulation of Agenda 21. It was estimated that it would costs over US600 billion, including about US&125 billion on grant or concessional terms to implement Agenda 21 annually. Actual costs would depend on the specific strategies and programme of individual governments.

In Kenya, investments in environmental management are justified in terms of: (a) halting or reversing environmental degradation so as to guarantee improved productivity of the environment and the natural resource base with a view to accelerating sustainable economic growth and improving human welfare; (b) building and strengthening human institutions and capital in environmental/natural resource management so that they can continually respond to new demands and challenges; and (c) holding open future options for resource conservation and development by formulating good policies so that irreversible losses are avoided and positive conservation culture and attitudes are inculcated into the people.

Sound investments in environmental management are in turn expected to generate a number of benefits, including: (a) increased earning at macro and micro levels due to improved productivity of biotic elements; (b) avoiding losses of future incomes (e.g. the impact of soil erosion on agricultural productivity; (c) avoiding future costs such as replacing lost soil nutrients and extensive curative medical care); and (d) having a healthy and productive labour force.

However, the realization of the aforementioned benefits can only be achieved if the following assumptions hold: (a) continued political commitment and support; (b) political, social and economic stability; (c) the willingness and ability of local resource users to participate; (d) regional and international collaboration and support; and perhaps most important (e) the timely availability of financial and technical resources.

The main sources of finance for environmental management in Kenya include public finance, external funding, private funding, voluntary contributions and micro-finance.

8.4.2. Public Finance

The government needs resources to fulfill its public role of funding environmental management activities. EMCA provides for resources for environmental management. Over the years, the government has provided funds for the management of the environment. These have mainly supported forestry management, wildlife conservation, soil and water conservation, resource surveys and remote sensing, public health/training of personnel, pollution control and waste management as well as promotion of clean technologies. These activities are spread throughout the government departments and institutions. Because of the cross-cutting nature of the activities it is not possible to determine the exact amount of money the government is using to support environmental management in Kenya.

However, the public funds for environmental activities have always been low. For example, in the fiscal year 2000/01, the projected recurrent expenditure for National Environment Protection

Programme was Ksh.14, 000,000. However, the actual allocation was only about 25% of the total. During the same fiscal year, the District Environment Support, which is a core poverty reduction programme, was allocated only 14% of the total requirement of Kshs.70, 000,000. In respect to this, only 32 districts have been covered by the programme. There is, therefore, need to increase funding for this core programme with a view to covering all districts, taking note of the fact that each has unique environmental concerns.

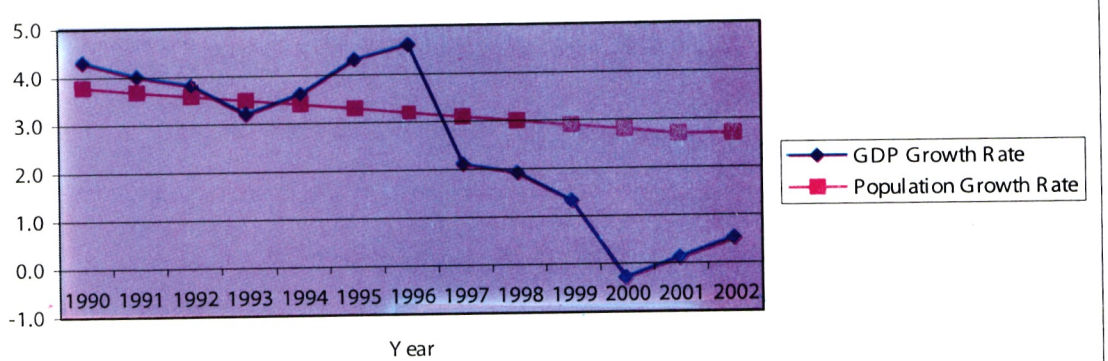
Some of the government funded programmes includes: water resources management, wildlife management, forestry management, pollution control and waste management, the follow up on Agenda 21, construction of environmental offices, follow up on implementation of environmental conventions, environmental impact assessments, promotion of cleaner technologies, development of environmental regulations, guidelines and monitoring of state of the environment.

8.4.2.1. Pressures on Public Funding

The economy has been in recession over the last several. GDP growth declined to 2.5% between 1990 and 1995 and to 1.98% between 1996 and 2000. After posting a positive growth of 1.2 % in 2001 from negative 0.2% in 2000, the economy grew by 1.1 % in 2002.

Economic growth rate has consistently been lower than the population growth rate, while the number of people living below the poverty line and who subsist predominantly on environmental resources was about 57% in 2002 (Figure 8.2). This coincides with a period when investment in environmental conservation has shrunk significantly. Investment in the water and forestry sectors declined by over 65% and 29% respectively between 1998 and 2002. The continued disparities in these rates will continue to exert pressure on environmental goods and services, including water, fisheries, agriculture and biodiversity.

Figure 8.1. Trend of GDP and Population Growth Rates (1990 - 2002)



Source: Republic of Kenya, Economic Survey 2003

Poor economic performance in the 1990s and early 2000s was mainly as a result of poor weather and infrastructure; uncertainties caused by the introduction of multi-party politics; depressed investments; declining tourism activities; poor performance of the manufacturing sector; declining donor support; fluctuation of exchange rates; low domestic credit; lack of alternative livelihoods; inadequate access to new and appropriate technologies; over dependence on ecological resources; exploitation of non-value added products; low output and of prices of major agricultural exports.

Poor economic performance, impacted negatively on the environment. These impacts include:

- Declining Public Finance
- Increased poverty levels
- Low investment in environmental management.
- Increased environmental degradation.
- Unsustainable use of natural resources.
- Low productively leading to low economic returns
- Accumulated debts

8.4.2.2. Natural Resources Based Economy

Kenya's economy is largely natural resource based and heavily dependent on the intricate linkages of the country's environmental and natural resource base. These resources contribute to urban and rural consumption, energy generation, agricultural development, industrial growth, livestock and tourism development. Undermining the value of the environment is thus an avenue towards economic decline as has been experienced in the last two decades.

A number of government reports have pointed out that poor governance and natural calamities of natural resources has increased the vulnerability of the country to extreme environmental events, such as droughts and floods that have had a strong influence on Kenya's economic performance. They also show that recovery from extreme events is costly and extends several years after an event. Poor environmental resources development, management and protection also impose a significant drag on the economy in the short- medium and long-term.

8.4.2.3. Public Debt

A major problem facing public finance in Kenya is indebtedness; especially external debt. The size of the current debt and debt service is compounded by poverty and the structural weaknesses of the economy. Public funds used to service the national public debt exceeds budgetary allocation to education, health, housing and community welfare, pollution abatement, water supply, sanitation and refuse collection. It is apparent therefore that there is a link between the increasing debt-burden to poverty.

The ratio of debt service charges on external debt to exports of goods and services has been declining for the last four years but dropped marginally in 2000. Thus the growth in export receipts has been faster than the increase in external debt service charge. The total net servicing charges declined by 19.8 per cent from Kshs.97, 842.4 million in 1999 to Kshs78, 431,39 million in 2000. Internal debt servicing charges went down from Kshs.66, 627.8 million in 1999 to Kshs. 44,869.74 million in 2000. The external net servicing charges increased by 10.4 per cent in the year 2000. The overall debt stands at 70 per cent of GDP. Outstanding public debt has been on the decline, standing at Kshs.328.9 billion in 1999 and Kshs.306.7 billion in 2000. Kenya has been making net repayments out of the foreign debt (redemption exceeding new borrowing) to the tune of 1 per cent of GDP in 1997/98, 1.2 per cent in 1998/99 and 1.9 per cent in 1999/2000. Kenya thus suffers from the problem of excessive borrowing internally and insufficient borrowing externally.

8.4.2.4. Low Priority for Environmental Programmes

Environmental programmes have not been given the priority they deserve. Short-term social and economic programmes are pursued at the expense of long-term environmental sustainability. Environment is given low priority because of increasing levels of poverty, competing interest with social and economic issues, poor governance and ignorance.

8.4.2.5. Funding Interventions

The Government recognizes the importance of a stable financial system in sustainable development. This led to the formulation of Sessional Paper No.1 of 1986 on Economic Management For Renewed Growth, and Sessional Paper No.1 of 1994 on Recovery and Sustainable Development.

In order to address the declining economic performance and increase financial resources, the government has put in place economic recovery strategies and policies. Some of these measure are: economic recovery strategies and policies including: -Poverty Reduction Strategy Paper (PRSP) of 2001, Poverty Eradication Programme (PEP), Economic Recovery Strategy for Wealth and Employment Creation (ERS) (2003) and public expenditure review and Medium Term Expenditure Framework (MTEF); direct foreign investment (DFI); promoting clean technologies and other economic instruments, which incorporate and measures necessary for poverty reduction, sustainable economic growth and environmental management.

The government's current fiscal strategy involves maximizing on foreign concessional financing; utilizing proceeds from privatisation to reduce debts and finance development; attaining a balanced budget before grants and prioritising funding under the MTEF. Initiatives for increasing financial resources for environmental management include creation of environment trust funds. A number of these trust funds have been established.

- ***The National Environment Trust Fund:*** EMCA (1999) created the National Environmental Trust Fund which is funded by donations, endowments, grants and gifts. This fund will be used to facilitate research, capacity building, environmental awards, environmental publications, scholarships and grants.

- ***The National Environment Restoration Fund*:** EMCA (1999) also created the National Environmental Restoration Fund whose sources include proportion of fees, deposit bonds, donations and levies. The objective of the Restoration fund is to act as supplementary insurance for mitigation of environmental degradation.

- ***Anti-Desertification Community Trust Fund*:** The National Action Programme to Combat Desertification created the Fund. The government has already provided some seed money.

- ***Community Trust Fund for Biodiversity Conservation***: The European Union is sponsoring this fund.

- ***Poverty Reduction Fund*:** The fund has been established with assistance from some development partners, to support among other things environmental activities.
- **Fees and levies** include EIA and audit registration fee, licence fee for both proponent and experts, inspection of the register and any other prescribed fees. NEMA has opened an account for these monies.

Since independent, Kenya has been applying economic instruments for environmental management in water, forestry, mining, waste management, and land management. Apart from land, application of economic instruments has not respected market rates. They have always been applied far below market rates or real value. This has led to the mismanagement of natural resources. However, in major economic sectors such as manufacturing, economic instruments have not been applied, leading to enormous pollution.

EMCA (1999) provides for the application of economic instruments and the polluter pays principle as tools for promoting sustainable development. There has also been pressure from the public to conserve and restore the environment.

It is expected that the application of economic instrument will promote environmental management and raise financial resources for environmental management. NEMA is in the process of formulating environmental regulations on economic instruments.

8.4.3. External Funding

The international community has continued to play an important role in the mobilization of resources for overall development including environmental management. Sources of external funding include official development assistance (ODA), and direct foreign investment. During the UNCED and WSSD conference developed countries pledged to increase support to developing countries through the official development assistance.

8.4.3.1. Official Development Assistance

The ODA to Kenya since 1992 has been unfavourable. In 1991 the IMF and World Bank reduced balance of payment (BoP) support to Kenya. Aid was further suspended in 1998. The ODA decreased from US$ 50 per capita in 1990 to US$ 16 per capita in 1998 recording a 68 per cent decrease.

The ODA allocations to conservation and sustainable use of environment and natural resources have been on the increase in the recent past. Despite the decrease in bilateral and multinational development funding in financial year 2000/2001, funding estimates to environmental protection increased from Kshs.637 million in 1999/2000, to Kshs1.8 billion in 2000/2001.

In 1999/2000 financial year, Kenya's Development partners contributed to a total of Ksh.34, 135 million towards development budget and during 200/2001, donor contributed a total of Ksh.23, 886 million in form of project funding.

On the other hand, the non-concessional financial flows (commercial credit) and direct investment are growing and will continue to focus on large-scale industry and infrastructure projects.

8.4.3.2. Bilateral Funding

During financial year 2000/2001, bilateral funding accounted for 59% of the total external development project budget. Bilateral funding covers activities implemented by both the public sector and civil societies. However, it is not possible to assess the level of civil society funding.

8.4.3.3. Multilateral Funding

The largest multilateral contributor to Kenya's development budget has been IDA. It contributed over 60% of multilateral assistance to Kenya during financial year 1999/2000. Multi-lateral funding for the environment include the Global Environmental Facility (GEF), multilateral fund of the Montreal Protocol for the protection of the ozone layer and technical cooperation trust funds. All these funds are for specific activities and are governed by specific rules and regulations.

Multilateral funding initiatives include the IMF/World Bank, the Lome Convention, the European Investment Bank (EIB) – Kenya Co-operation; and the Global Private Enterprise (GPE). The GEF is the designated "financial mechanism" for the Conventions on Biological Diversity, Climate Change, Persistent Organic Pollutants (POPs) and Convention to Combat Desertification (CCD). Project eligibility requirements include endorsement by host government; production of identifiable global benefits; inclusion of processes for monitoring, evaluation and incorporation of lessons learnt.

GEF funds are limited both in topical areas and scope (Figure 8.3). They are competitive and therefore require good indigenous capacity for the preparation of proposals. Other multilateral initiatives include the multilateral funds for phasing out ozone depleting substances (Figure 8.4), clean development mechanism and carbon trading.

Fig. 8.2. GEF projects according to focal areas

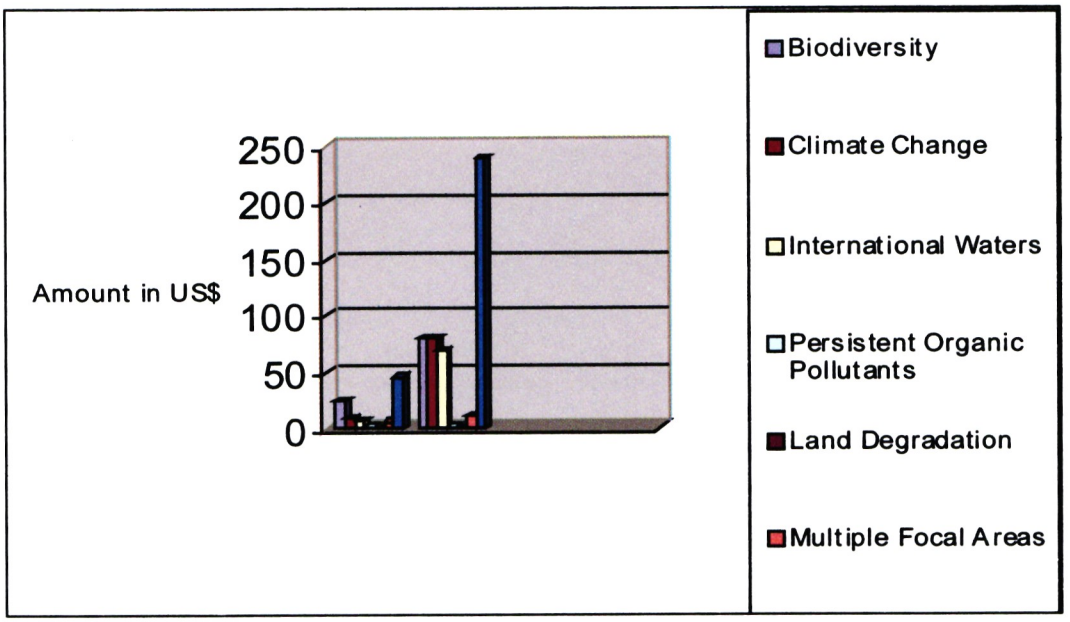
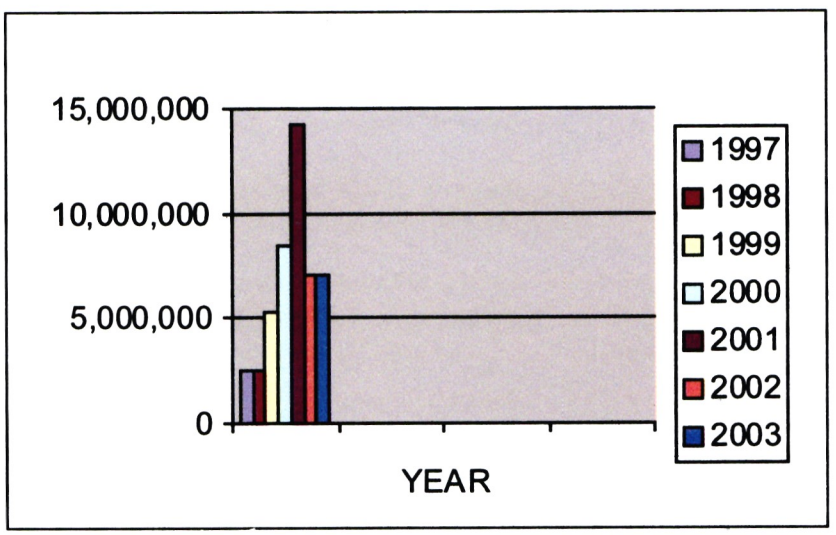


Figure 8.3. Support from ozone multilateral fund



8.4.3.4. Direct Foreign Investment

Mobilization of higher levels of foreign direct investment and technology transfers are often encouraged through national policies that promote investment or through joint ventures and other modalities. These investments include mobilization of higher levels of foreign direct investments and technology transfer through joint ventures. The government facilitates these activities by creating a conducive environment for such funding initiatives.

Corporate responsibilities are becoming popular as companies see the need to plough back some resources to the communities to support conservation and socio-economic activities. In Kenya, several corporate bodies participate in such initiatives including banks, oil companies, mining companies, aviation companies, tour operators, manufacturing and regional development authorities. Some institutions like KWS have established partnerships with local communities for purposes of benefit sharing in wildlife management. Development finance institutions (DFIs) are being privatized to instil commercial ethics in management, fund raising and lending.

8.4.4. Micro-finance including Community Funding

Most of these funds are geared towards poverty alleviation/income generation programmes. They indirectly touch on issues of environmental health and natural resources management. However, there is need for a deliberate effort to use this source of funding for direct environmental management. There has been phenomenal growth in micro-finance institution, the reasons basically being:

- Donors wish to disburse funds to target groups through civil society organizations;
- Greater awareness among the population on the role of micro-finance institution;
- Increased level of poverty within the country currently at 57% of the population.
- Inability by banks to lend to the vulnerable groups or those involved in micro-enterprises;
- The high rates of interest charged by commercial banks;
- The micro-finance institution offer both financing and training to those that they lend to.

Cooperative Societies particularly in the agricultural sector can play a significant role in environmental management through training on safe use of chemicals and pesticides. They can also be used to transfer appropriate technologies as well as contribute to financing environmental activities at community level.

The Harambee spirit has been in existence in Kenya since independence. Harambee means pulling together for a common cause and it is in this spirit that several projects have been implemented in the country. Many people in Kenya are poor and have used the Harambee spirit to uplift their living standards. Schools, hospitals, water projects, environmental projects such as soil conservation, tree planting, school fees, and bursaries have been aided by proceeds from Harambees. However, it is difficult to quantify the total contributions, which has been made through this initiative.

8.4.5. Conclusion

Environmental issues are cross cutting. Other sectors also undertake environmental activities, which are funded by the government and other development partners. These activities complement environmental conservation. Some of these include soil and water conservation, and pollution control.

The GOK/Donor coordination system on environment and natural resources aims at achieving greater efficiency of all donor assistance in the sector. It is supposed to remove duplication, overlaps, and identifying gaps and priorities for funding. Currently, the meeting is co-chaired by the Permanent Secretary for Environment, Natural Resources and Wildlife together with UNDP. The meeting is held once every three months.

The challenge for financing sustainable development is threefold. Firstly, there is need to improve the rates of capital formation so that there is adequate funding to go around. Secondly, there is need to come up with new formulae and instruments to finance environmental projects. Lastly, there is need to make financing mechanism sustainable.

8.5. EMERGING AND CROSS-CUTTING ISSUES

The sound environmental management and governance is affected by several factors some of which are recent occurrences whose impacts are quickly being manifested in the environment. These factors with negative impacts on the environment cut across several sectors and are further aggravated by processes such as environmental degradation. The control of such cross-cutting factors must be addressed collectively by all the affected sectors in order to effectively halt the spread of their negative impacts on the environment. The complex interrelationships among human activities, economic values and the environment need to be acknowledged. Some of the emerging and cross-cutting issues with adverse environmental impacts include poverty, gender, disasters, HIV/AIDS pandemic, influx of refugees, security concerns including civil strife and terrorism and effects of globalisation.

8.5.1. Gender

Awareness on gender dimensions in environmental management is low although it is now a key development issue. Most cultures ascribe different responsibilities and roles for environmental conservation and management to women and men. In their own right, women play essential roles in community affairs including how to care for the family, food production and other vital social and economic activities. Agricultural activities and gathering water and fuelwood in most communities are primarily carried out by women and girls.

However, the economic contribution of women and the role they play in overall environmental conservation is often underestimated. Development programmes with new technological innovations that increase economic power are often taken over by men and thereby marginalizing women further. Women are further disadvantaged as the society becomes more open with the break down of traditional practises. Environmental degradation forces women to spend more energy and time gathering fuelwood and water. Despite their central role in the community life, women are the least informed, are denied educational opportunities and often play peripheral roles in development initiatives.

To address some of these sensitive gender issues, the government has initiated and implemented proactive policies and programmes that favour women and the girl-child. There is a deliberate effort to mainstream gender issues in all developmental programmes. EMCA (1999) provides for the consideration of gender, intergenerational and intragenerational issues in all environmental conservation and management activities. This includes allocating specified membership of women on the PECs and DECs. Community programmes will only succeed where the roles of women, men and youth are duly recognized.

8.5.2. HIV/AIDS Pandemic

The government of Kenya has declared the HIV/AIDS pandemic as a national disaster. The prevalence of HIV/AID has increased rapidly in the country since the initial cases were reported in the mid 1980s. Urban areas have in the past recorded the highest infection rates as compared to rural areas but this situation is now changing and rural areas are now recording increased infection rates. The rise of HIV/AIDS victims in the rural areas has serious implications for the conservation of the environment. The most active segment of the rural communities which manages the environment is the most affected. There is also heavy reliance on an already overstretched environment to provide resources to care for the infected. As an emerging societal issue, the HIV/AIDS pandemic therefore presents another challenging dimensions in its management.

8.5.3. The Influx of Refugee and Related Issues

For many years, Kenya has provided a home for a large number of refugees from neighbouring countries. This influx of refugees into Kenya has been as a result of prolonged civil strive particularly from Sudan and Somali. The major refugee camps in the country are Kakuma in Turkana and the Dadaab in Garissa

The Kakuma refugee camp was established in 1992 initially to house 22,000 unaccompanied minors from southern Sudan. This population increased over the years to about 46,000 in 1994; then 50,000 by 1997 to about 62,000 by 2002. On the other hand, the Dadaab refugee camp hosts over 110,000

refugees mainly from Somalia. All the refugee camps in the country are located in ASALs which are ecologically fragile and characterized by low, erratic rainfall, poor soils and scarcity of natural resources. Demand for wood and other natural resources are therefore unsustainable. Consequently, Environmental degradation has been a major concern to the government since the refugee problem has persisted for a long time and their impacts in the affected refugee-hosting areas are very devastating. Some of the common occurring negative environmental impacts associated with refugee hosting areas include:

- Change in land use.
- Excessive use of fuel wood as a source of energy causing deforestation and destruction of these ecologically delicate areas. The demand for dry wood for firewood has increased drastically needed to cater for the ever-increasing refugee population. This has led to the cutting of live trees for fuel, which causes the most environmental degradation. The access to wood fuel has been a source of conflict between refugee population and local community as recently experienced at the Kakuma refugee camp in Turkana between the refugee community and the local population.
- Contamination of soil and water due to sewage and solid waste.
- Health hazards due to lack of sanitation facilities such as water sewage and solid waste disposal.
- Social conflicts between refugees and local communities over the use of natural resources, in particular water and forage. Other sources of conflicts are the supply of relief food by donor communities to the refugees' population oblivion of the needs of the local people.
- Insecurity has also become an issue in refugee-hosting areas.

The government has instituted some policy responses to the environmental management challenges:

- Formation of the National Committee on Environmental Impact on Refugee
- Settlements in Kenya through Ministry of Environment Natural Resources and Wildlife (MENR&W). Other stakeholders include UNEP, UNHCR and GTZ.
- under EMCA (1999), the NEAP process, which include the respective environmental action plans will address the environmental management issues including the degradation at refugee camps.
- Kenya also spearheaded initiatives under the auspices of IGAAD, to bring peace between the warring factions in Somalia and Sudan. This will stem out the need for people to flee their country.

8.5.4. Security Concerns

Several security issues have become a major concern to the environment and can no longer be ignored. Insecurity impacts negatively on the environment through unsustainable use of natural resources.

Terrorism: Terrorism is manifested in form of subversive or barbaric acts. Of late, terrorism has manifested itself as a conflict between north and south or Islam verses Christianity. Recent Terrorist acts include:

- The February 1997 bombing of OTC bus in Nairobi during which some people died and others suffered injuries.
- The December 1980 bombing of Norfolk hotel in Nairobi during which 16 people died and many others injured.
- The August 7th 1998 twin bomb attacks in Nairobi and Dar-as-Salaam during which more than 250 people died while about 5000 were injured in Nairobi.
- The November 2002 bombing of paradise hotel in Mombasa during which 16 people died while scores of others were injured.

Some of the impacts of terrorism are: Human loss and injuries, destruction of property, disruption of telecommunication and other infrastructure.
tension and general dissatisfaction, trauma on affected persons, strained international relations, political instability, decline in economic confidence, as well as land degradation through deposition of bomb wastes, therefore decreases in food production, increased import of food and fertilizers and malnutrition.

Certain responses have been made with the aim of reducing the subversive acts. Some of the responses are as follows:

- Legislation: Currently, an anti-terrorism bill has been prepared and is awaiting presentation to Parliament.
- Build capacity in personnel and equipment for counter-terrorism operations.
- International conventions about terrorism have been drafted.
- Apprehending and prosecuting individual terrorists.
- Training of human personnel in disaster management.
- Setting up of a disaster fund.
- Improving security overall and surveillance at airports, embassies and other significant installations.
- Cancellation of travel advisories.
- Solving regional conflicts.
- Compensation and counselling of victims.
- Sharing information on intelligence on terrorism issues.
- Elimination of extremists by depriving them the circumstances to recruit, train and operate.

Civil Strive: Civil strife in the neighbouring countries has resulted in security concerns with negative impacts on the environment. There has been a marked increase in the number of small arms and landmines in the country. Occasionally, explosions have occurred thus devastating local environments. General insecurity causes anxiety resulting in diminished social and economic activity. Again sporadic cases of civil strive have occurred occasioning the internal displacement of people in some pockets of the country.

8.5.5. Disasters

Disasters are unexpected, unplanned and unpredictable occurrences, which cause damage to both human and the natural environment often causing immense negative impacts on the environment.

The human and environmental impacts of disasters are so immense to be ignored. Some of the most frequent disasters that have occurred in the recent past include floods, land/mud slides, drought, famine, fires and disease outbreak (Plate 8.2).

Floods in Kenya have been exacerbated by deforestation of catchments areas, settlement on steep slopes and the general land degradation in downstream areas due to unsustainable land use practices. This situation has resulted in the occurrence of flash floods following torrential rains which could before be slowed down by natural canopy and vegetation cover. Other factors promoting flooding conditions are the breakdown and poor maintenance of flood control structures such as dykes, canals or dams. Floods have occurred in the recent past in the Bundalangi and Nyando areas of Western Kenya. The situation has been aggregated by changes of hydrological cycles such as *El Nino* resulting in prolonged raining season.

Landslides are a common occurrence in areas of steep slope where human settlement has exceeded the recommended slope gradient. Land/mud slides have occurred in both Meru and Murung'a districts. Some of these disasters are exacerbated by human activities such as the clearing of natural vegetation, quarrying, mining and construction.

Plate 8.2. Forest destroyed by fire.

Plate 8.3. A bushland reduced to bare ground by drought

Drought creates harsh climatic conditions that are not favourable to both plants and animal life. Severe weather conditions such as *La Nina* have caused drought conditions resulting in loss of vegetation cover, which reduces available forage to support animals. As a result, drought causes animal mortality, famine, and lack of drinking water for both humans and animals. Kenya experienced a very severe drought during the year 2000 which resulted in a high mortality rate of both livestock and wildlife. Other social economic problems experienced then included rationing for both water and power in the city of Nairobi. Pastoral communities mainly the Masai, Turkana, and Samburu experienced the most loss. Intervention measures include:

- Early warning mechanisms have been put in place to enhance prediction of various weather conditions. Early warning systems help to minimize the effects of drought related disasters at both national and community based levels.
- Dissemination of timely and accurate meteorological data has been recognized as key to mitigate drought occurrences.

- A Drought Monitoring Centre has been established in Nairobi in close collaboration with member states of the (IGAD) Intergovernmental Authority on Development. This has enhanced the monitoring of climate, precise prediction and early warning of climatic events. This centre has improved drought monitoring in the region allowing broad based comparison of data and information. This centre therefore should be strengthened to become a specialized institution in analysing weather and climatic information in the entire Eastern African region.

The status of the environment has a strong bearing on the health of its population both in the urban and rural areas. There are a number of environmental diseases such as malaria, bilharzias, worms, respiratory diseases, diarrhoea, and tuberculosis. This may be as a result of the presence of vectors and stagnant waters, enhanced by congestion due to high population and poor sanitation. The prevalence of these diseases has increased in past few years due to the worsening of socio-economic conditions, breakdown of infrastructure, pollution, and waste management. The government has prepared a Disaster Management Strategy Paper. This is coordinated by the Office of the President Disaster Management Centre.

8.5.6. Globalization

The globalization process has been enhanced by the advent of the ICT revolution which has turned the world into a global village. Thus, Kenya has to operate within the framework of the global community which determines the international economic relations within the uneven nature of the world economy between the rich north and the poor south. While the sustainable development paradigm recognizes common but differentiated responsibilities, globalization perpetuates liberalization or "Free Market". This is done through intense lobbying and advocacy by the rich north.

On the environment, this sidelines concerns on equity and hence poverty and unsustainable livelihoods with little resources set-aside by the government on environmental protection. In globalization, the partnership approach is discarded and Aid for Technology transfer tightened under the Intellectual Property Rights (IPR) of patent holders. The rights of Kenya's biodiversity-based knowledge is marginalized.

The NEAP report seeks to integrate environment management in Kenya's development planning and macroeconomic policies. The developmental dimensions are placed in the context of environmental policy. NEMA participates in WTO international meetings on environment and trade.

The major constraints of dealing with emerging and cross-cutting issues is inadequate capacity to deal with them. This includes funding, skilled personnel, equipment, early warning systems and the political will to courageously face these challenges.

BOX 6: FUTURE OUTLOOK FOR ENVIRONMENTAL GOVERNANCE, INFORMATION, EMERGING AND CROSS-CUTTING ISSUES

Governance

- The achievement of sustainable development will depend on the empowerment and capacity of the public and civil society. It is therefore necessary to enhance the capacity of individuals and institutions to enable them take advantage of existing technical and financial facilities.
- Adequate funding is needed for building infrastructural and human capacities on all thematic areas for effective environment management.

Information

- There is need to increase budget allocation for data collection and management as well as for establishing linkages and networks with other data centres and sources.
- It is necessary to establish mechanisms for identifying and filling data/information gaps, as well as building capacity in data collection, archiving, analysis and retrieval.

Refugees

- The security and peace initiatives for the neighbouring countries will need to be accelerated to avert the influx of refugees into Kenya.

Cross-Cutting Issues

There are a number of cross-cutting actions, which if carried out, would help to halt and even reverse environmental degradation and reduce human vulnerability. These actions include:

- Enhancement of the coping capacities of the Kenyan population, with regard to adverse environmental change and reduction of environmental insecurity.
- Mobilization of domestic financial resources for environmental management.
- Enhancement of institutional capacity to coordinate, monitor and supervise environmental management.
- Promotion of greater public awareness and active public participation.
- Improvement of environmental information systems.
- Promotion of good governance.
- Setting targets and monitoring performance.

ANNEX 1

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ANNEX 2

ANNEX 2.1. POPULATION DYNAMICS DPSIR (DRIVERS, PRESSURES, STATUS, IMPACTS AND RESPONSES)

	Driving force	Pressures	State	Impacts	• Response
Rapid population growth	• High population growth rate • High fertility rates • Mortality rates	• High fertility rates before late 1980s • Declining mortality rates before late 1980s. • Inbuilt population momentum- • More mothers entering reproductive age. • Low contraceptive rates • Desire for large families in 1960s • Ineffective family planning services • Social cultural and religious settings • Improved health services and social economic conditions in 70s • Decline in quality delivery of health services leading to increase in mortality • HIV/AIDS pandemic • Poor sanitation/water leading to increase in water borne diseases e.g. malaria • Poverty levels	• Pop size 28.7m for 1999 • 14.5m women, 14.2m men • Pop growth rate 2.7 % 1999 • 0-14 yrs---- 44% • 15-64yrs------54% • + 65yrs---- 2% • Population was 5.4m,growth rate 2.5 % in 1948; 8.6m and 3% 1962; 11m and 3.5% 1969;15.3 m and 4% 1979;21.4 m and 3.3% 1989;28.7 m and 2.7% 1999 and projected to be 32m and 2.1% 2005. • Total fertility rate was 6.6 in 1948,6.8 in 1962,7.6 in 1969,7.9 in 1979,6.7 in 1989,4.7 in 1999 and projected to 3.6 in 2005. • Current TFR 4.0 is high • General mortality rate was 50 in 1948,1962,1969 respectively and 48 in 1979,1989,1999. • IMR declined from 184 in 1948 to 168 in1962; 118 in 1969 to 114 in 1979; 63 in 1989 but rose to 66 in1999.	• Increasing levels of poverty 1992 48% of pop below absolute poverty level to 56% 1997 • % of wood fuel consumption. Encroachment of agriculture into marginal areas; • % of land under forest has declined • Decline in wildlife numbers over the years. Elephant numbers declined by 3.5% between 1998 and 2001.Eland and B. Zebra declined by 43 and 31.6% respectively between 1997 and 2001.all due to drought (erratic rainfall), habitat destruction (agric/settlement encroachment on habitat) • High dependency on health, education, employment • Economic decline GDP falling. • Declines in access to portable water and sewerage system due to rural urban migration; • Water quality degraded in urban areas thro' increased use of pesticides and fertilizers to sustain high levels of food production. • Housing in squatters settlements /slums overburdened /inadequate transport system.	• Sessional Paper No. 10 of 1965 on African socialism and its Application to planning • Family Planning Programme of 1967 • Sessional Paper No. 4 of 1984 on population Guidelines • Kenya Health frame work • Reproductive Health Strategy • Sessional Paper No.4 of 1994 on AIDS in Kenya • Various International Conventions on Population • Sessional Paper No. 1 of 2000 on Population Policy for Sustainable Development • Adolescent Reproduction Health and Development Policy • Partnership with NGOs, CBOs, civil society and religious organisation

ANNEX 2.2. HUMAN SETTLEMENT DPSIR (DRIVERS, PRESSURES, STATUS, IMPACTS AND RESPONSES)

Issue	Drivers	Pressures	State	Impacts	Response
Weak Institutional Frameworks (Town Planning Act of 1948 and Land Planning Act of 1960	• Inefficient legal framework before Physical Planning Act Cap 286 (in 1996) • Inadequate human and financial resources • Inadequate planning information and technology • Lack of political goodwill	• Political dispensation • Competition for resource allocation e.g. Land • Rapid population growth rate • Rapid rate of urbanization	• Increasing depletion of natural resources • Increasing growth of informal and slum settlements (60% in Nairobi) • Lack of approved and up-to date physical development plans	• Falling living standards • Polluted air and water • Degraded land resources • Loss of natural habitat and biodiversity • Deteriorated environmental health: human beings, flora and fauna	• Town Planning Act no. 1948, Land Planning Act, Physical Planning Act Cap 286, Local Government Act 265 • National Land Policy, Regional Physical Development Plans, Local Physical Development Plans, • Sessional Paper No. 10 on Environment and Development National Environment Action Plan, Provincial And District Action Plans • Green Towns Project; Urban Environmental Plans
Shortage of Appropriate Housing	• Lack of housing policy up to 2000 • High rate of population growth • Rapid rate of urbanization • High cost of capital • Inappropriate housing standards	• Low income (affordability) • Hostile economic environment • Adoption of foreign housing standards • Cultural values and technology • High demand for certain housing typologies (middle and low income)	• Inadequate housing supply • Increased slum, squatter and informal settlements • Overcrowding • Little investment in housing	• Low living standards (60% in Nairobi) • Deteriorating environmental health: human beings, flora and fauna • Loss of agricultural land Pollution of ecosystems	• National Housing Policy, 2003 • Upgrading of slum areas and informal settlements • Appropriate Low Cost Building Technologies • Secondary Mortgage Markets • Housing Revolving Fund • Private-Public Partnership Strategy • Develop a Land Bank for housing project
Lack of adequate water and sanitation	• Rapid population growth • High rate of urbanizations. • Weak and deteriorating institutional infrastructure and resources.	• High rate of urbanization (6%). • Inadequate human and financial resources.	• Poor and deteriorating water and sanitation services. • Rising quantities of uncollected garbage.	• Deteriorated environmental health for human beings, fauna and flora: • 30% of urban centres have a sewerage system • 60% of Nairobi city residents live in the slums.	• Water Act 2002 • Local Government Act • Public Private Partnership in Water and Sanitati • Growth Centre Policy. • Rural Trade and Production Centre
Poor and deteriorating roads and road network	• Lack of roads development and maintenance policy up to 2000. • Inefficiency and corruption in roads construction and maintenance.	• High rate of urbanization (6%). • Increased • monetarisation of the economy. Insufficient financial resources.	• Poorly maintained roads. • Increased energy consumption • Most roads are seasonal. • Poor national and regional road networks. • Inefficient flow of goods and services.	• Falling living standards. • Increased poverty. • Inefficient economic performance. • Deteriorating environment. • *Classified roads are 41000km. • *Since 1963, classified road network has grown by 51 per cent. • *Tarmacked road is only 8937km in a country of about 580000km^2. • High cost of production thus weakens Kenya's competitiveness in the market.	• Growth centre policy • Rural trade and production centre strategy. • Urban-rural linkage • Urban transport roads project. • Road Act, 2000 • Roads Petroleum Levy. • El Nino Roads Rehabilitation Project. • Roads Board and District Roads Committees. • Rural Urban Linkage strategy.
Shortage of energy supplies	• Heavy dependence on wood fuel. • Heavy dependence on imported petroleum.-Inefficient electric energy supply.	• High rate of population growth (3%). • High rates of urbanization (6%). Insufficient financial resources. • Increased poverty.	• -Uneven distribution of electric power. • -decrease fuel wood and wood-fuel stock. • -Increased importation of petroleum and petroleum products.	• Wood-fuel depletion. • low living standards. • High cost of production • Increased pollution.	• Rural electrification programme. • Energy conservation strategy: improved jikos. • Agro-forestry programme.-Introduction of unleaded fuel.

ANNEX 2.3. POVERTY DPSIR (DRIVERS, PRESSURES, STATUS, IMPACTS AND RESPONSES)

Issue	Driver	Pressures	State	Impacts	Responses
High levels of Poverty	• Low agriculture productivity • Poor marketing • Declining economic growth • High levels of inequality • Gender imbalances • Lack of access to land and other productive assets • High cost of education • Bad governance and corruption • Poor service delivery • HIV/AIDS • Unemployment and low wages • Insecurity and ethnic tensions • Vulnerability	• Land use conflicts • Unsustainable land use • Declining employment opportunities • Lack of access to basic services e.g. education, health • Limited resources • Unplanned settlement • Inadequate infrastructure facilities • Negative aspects of globalization • High population growth • Cultural tendencies and beliefs	• High poverty levels with 57% of the population living below the poverty line in 2002 • Rural food poverty 51% and overall rural poverty 53% in 1997 • Urban food poverty 38% and overall poverty 49% in 1997 • Rising unemployment • Inadequate consumption and welfare patterns • High levels of child labour	• Low agricultural productivity • Poor farming methods • Poor delivery of services • Unemployment &underemployment • Low wages • Insecurity &ethnic tensions • Poor consumption patterns • Marginalisation of people with disabilities • Settlement in ecologically fragile zones leading to soil erosion • Envi'tal degradation through cutting of trees for settlement • Mushrooming of slums • Destruction of water catchment areas and deforestation • Air and water pollution • Low stands'. of living • High dependency ratio • High prevalence of diseases	• Sessional Paper No. 10 of 1965 on African Socialism and its Application to Planning and Development • All development Plans since Independence • National Poverty Eradication Plan 1999 -2015 • Poverty Reduction Strategy Paper and PRSP Action Plan • Medium Term Expenditure Framework Core Poverty Programmes • Economic Recovery Strategy on Wealth and Employment Creation (ERS) 2003 – 2007 • ERS Investment Programme • Millennium Development Goals (MDGs) • Community initiatives

ANNEX 2.4. AGRICULTURAL LANDUSE DPSIR (DRIVERS, PRESSURES, STATUS, IMPACTS AND RESPONSES)

Theme	Issues	State	Pressures	Impacts	Response
Land & land use	*High potential/ medium lands (HMPL),* Limited arable land, Land degradation, Land tenure	• Only 17% is HMPL, Extension of degraded lands, Different tenure systems occur	• High Population, Expansion of agriculture into the ASALs, Loss of soil fertility, Cultural practices, Government policies	• Sub-division into uneconomic land sizes, Land degradation, Land conflicts, Food insecurity, Shift of agriculture to other areas (ASALs), Loss of forest biodiversity	• Land use planning, intensification of agriculture, land tenure arrangements for access to land, conservation of biodiversity
	Arid and semi-arid Lands (ASALs)	• Over 80% of the country's total land area is ASALs	• ASALs Supports 30% of the country's population, 50% of livestock and most of the wildlife	• Poverty, Encroachment by agriculture and other uses Land use conflicts	• Formulation of a poverty reduction strategy paper, national Action Plan to Combat Desertification, Arid lands Resources Management Project, Arid Lands Development Policy (1992)
	Land use	• Changes in land use occur over-time	• Over-exploitation of natural resources, expansion of agriculture	• Over-grazing, land degradation (soil erosion, loss of soil fertility, loss of biodiversity), land use conflicts	• Enactment of EMCA, establishment of National Environment Management Authority, Physical Planning Act (land use planning), formulation of ASALs Development Policy (1992)
	Land tenure	• Communal land ownership more common	• Government policies e.g. change in tenure arrangement from communal ownership to individual tenure or public ownership	• Land degradation, cultural erosion by immigrants, social instability	• Various legislations on land access rights e.g. Trust Lands Act, Land Control Act, Land Registration Act, Land Titles Act etc.
	Droughts	• Cyclic droughts occur frequently in the ASALs and periodic in the high potential areas	• Climate change	• Shortage of water resources for all uses, death of livestock, wildlife, fish and other flora and fauna, increased conflict between people and wildlife, and drying of wetlands, loss of livelihoods, land degradation, decreased crop and livestock performance, food shortages, and increased livestock diseases.	• Drought monitoring, famine early warning, Implementation of NEAP
Agriculture and livestock	Limited arable land	• Only 17% of total land is HMPL	• Feeding the increasing population, Expansion of agriculture into ASALs, • Loss of soil fertility, cultural practices, government policies	• Sub-division into uneconomic land sizes Land degradation and conflicts. Food insecurity Shift of agriculture to other areas (ASALs) Loss of forest biodiversity	• Several policy and legislation are in place and implemented or being formulated to improve agricultural sector performance. Examples are: Kenya Rural Development Strategy (KRDS), National Agricultural Research Programme, EMCA, Special Food Security programme for Kenya, NAEP, NALEP land use planning etc
	Pest and diseases	• Crops and livestock pests and diseases are common all seasons but increases during the dry seasons	• Weather conditions, climatic variables, type of crop, livestock breed, land use type/enterprise mix	• Loss of yields and productivity, food shortage, loss of biodiversity, loss of income and increased poverty	• Crop protection policy, Pest and disease control programmes, etc
	Inadequate agricultural credit	• Poor performance of agricultural credit institutions e.g. Agricultural Finance Corporation, Kenya Farmers Association and most of farmer-cooperative societies and limited lending interest to the sector by mainstream financial institutions and commercial banks	• Poor macro-economic performance, political interference	• Decline in agriculture sector performance, decline in rural employment, increased rural poverty	• A number of policy actions have been put in place to turn around the situation e.g. PRSP, Kenya Rural Development Strategy (1999), New Economic Growth Strategy*, National Agricultural Extension Policy, National Agriculture and Livestock Extension Programme etc

	Low priority for research and development	• Less than 1% of total budgeted expenditure is allocated for agricultural research, making national research donor-driven.	• Competing budgetary requirements, limited growth of the national economy, limited vision for national development	• Limited research and development use of low quality inputs by majority farmers, poor agricultural yields and general poor performance of agricultural sector and the total economy.	• Policy and strategic options for research are many e.g. National Agricultural Research Programme (NARP) implemented by KARI
	Poor quality inputs	• Majority of the farmers use certified seeds and limited fertilizers and pesticides. Fake farm inputs are also sold by fraudulent businessmen to farmers, limited use of quality animal breeds	• Poverty, inadequate supply of good quality inputs, high inputs'	• Poor yields, food insecurity, poor performance of agriculture and livestock sector	• A number of policy actions have been put in place to turn around the situation e.g. National Agricultural Research Programme, Inputs monitoring, New Economic Growth Strategy, PRSP, Kenya Rural Development Strategy (1999), National Agricultural Extension Policy, National Agriculture and Livestock Extension Programme etc
	Low adoption rates of new technologies	• Limited number of farmers adopt new technologies	• Low levels of income, risk averseness, high level of supply of new technologies, poor research-extension-farmer linkage	• Culture and traditions, Poor agriculture and livestock performance, degradation of the environment	• A number of policy actions have been put in place to turn around the situation e.g. National Agricultural Research Programme, EMCA, National Agricultural Extension Policy, National Agriculture and Livestock Extension Programme, Agricultural Technology and Information Response Initiative (ATIRI)
	Poor rural infrastructure	• Currently, most of the rural infrastructure, especially roads are in dilapidated conditions	• Limited budgetary allocation for rural infrastructure development, corruption, limited infrastructure networks, limited/poor maintenance	• Poor access to markets, spoilage of fresh agricultural and livestock produce, general inefficiency in commodity marketing	• Policies on national infrastructure development, particularly rural roads, and electricity
	Low investment in and budgetary allocation for agriculture	• Currently, investment in and budgetary allocation for agriculture is quite low	• Competing destination for investment funds and budgetary allocations.	• Slow agricultural sector development and performance	• A number of policy actions have been put in place to turn around the situation e.g. commodity-specific policies for cash crops, institutional reforms e.g. management of the cooperative societies and marketing boards are being reformed to enhance performance
	Commodity price fluctuation	• Commodity prices offered to farmers both at local and international levels are low	• Participation of middlemen in marketing and globalization	• Low commodity prices, low income and poverty	• A number of policy actions have been put in place to turn around the situation e.g. commodity-specific policies for cash crops, institutional strengthening e.g. the cooperative societies and marketing boards
	Policy, legal and institutional frameworks	• Policy, legal and institutional are inadequate to regulate agricultural and livestock sector performance	• Politics	• Poor performance of the sector	• A number of policy actions have been put in place to turn around the situation e.g. commodity-specific policies for cash crops, institutional strengthening e.g. the cooperative societies and marketing boards
	Agrochemical use	• Increasing annually due to modern agriculture, Obsolete and banned agrochemicals use, • Misuse of agrochemicals, • Eco-system pollution	• Demand for safe food, • Consumers awareness, • Poisoning instance, • High cost, New chemicals	• Environmental contamination and pollution, Human health, • Low agricultural productions, • Food insecurity, Poverty	• Environmental policies Agrochemical control acts, • Consumer education, Safe uses projects.

ANNEX 2.5. RANGE LAND USE AND TENURE DPSIR (DRIVERS, PRESSURES, STATUS, IMPACTS AND RESPONSES)

Issues/Theme	Status	Pressure	Impact	Responses
Dryland/ Rangelands	• Over 80% of Kenya's total land surface is classified as Dryland/Rangeland	• Supports 26-30% of the total population; 50% of the livestock sector wide variety of wildlife	• 8-10 million people adversely affecting desertification and drought. Highest incidence of poverty (68 – 84% in 1994). • Losses of land by encroachment and alienation process, insecurity, cattle rustling continued to claim lives of communities in ASALs areas	• The National Environment Action Plan (NEAP) (1993). • The National Poverty Eradication Plan (NPEP) of 1999. • The Environmental Management and Coordination Act (1999) • The NAP to Combat desertification • Poverty Reduction Strategy Paper (PRSP).
Land use	• Changes of land use	• Over-utilization and unsustainable utilization of natural resources	• Over-grazing, land degradation	• *National Environment Management Authority (NEMA) to* review and establish, in consultation with the relevant lead agencies, a comprehensive land use policy and guidelines that will alleviate land degradation and increase food security in ASAL areas.
Land Tenure	• Communal land ownership	• Restrict pastoralists movement hence disrupting their traditional land management systems.	• Land degradation	• The *Environmental Management and Coordination Bill, 1999, provides for* review of sectoral laws governing the management of the natural resources including land tenure

ANNEX 2.6. BIOTECHNOLOGY AND BIOSAFETY DPSIR (DRIVERS, PRESSURES, STATUS, IMPACTS AND RESPONSES)

Driving force	Pressure	State	Impact	Responses
Food sufficiency Source of livelihood Health of people Poverty reduction	• The need to protect the biodiversity and also the need to exploit biodiverity sustainably. • The need to provide a meal for every Kenyan. • The need to develop the economy	• There are 35,000 known species of flora, fauna and micro-organisms in Kenya • Biotechnology is being researched and applied in agricultural sector and in medical fields	• Safety to environment is crucial for sustenance. • The biodiversity is useful as a source of food, fuel-wood fibre and medicine for local communities	• There are country policies on conservation e.g. under NEMA and also NBSAP • There are international instruments in place e.g. CBD and Biosafety protocol
The poverty levels and the need to assure food security is important	• The need to exploit biodiversity using the modern biotechnology	• Tissue culture is used for certain crops • Vaccine development for animal health is in progress	• Safety to human health. • Biotechnology has a great potential as source of food but the fears related to allergenicity, toxicity. The impact is not known	• A policy is being finalised • Monitoring and inspection protocols are being put in place
The need to develop biotechnology and implement the Biosafety Protocol in harmony with the domestic regulations and laws pertaining to the same is a pressure being addressed			• Guidelines and regulations have been used by the National Biosafety Committee to allow importation of sweet potato	• These have been developed and are being revised
Intellectual property issues, trade issues, social economic issues, market forces		• The biotechnology and biosafety policy has not been adopted as yet. It is expected to address many issues	• Policy and Legal framework Will have an impact in future when implemented	• A policy on biotechnology and biosafety is being finalised
The public is the major stakeholder in biotechnology and biosafety		•	• Public information will have an impact in decision making	• The decision making process is expected to incorporate the public information
The need to train various cadre of staff, The infrastructure for modern biotechnology and for containment		• The universities and research institutions have some manpower for biotechnology and biosafety but this is not sufficient	• Capacity for biotechnology including equipments for research and detection of GMOs are not sufficient • Capacity for biosafety containment is needed	• Through the UNEP GEF project capacity is being developed for human and physical containment

ANNEX 2.7. AQUATIC ECOSYSTEMS DPSIR (DRIVERS, PRESSURES, STATUS, IMPACTS AND RESPONSES)

Ecosystem	Status	Pressure	Impacts	Responses
Coastal and Marine: Kenya possesses 640 km of shoreline and 200 nautical miles of Exclusive Economic Zone (EEZ).	**Mangrove ecosystem** 9 species described. *Rhizophora mucronanta* is the dominant sp. Coverage: 54000 ha Tudor, Mtwapa, Kilifi creeks, Takaungu, Ngomeni, Lamu, Kiunga. Important habitat for a variety of plant and animals; Prawns, crabs, molluscs, migratory birds Conservation Status: Big area not protected except those closer to Malindi/Watamu marine parks.	Increased development, along the beaches Over fishing and destructive fishing Increasing human population Oil spillage from the port area. Clearing of mangrove trees to create access routes to shorelines and pave way for physical developments.	**-Increased pollution** -Loss of mangrove forests and biodiversity. -High levels of poverty	**Establishment of Marine National parks, reserves and Biosphere reserves e.g. Malendi Watamu, Mombasa, Kiunga Mpunguti** Policy frameworks
	Sea grass ecosystem There are 12 species of seagrasses on the Kenyan coast .The most common and widespread species are *Thalassia hemrichii* and *Thalassodendron ciliatum*, while Halodule is the main pioneer genus; colonising new areas of seabed or recolonising damaged areas.	Development of tourism industry. Poor enforcement of existing legislation and weak institutional capacity. Mining and shipping industry Damping of solid waste and non-biodegradable materials, sewage and industrial toxic wastes.	**-Increased beach erosion**	EMCA The Water Act Agriculture Act Forestry Act Fisheries Act. Industry Act --Merchant Shipping Act Wildlife conservation and Management Act **Maritime Zones Act**
	Coral reef ecosystem **Coverage: 50,000ha** **Types include the families Portidae (*Porites* and *Ganiopora* spp.) and Faviidae (*Meandrina* and *Favina* species).** Diversity: Marine fish species composition stands at 935 and 104 shark species. Out of this, 151 fish families have been identified. The most famous marine fish are colourful reef fishes (particularly wrasses and parrot fishes) and the large sport fishes such as marlin, sail fish, tuna, carangids and sharks.	Oil spillage from the port area.	**-Coral bleaching in 1997-1998 Bleaching related loses USD 5-9M-Depleted coral fisheries**	-Coral reef task force under Nairobi convention, -International coral reef initiatives (NRB convention COP).
	Birds Kenya has one of the richest avifauna in Africa, with 1089 bird species presently listed. The coastline currently holds approximately 86,000 waterbirds. Out of 1100 species recorded in Kenya, more than 450 species (41%) are found in the coastal strip.		**-Reduced water bird population** -Increased no. of Indian pied crows	-The Continental Shelf Act **-Land Planning Act** **-Town Planning Act** -Local Authority Government Act -Coast Development Authority Act
	Marine Turtles Out of these five species of marine turtles have been recoded along the East African coast. Out of these two are found nesting on the Kenya shores are green Turtle (*Chelonia mydas*) and the hawksbill turtle (*Eretmochelys imbricata).*	By catch in fishing operations Expansion of beach hot	**-Loss of turtle nesting sites.** **Turtles are endangered**	**Sea turtle conservation project.** **Trials on Turtle exclusion devices**

	Marine Mammals: Driving force: Demand for meat oil, skin of cetaceans e.g. dugong, and. The Kenya coast is an important habitat for a variety of Cetaceans, which are severely depleted worldwide. Apart from Cetaceans Kenya coast is popular for its sea cows or manatees, the herbivorous *Dugong dugong.*	-Accidental catch by fishing nets		**Legislated as Marine Sanctuary**
Aquaculture/mariculture	Coastal mariculture is mainly for shrimp *.P indicus* and *P. monodon.* Oyster farm	-Environmental degradation from wetland reclamation is the biggest problem. E.g. Tana delta project.		**None** **A lot of resistance to prawn farming**
Lake Victoria basin:				
Shared water body: Kenya possess approx 6% of 68,890 km2 six major rivers discharge and a drainage basin of 156km^2.	17 fish taxa of Fish 400 cichlid species Produces 90% of Kenya's total fish catch Important water bird area	-Overexploitation of fisheries resources Pollution -Introduction of alien species: water hyacinth, and Nile perch, and four introduced tilapia sp. -Over harvesting of papyrus -User conflicts Drainage of Yala swamp	-Reduced species -Proliferation of invasive alien sp -Poor water quality	Regional conservation initiatives: EAC, LVFO and LEVMP
Riverine Ecosystems				
Tana River basin. **1000km long.** Catchment: The Tana River system Galoloe to Kokani Mbalala to Tana Delta Total area 360,000	Support unique Habitats for flora and fauna e.g. Oxbow lakes. Floodplain forests. Habitat for endemic monkey species, Crested Mangabey and Red Colobus Source of water for Irrigation. **Fish**: 60 species. Common sp: *Protopterus, clarias* and cichlid spp **Reptiles**: 12 reptile and 9 amphibian species. **Birds**: 300 species and 75,000 water bird groups **Mammals**: 57 species identified within the basin. Fisheries (source of food) Supports flood plain Farming (Pokomo)	-Riverine forest destruction -Overexploitation of fish resources. -Damming (seven folks) and irrigation projects (Tana Delta and Bura) -Weak policies on riverine resources -Introduced species e.g. *Prosopis juliflora* *Cray fish,* -Accidental introduction from aquaculture farms. -Development of man-made lakes: -Bura irrigation scheme. Tana Delta irrigation Project. Building of dykes. -Destruction of riverine forests	**Endangered**: Tana River red Colobus, Tana River Mangabey. Vulnerable: Crocodile (*Crocodilus niloticus*). Support unique **Destruction of riverine forests** -Increased siltation loads	Mostly un-protected. Some sections are protected in Mwea National Park Reserve, Meru National Park. **North Kitui National Reserve, Kora National Reserve, Arawale National Reserve and Tana River Primate Reserve** -Proposed reserve in the delta
The Athi/ Tsavo/ Galana System Merueshiflood-plains Kiiboko floodplains Area 25,000 &13,500	Habitat for diverse Flora and fauna. Source of food (fisheries). Supports flood plain agriculture. Water supply for Mombasa (Mzima Springs).	-Pollution from industries -Agricultural runoff -Soil erosion	**-Increased siltation** -Poor water quality -Reduced biodiversity	Partially protected. Some section. protected in Nairobi National Park, Tsavo East and West National Parks, Amboseli National Park.
Ewaso Ngiro north-system Ewaso Narok swamp (near Rumuruti), Lorian Swamp Total area: 347.000	*Important habitats* in the arid and semi arid environments. Source of food and water for livestock and wildlife and man Birds refuges			Partially Protected. Sections of Ewaso Ngiro North are protected in Buffalo Springs National Reserve, Samburu National Reserve and Shaba National Reserve
Ewaso Ngiro south system Ngare Ngiro Swamp	Forms a suitable habitat for rich vertebrate fauna and abundance of birds. Sources of water in a semi-arid environment			Unprotected

South Western RiversSystem Yala/ Nzoia Delta Swamps30,000 Nyando Swamp 10,000 Kimandi Swamp 4,800 Saiwa Swamp 1,500 Total 52,300	Best papyrus swamp development. suitable habitat for sitatunga. source of Peat and sludge (nutrients) into Lake Victoria Farming activities	Lake swamps are drained for agriculture. 2300 ha of Yala swamp has been drained. 900ha Kano Plains have been drained for rice.		Virtually Unprotected Only Saiwa Swamp forms Part of Saiwa swamp National Park Recommendations: Stop swampdrainage. Invest on alternative use of swamps ecosysteme.g. harvesting. Protect more swamps especially buffer zones
Rift Valley Lakes				
Lake Turkana	**Fish:** 48 species, ten endemic Lake is dominated by nilotic riverine fish, e.g. *Polypterids, Synodontis spp, Cytherinus, Heterotis spp.* Reptiles and amphibians: *Crocodile niliticus, Varanus niloticicus.* *Birds:* 350 species recorded. Important bird area. Habitat for palaearctic migrant bird species.	Drop in water level due to damming in Omo River (Ethiopia). Disturbance of water bird colonies by fishermen. Increased human population Overgrazing of livestock		**Partial protection Sibiloi National Park and** Central Island National Reserve and Mt. Kulal
Lake Baringo Area 130 km^2	Reptiles: Support large population of crocodiles. Birds: > 500 species recorded. Large colony of Goliath herons. **Fishes**: 7species recorded.e.g. *Orechromis niloticus baringoensis, Clarias gariepinus, Protopterus* The lungfish, *Protopterus aethipicus* is an introduced species in the lake. *Barbus stigmatopygus* is found in River Getiborok (a tributary of Kerio River) and *Barbus keiithi* found in Molo Perkerra rivers all in the lake Baringo system.	-Poor land use practices -High numbers of livestock -Clearing of forests for charcoal -Periodic floods -Excess water abstraction from Molo River	-Major erosion and siltation problems. -High siltation and turbidity -Declining fish stocks -Reduced water volume reaching the lake *Labeo ylindricus* is classified as an endangered species at the moment.	**The lake and its hinterland. Protected under Baringo county council**
Lake Bogoria 34 km^2 0°11'-0°20N and 36°07'E-36°15'E 963m asl. 4250 ha	Important water bird area e.g. Lesser flamingos -20,000 water birds. Millions of flamingos present No fish species but abundant zooplankton	-Overgrazing and human settlements within the reserve boundaries. -Soil erosion	**-Lesser flamingo globally threatened.**	**A National reserve under Koibatek and Baringo County council**
Lake Nakuru **50 km^2** Basin 1800 km^2	-1.5m birds. Mostly Lesser flamingo and greater flamingos.534 bird species. **Fish**: Introduced fish; *Oreochromis grahami, Tilapia alcalicus.* **Wildlife**: *Black Rhinoceros* and Introduced white Rothschild's Giraffe.	-Industrial waste -Domestic sewage -Agricultural wastes -Heavy tourism -High water abstraction and damming and irrigation upstream	-Flamingo deaths -Reduced bird population -	Protected in Nakuru National Park, L. Nakuru is also a ramsar site
Naivasha **Area 156km2**	All fish species are introduced. Tilapia sp O. *leucosticus*, and *T. zillii* and the predatory Black Bass crayfish (*Procrambras clakii*). Over 20,000 waterbird groups. Large population of African spoon bill (150) and Little Grebe(500). Mammals: *Hippopotamus amphibias* 300 individuals. **Reptiles:** Kenya horned viper *Bitis worthingtoni.*	-High agricultural activities in the catchment -Changes in land use Introductions into the lake e.g. several fish species, *Salvinia Coypus, Crayfish Eichhornia, Salvinia* beetle Reduction of papyrus swamps: Before 1970s –5000 ha of swamps 1977-20000ha 1991 –500ha	**-Utrophication** -Decline in fish production: 855t 1968- 56t 1988	**-A Ramsar site 1990** -Lake Naivasha Riparian (Association (LNRA) has developed a community based management plan.
Lake Elementaita 1,800ha	Habitat for cyno-phytes and copepods, Occasional habitat for flamingos. Fish: Oreochromis alcalicus grahami			

Magadi **Area 104km^2**	Habitat for specialised flora (Halophytes) An endemic fish *Oroechromis alcalicus grahami* and flamingos (.20,000 lesser flamingos). Commercial exploitation of trona Tourism (unexploited). Commercial exploitation of soda ash- source of revenue to the country.	No threat	Lesser flamingo and Great Egret threatened locally	**Unprotected**
L. Kwenia 1,600ha **(1 47' S/36 24 E) South East of Magadi**	This is a seasonal lake and a habitat for flora and fauna.	No threats documented	Gulley erosion of the banks	Not protected
L. Kabongo 2 05' / 36 24' E S. East of Magadi	Habitat for flora and fauna	No threats		Not protected
Lake Amboseli Area 10,000km	Source of food, habitat and water for fauna and flora, Game viewing, Bird watching, Tourism	-Destruction from wildlife Changes in water Table.	Die-off of *Acacia xanthoph-loea trees*	Protected in Amboseli National Park. Managed by group ranches.
High Mountain Lakes (Mt. Kenya Mt. Elgon, Abadares, **Charangany Hills)**	Unique habitat for specialised flora and fauna.	Some areas are protected in Mr. Kenya National Park		
Aquaculture	Production has stagnated to around 1000t /annum over the last decade. Main fish sp. farmed: Tilapia, Catfishes, Carps, Trouts etc.	Main source of accidental introductions to natural water bodies e.g. common carp and *procambras Clakii.*		

ANNEX 2.8. WILDLIFE DPSIR (DRIVERS, PRESSURES, STATUS, IMPACTS AND RESPONSES)

Drivers	Pressure	State	Impact	Response
Sustainable utilisation of wildlife.	Protection of wildlife.	8% of land is gazetted as protected land for wildlife.	Wildlife is important for tourism, for aesthetic value, for food.	Integrating conservation and development to ensure wildlife assumes a positive economic role.
Encroachment of the parks and reserves by communities and the wandering of animals into community lands.	Competition for resources such as water and pasture and food.	Some animals such as elephants, baboons gazelles cause damage to crops while elephants cause human injury. Animals such as lions leopards predate on livestock and cause human injury.	Reduction in population of wildlife.	Fencing of some parks, Establishment of community sanctuaries Translocation of animals. Development of a comprehensive land use policy.
Human settlements, agricultural and industrial developments.	Pollution from industrial, domestic and agricultural waste	Parks which are near		Promoting research and monitoring.
Poverty and Lack of finances	Human population pressure			
Proper utilisation of land.	Lack of policies on land use especially relating to dry land areas use is a problem..		The lack of land use policies hampers natural resource management as far as management of wildlife is concerned	Lobbying to influence land use policies to be developed that will favour biodiversity conservation.
Fragmentation of land especially in the migratory corridors and buffer zones.	Human wildlife conflict.		Crop damage and human injury occurs in some areas bordering the parks e.g. at Laikipia.	Protected areas strategies to include compatible human activities. Conflict resolution is a key component of natural resource management therefore encourage co-existence of animals and human
Cultivation	Habitat destruction	Cultivation on Tana river forest and tree felling and irrigation schemes have led to the decline in Crested Mangabey and Red Columbus		
Change of land use	Reduction of wetland habitat	Animals such as Sitatunga found in Saiwa Swamp National Park		Kenya is a signatory to the Ramsar convention and hence it is committed to conservation of critical habitats
Market for ivory tusks and bushmeat	The value attached to ivory and rhino tusks for their aphrodiastic purpose	Poaching of some animals such as elephants and rhinos causes a decline in numbers	Numbers of elephants and rhinos are fluctuating	Security of animals to continue receiving support Maintain elephants in Appendix 1 of CITES

ANNEX 2.9. WETLANDS DPSIR (DRIVERS, PRESSURES, STATUS, IMPACTS AND RESPONSES)

Key Basins	State	Drivers	Pressures	Impacts	Responses
Lake Victoria and associated wetlands (Lake Victoria shores, Yala Swamp, L.Kanyaboli, Lake Simbi, Sondu Miriu Nyando and Nzoia Rivers)	High diversity of wetland types (palutrine, Lacustrine and riverine) 34% of all the wetlands in the region are under threats.	Human population, poverty, Poor governance inadequate management capacity, climate change	Inappropriate land use and over utilization, conversion of land for agriculture, unsustainable exploitation of resources, increased demand for resources	Pollution Loss of land cover, invasive species, loss of water quantity and quality Loss of biodiversity, Flooding, Reduced fisheries,	• LVEMP initiative • LBDA Initiative • EMCA (PEC & DEC) • Nile river basin Initiative • E.A C • Research, education and awareness • NGOs, CBOs Initiatives • Relevant sectoral policies and Action plans
Rift Valley wetlands (Naivasha, Nakuru, Elementaita, Baringo, Bogoria, Solai, Magadi, Turkana)	Most of the wetlands are saline and rich in biodiversity particularly Avifauna. They are also experiencing fluctuating water levels and increasing pollution. Several are protected and designated as Ramsar sites	Climate change Poor governance, Human population, poverty, inadequate management capacity,	Urbanization, Inappropriate land use and over-utilization, conversion of land for agriculture, Unsustainable exploitation of resources, Increased demand for resources, Settlements	Loss of Catchments, Pollution Loss of land/forests cover, invasive species, Loss of water quantity and quality Loss of biodiversity, Flooding, Reduced fisheries,	• Regional Development Authorities (KVDA, EWSDA) • EMCA (PEC & DEC) • Research, education and awareness • NGOs, CBOs Initiatives • Relevant sectoral policies and Action plans • Recognized/designated conservation sites (Ramsar, National parks/Reserves, World heritage sites)
Ewaso Nyiro North and South. (Mau Forest, Amala River, Ewaso Nyiro Rivers, Shompolle Swamps, Lake Natron, Lake Olbollosat, Habasweni swamps)	Riverine Trans- boundary wetland linking into a critical flamingo breeding area. Proposed HEP has potential to alter the ecology & hydrology of the Ewaso river south and Lake Natron	Climate change Poor governance, Human population, poverty, inadequate management capacity,	Inappropriate land use and over-utilization of water, conversion of land for agriculture, Overstocking, Increased demand for resources, Settlements	Pollution Soil erosion/siltation loss of land/forests cover, Overgrazing, Reduced water volumes,	• Regional Development Authorities (EWNDA, EWSDA) • ASAL Program • EMCA (PEC & DEC) • Research, education and awareness • NGOs, CBOs Initiatives • Relevant sectoral policies and Action plans • Recognized and designated conservation areas • Increased catchment protection • EAC Cross-border protocols
Tana River basin Wetlands (Aberdares and Mt. Kenya catchments, Man-made Reservoirs, Tana River, Tana Delta)	Largest riverine wetland. Important for HEP, Biodiversity conservation and irrigation. Provides lifeline support to neighboring communities	Climate change Poor governance, Human population, poverty, inadequate management capacity,	Inappropriate land use and over-utilization of water, conversion of land for agriculture, Overstocking, Increased demand for resources, Settlements	Pollution Severe soil erosion/siltation, Loss of land/forests cover, Overgrazing, Reduced water volumes, Loss of critical habitats and species	• Regional development Authorities (TARDA & CDA) • ASAL Program • EMCA (PEC & DEC) • Research, education and awareness • NGOs, CBOs Initiatives • Relevant sectoral policies and Action plans • Recognized and designated conservation areas

					• Increased catchment protection
Coastal and Marine wetlands (Tana Delta, Mangroves, Coral reefs, Sea-weed & sea-grass beds, Beaches, Coastal forests)	Most of the wetlands are saline, brackish and fresh water. Rich in marine and coastal biodiversity. They are experiencing increasing pollution levels. Several are protected and designated as Conservation areas. Important for socio-economic development,	Climate change Poor governance, Human population, poverty, inadequate management capacity,	Urbanization, Inappropriate land use and over-utilization of resources, conversion of land for tourism development Increased demand for resources, Settlements, Tourism	Pollution Siltation, Loss of coastal forests cover, Cultural erosion, Loss of critical habitats and species Salty water intrusion	• Regional development Authorities (TARDA & CDA) • ASAL Program- Tana River District • EMCA (PEC & DEC) • Research, education and awareness • NGOs, CBOs Initiatives • Relevant sectoral policies and Action plans Recognized and designated conservation areas
Nairobi Wetlands (Ngong and Karura forests, Nairobi Dam, Nairobi River, Athi River Dams inside Nairobi Park)	Riverine and natural wetlands and several constructed wetlands highly polluted wetlands and rich in biodiversity in Nairobi National Park	Human population, poverty, Poor governance, Inadequate management capacity, Climate change Poor infrastructure Slum development Lack of awareness	Settlements along the rivers, Poverty, Lack of land-use and urban planning Inadequate management capacity and technology, Infrastructure development and poor sanitation Deforestation of catchment areas.	Water diversion Conversion and drainage Loss of catchment areas Encroachment, Pollution, Siltation/Sedimentation Loss of biodiversity Loss of socioeconomic and ecological values	EMCA 1999 (PEC and DEC) Nairobi River basin project – UNEP Education and awareness Training and capacity building Research inventory and monitoring Sectoral policies and plans of action NGOs, CBOs, Cibvil society and private sector intervention Nairobi City Commission Strategic Development Plan

ANNEX 2.10. FORESTRY DPSIR (DRIVERS, PRESSURES, STATUS, IMPACTS AND RESPONSES)

Drivers	Pressure	Status	Impact	Response
Poor national economic performance	High dependency on natural resource base in the country	Reduction of forest coverage to less than 1.7% of the land area.	Loss of forest cover, biodiversity and depletion of water catchment areas	National poverty reduction strategy initiated,
Loop holes in forest management legislation and policy	Unprocedural settlement schemes	Existence of irregular settlements schemes in forest reserves	Loss of forest cover, depletion of water catchment areas and loss of biodiversity	Forest Act review initiated, enactment of EMCA and water Act 2002
Poor national economic performance, lack of a policy on land	Illegal cultivation and encroachment in forest reserves	Misuse of the shamba system	Loss of forest biodiversity in indigenous forest, reduction of forest estate,	Land use policy initiated, Review of shamba system
Poor forest management	Un controlled Livestock grazing	Over grazing in forest reserves	Low regeneration of forests, soil erosion,	None
Poor forest management	Un controlled mining	Existence of quarries in forestland	Loss of forest cover and biodiversity	None
Poor forest management	Illegal cultivation, logging and charcoal burning on steep slopes	Landslides I forest areas	Loss of forest cover and biodiversity	None
Poor forest management	Settlement in wildlife migration routes and areas	Human / Wildlife conflicts	Damage to crops, loss of human and wildlife lives, Potential tourism may be affected	Collaborative forest management approaches
Poor national economic performance, lack of affordable energy alternatives	Charcoal burning,	Reduction of forest cover, certain tree species classified as threatened, increased forest fires.	Loss of forest biodiversity,	A policy on energy and wood fuel initiated
High demand for hardwood products	Illegal logging in indigenous forests	Reduction of forest cover, certain tree species classified as threatened.	Loss of forest biodiversity	MoUs between KWS, NMK, KEFRI and Forest Department in place
Poor forest management	Ban on logging	Low supply of timber from government forests creating artificial high demand,	Illegal logging in plantation and indigenous forests	Proposed forest bill
Poor forest management, inadequate forest staff		Backlog in planting	Harvested forest land left unplanted	Review of the Shamba system

ANNEX 2.11. TRADE DPSIR (DRIVERS, PRESSURES, STATUS, IMPACTS AND RESPONSES)

Sector	Issue	Driver	Pressure	State	Impact	Responses	Gaps
1. Hawking	-Pollution	-Unemployment -Employment opportunities	-Rural-urban migration	-Increased hawking - Increased pollution in the environment	- Pollution air, noise water	-Health Act -Local Authorities Act	-Lack of regulatory framework
2. Motor vehicle repairs	Pollution	-Employment opportunities -Demand for vehicle repair services	-Growing population of vehicles -Increasing nos. unemployed of Kenyans	-Increasing number of garages -Increasing number of motor vehicles	-Heath hazard -Pollution air, water, soil -Clogging of sewage systems	-EMCA -Local Authorities -Trade Licensing Act -Public Heath Act	-Poor Institutional coordination -Poor planning in Local authorities -Inefficient waste disposal practices
3. Hides and Skins	-Pollution	-Foreign exchange earnings -Population increase -Nutritional balance -Clothing market	-Market-Bilateral & Multilateral -Trade agreement -Cropping of animals	-Declining animal population Closure of tanning facilities	- Pollution air, water and soil - End products are not recyclable	-EMCA -Public Health Act -Dumping regulations	-Lack of proper regulatory mechanism
4. Wood-fuel, charcoal, carvings & timber	Forest deforestation	Construction industry Need for fuel Foreign exchange earnings	Demand for housing Furniture Fuel Foreign exchange	Deforestation Extinction of some tree species	Soil erosion Decrease of water and water levels Pollution of air and water Health hazard	EMCA Forest Act Agriculture Act Research for other sources of energy	Lack of awareness creation on environmental matters
5. Hotels and Restaurants and other catering facilities	-Pollution -Waste gene ration -Land degradation	- Consumer demand -Tourist attraction sites - Employment	- Population growth - Rural-urban migration - Tourism activities	- High generation of waste - High growth in the sector	- Pollution of water, air, soil -Destruction of marine life -Destruction vegetation cover	- EMCA -Public Health Act -Local Authorities Act -Cleaner Production Centres -Hotel and Restaurant Act	Uncoordinated efforts by lead agencies
6. Agricultural produce market	-Pollution Waste gene ration	-Consumer demand -Employment opportunities	-Growing population -Rural-urban migration -Export market	-High generation of waste -Poor infrastructure -Congestion of entrepreneur -Insecurity	-Health hazard -Pollution noise, air water	-EMCA Act -Local Authority Act -Public Health Act	-Bad governance -Uncoordinated efforts by lead agencies
7. Fishing	Pollution Waste gene ration	Export and domestic markets	Foreign exchange earnings	Sector growing	Water and air pollution	Fisheries Act Water Act Public health act	Poor coordination by lead agencies

			Consumer demands			EMCA	
8. Wholesale retail and distribution trade	-Pollution Waste gene ration	-Market demand -Consumer needs -Employment	-Rural-Urban migration -Population increase -Consumer habits	-High growth in the sector -Uncontrolled retail outlets due to liberalization -Generation of high volume of garbage -Poor planning - Insecurity -Unavailability of sanitation facilities Outlets of counterfeit and substandard goods	-Congestion -Increase of respiratory diseases -Generation of non bio-degradal waste materials -Pollution of water, noise, air, soil -Destruction of vegetation to provide for operational sites	-EMCA -Municipal by Laws -Weights & Measures -Trade Mark Act, Cap 506 -Public Health, Cap 242 -Water Act -Trade Licensing Act	-Bad governance -Lack of coordination of lead agencies

ANNEX 2.12. INTERNATIONAL TRADE DPSIR (DRIVERS, PRESSURES, STATUS, IMPACTS AND RESPONSES)

Sector	Issue	Driver	Pressure	State	Impact	Responses	Gaps
1. Import	-Dumping and counterfeit products some of which may be environmentally unfriendly	- Consumers need -Gaps in manufacturing sector -Shortfall in goods and services -Liberalization and globalization	-Consumer demands -High population growth -Rural-urban migration -Trade agreements	-High importation of raw materials -Importation of counterfeit goods -Dumping	-Dumping of sub-standard goods pirated and counterfeits -Pollution by hazardous material to environment -Health hazard	-EMCA -Trade Act -Trade Mark Act -Import, Export and supplies Act -KEBS KEPHIS KRA	-Lack of coordination by the lead agencies -Bad governance
2. Export of cut flowers horticulture and French beans	Pollution	-Foreign Exchange earnings Market for Kenyan produce	-Bilateral, regional agreements -Balance of trade -External debt	-Growing markets -High usage of chemicals in production -Increase of EPZ activities	-Pollution: water, soil, air -Health hazard Increase of EPZ activities)	- EMCA - KEPHIS -Import, Export Supplies Act, Cap 502, -KRA -EPC	-Lack of awareness on environmental matters

ANNEX 2.13. INDUSTRIAL AND SERVICES DPSIR (DRIVERS, PRESSURES, STATUS, IMPACTS AND RESPONSES)

Sector	Issues	Drivers	Pressure	State	Impact	Responses	Gaps
Coffee processing, tea, cashewnuts, madadamia and coconut	-Deforestation, -Pollution of water	Market	Export market Local market	-Coffee & tea well established -Being revived (cashew-nuts, macadamia & coconut)	-Depletion of forest cover -Coffee pollution through disposal of water -Slow biodegradal waste generated by husks	-EMCA Act -Forest Act -Agriculture Act - R&D players	-Awareness on environmental impact -Lack of reduction of tax for alternative sources of energy.
Slaughter house	-Pollution of water -Waste generation	-High food demand -Adding value	Increasing quality demand	-Sector growing rapidly -Destruction of land for construction of industry	Pollution of water through release of effluent to water ways.	-EMCA Act -Cleaner Production KEBS Industrial Property Act, 2001	
Leather and Tanning	-Pollution -Sulphides -Chlorides -Nitrogenous Oxides -Amonia -Chrome -Acids and alcohols	-High demand of leather products -Marketing demand	Stringent requirement by consumers (importers)	Most of industries have collapsed due to inappropriate technologies - Liberalization	Pollution of the environment (air and water). Noxious Smells (Odours)	-EMCA Act -Cleaner Production -Public Health Act, Cap 242 Industrial Property Act, 2001 -Water Act, 372	
Rubber and Rubber Products	Non-biodegradable waste	-Demand for tyres -Demand for protective clothing Demand for shoes	Motor Industry Domestic demand	Increasing demand for shoes and bicycle tyres Decline in motor vehicle tyre production	-Pollution of soil and water -Health hazard non-biodegradable waste	EMCA Act Public Health Act Water Act - Agriculture Act	Uncoordinated regulation by lead agencies
Printing and packaging	Pollution of air, water and soil -Non-biodegradable waste *Obsolete technology*	Market Stationery demand Demand packaging material	Market Education system	The sector is performing well Disposal of the printing by products polluting environment Non-biodegradable packaging	-Pollution of soil, water through disposal of tonners and printing ink Health hazard	-EMCA Public Health Act -Water Act Cleaner Production Centre - KIRDI	Lack of appropriate Disposable systems for ink and by products.
Cement	Land degradation	Demand for housing Trade arrangements in the regional and Comesa	-Growing pollution -High demand in the regional markets	-High rate of growth in the sector	-Pollution of air -Health hazard -Destruction of forest -Destruction of fauna and flora -Imbalance of ecosystem	EMCA Act Public Health Act Water Act Forest Act - Mining Act	
		Market driven	High value in	Increase in production	Health hazard	Public Health Act	

Tobacco	Pollution-air, health hazards	Addiction	export market Addiction	Increased consumption by youth	Addiction in consumption in youth Pollution of the air Advert on mass media an billboards	Cap 242 EMCA Industrial Property Act Cap 2001 Government Chemist KENS	
Petroleum Refining and Petroleum products	Pollution of air, water & soil	Market	-Industrial demand -Transport demand Domestic consumption	Mushrooming of petrol stations both corporate & small scale	-Pollution of air, water and solid Health hazard Disposal of waste	EMCA Act Public Health Act Water Act - Petroleum Act	Lack of appropriate policy on petroleum licensing Uncoordinated regulation by lead agencies
Film Production	Generation of non-biodegradable waste Pollution	Entertainment Education Marketing strategy	-Changing ways of life -Rural-urban migration -Perpetuation of history	-Low growth -Lack of awareness on potentiality -Heavy investment Stringent regulations	-Erosion of culture -Destruction of resources -Destabilization of vegetation and wildlife	-Tourism Act -EMCA -Local Authorities -Film Corporation of Kenya -KWS -National Museums of Kenya	Lack of clear cut policy
Pharmaceuticals	Health hazard Pollution – air, soil water	Health Market	-Export Market -Living habits -Emerging diseases -Resistance on available drugs	-The sector is growing steadily -Problem of quality control Counterfeit drugs	-Disposal of waste and packaging material -Pollution of air, water and soil	-Industrial Property Act 2002 -Public Health Act Cap 242 -EMCA -Water Act -KEBS -Cleaner Production Centre -Pharmacy and Poisons Board	Property regulation and monitoring of drugs
Chemical Industries (paints, furnishers, lacquers, soaps and detergents)	Pollution – air, water, soil	-Increase in housing, regional and COMESA markets -Increase in body-building in the motor industry -Increased awareness in hygiene -Market availability	-High market demand -Increased demand in the regional and COMESA area -High hygiene levels	-Increasing number of producer, both large and small industries -Lack of adequate safety precautions, especially in small industries -Lack of appropriate technologies for small and medium enterprises -Increased production in both large and small industries	-Pollution to soil, water and air -Hazardous to human health -Pollution to surface water (streams and rivers)	KEBS Cleaner Production Centre Industrial Property Act Health Act Cap 242 Water Act EMCA Chief's Act KIRDI	

				-Increase in variety -Lack of appropriate technology for medium and small enterprises			
Textile	Pollution- water Health hazard	Demand for clothing AGOA Export Market demand	-Growing population -Trade arrangement, both regionally and internationally	-The sector collapsed Bad governance -Decline in production of cotton due to poor payment to farmers Importation of second-hand clothes	-Pollution to the environment through effluent discharge	-Agricultural Act -Water Act -EMCA Public Health Act Cap 244 -Industrial Property Act 2001	
Transport (air, road, marine, pipeline, animal, bicycle)	- Pollution of the air, water & soil	-Communication -Goods and services -Human transportation -Animal transportation	-Market demand -Communication -Rural-urban migration -Population increase	-Kenyan road network over burdened -Congestion -Stress creation	-Pollution sound (noise), air, water -Ozone depletion -Soil -Health (respiratory related diseases, infertility in case of bicycle riding) Interference with rain pattern - Depletion of vegetation due to road construction -Soil erosion -Accidents	-EMCA Act -Traffic Act -TLB – Transport - Licensing Board -Axil Road Load Control -Kenya road Board -Kenya Railway - Board -Kenya Ports Authority -Kenya Civil Aviation Authority -Kenya Pipeline Corporation	-Lack of coordination of lead agencies in the sector
Telecommunicati on and mobile Phones	Non-biodegra- Dable waste	-Market -Advancement in technology -Communication	Communication	-Sector is growing fast Non-biodegradable products	-Pollution of soil and water Health hazard -Depletion of forest	CCK EMCA Act Public Health Act Water Act - Forest Act	Lack of proper systems for disposal of unusable and unrepairable equipment
Construction	Land degradation	-Shelter -Road -Industrial power -Dykes -Dams -Tunnels -Jetties	-Rural-urban migration -Population growth	-Increasing construction activities	Soil excavation Depletion of vegetation Pollution of air, water and noise Health hazard Change of scenery Tremor leading to building hazards	EMCA Public Works and Housing Act Road Board Local Authority Act	Lack of good governance Lack of coordination of lead agencies
Wood and Wood products (pulp	Degradation of forest	-Construction -Energy	-Demand for housing	-Deforestation -Land species	-Soil Erosion -Decrease of water	EMCA Act Forest Act	-Lack of awareness creation on environmental

and paper, carving, charcoal burning and timber)		-Sculpture and Art -Stationary	-Demand for furniture -Demand for paper -Demand for fuel Demand for export	degradation -Climate Change -Interference of catchment areas and decline in water volumes Increase of green gas -Bad governance	and water levels -Imbalance of ecosystem and biodiversity -Pollution of air and water -Health hazard	Agriculture Act -R and D (for other sources of energy) - NGOs	impact

ANNEX 2.14. MINING DPSIR (DRIVERS, PRESSURES, STATUS, IMPACTS AND RESPONSES)

Sector	Issues	Driver	Pressure	State	Impact	Response	Gaps
Harvesting of sand	-Soil Erosion -Water table -Fauna and flora	-Employment -Demand for sand	Population increase Rural-Urban migration	-Increasing poor enforcement of by laws -Lack of awareness -Weak policies	- Degradation of river channels - Pollution of water - Ecosystem Imbalance	EMCA Forest Local Authority Act or bylaw Public Health Act Water Act	- Lack of enforcement - Lack of awareness of alternative material
Harvesting of salt	Coastline	- Employment demand for salt/local and export	-New Market opportunities -Population increase	Increasing	-Pollution -Environmental degradation -Forest depletion - Ecosystem imbalance - Health Hazard	- EMCA - Forest Act - Fisheries & Marine Act	- Act of Enforcement and awareness
Quarrying of 1. Building stone 2. Gravel 3. Murram 4. Dimension stone 5. Limestone for cement manufacturing	Land degradation	Rural-Urban migration	Construction	- Increasing - Weak regulatory framework and policies	- Insecurity - Pollution due to dumping of waste, noise - Conflict between communities and miners - Health hazard - Degradation	- EMCA - Mining Act -Explosive Act - Forest Act - Public Health Act - Water Act	- Lack of Co-ordination and monitoring - Review mining Act
Artisanal mining of (a) Gold (b) Gypsum	Environmental degradation Use of mercury and Cyanide	Employment	- Unemployment	- Increasing - High use of mercury and cyanide	- Degradation - Health hazard to people, animals and fish - Pollution of water, air and soil - Soil erosion	- Mining Act - EMCA - Public Health Act - Forest Act - Water Act	- Lack of awareness of the impacts - Appropriate technology
Surface or open cast and subsurface mining	-Land degradation -Destruction of vegetation - Ecosystem Imbalance	-Export Construction industry	-Rural-urban migration -Regional markets	- Increasing - High consumption of water and energy - Littering of abandoned equipment	- Loss of cultural and archeological heritage site - Loss of biodiversity - Pollution: dust, noise, water - Land degradation - Lowering of water table - Siltation of rivers	- Mining Act - Explosives Act - EMCA - Forest Act - Water Act -Public Health Act	Poor Co-ordination By lead agencies

ANNEX 2.15. TOURISM DPSIR (DRIVERS, PRESSURES, STATUS, IMPACTS AND RESPONSES)

Issue	Driver	Pressure	Impacts	Responses
Marketing	International committement Foreign exchange	Need to promote Kenya as a global tourist destination	Low foreign visitation	Enhance financial and human capacity to develop appropriate strategy
Environmental degradation	Tourism products Lack of information	Preference for specific destinations and wildlife species	Loss of wild species Changes in animal behaviour Soil erosion Poor waste disposal Decline in tourist numbers	Diversification of tourist destination and products Improvement of infrastructure Creation of awareness
Safety	Travel advisories	Insecurity (Terrorism)	Decline in tourist numbers Reduced revenue Loss of jobs	Enhance security
Over reliance on foreign visitors	Attitude	Reduced visitation by foreigners	Loss of revenue Loss of enjoyment by locals	Aggressive marketing for domestic tourism Create awareness of locals Review tariffs for locals
Loss of biodiversity	Tourism benefit sharing Competition for resources	Need for farming and settlement land	Human -wildlife conflict	Formulate workable land use policies