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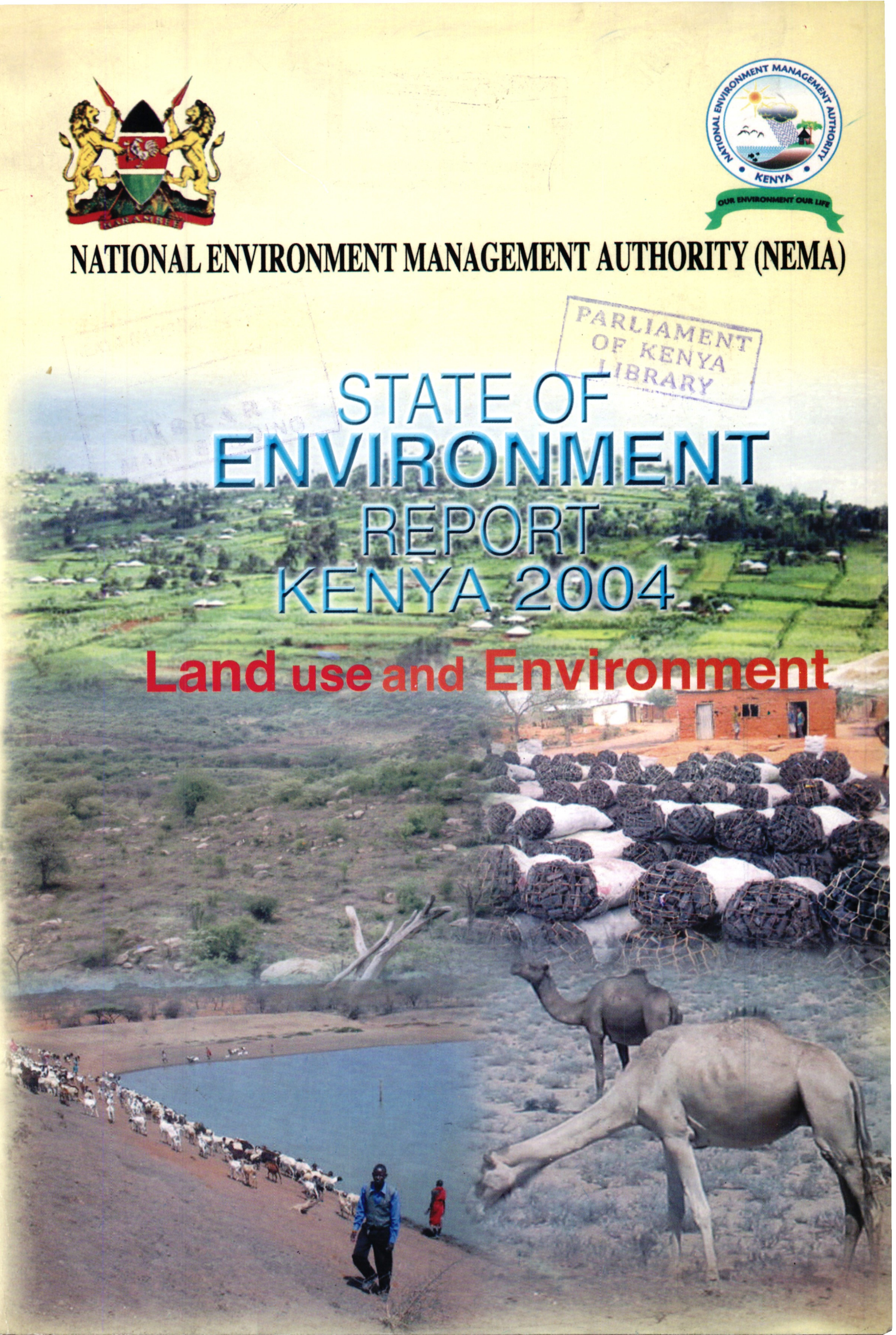



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TABLES OF CONTENTS

Foreword		xiii
Preface		xiv
Acknowledgement		xv
Executive Summary		xvii
CHAPTER ONE: INTRODUCTION		**1**
1.1	Background	1
1.1.1	Global Perspective	1
1.1.2	National Level	1
1.2	The 2004 SoE Report Preparatory Process	2
1.2.1	The Theme and Relevance	2
1.2.2	Methodology	3
1.2.3	Scope of the 2004 SoE Report	4
1.3	Country Profile	5
1.3.1	Zonation of Kenya into High Potential and ASALs	5
1.3.2	Carrying Capacity	5
1.3.3	Population	9
1.3.4	Poverty and Environment	9
1.4	Land Cover Classification	10
CHAPTER TWO: LAND POLICY AND ENVIRONMENT		**13**
2.1	Introduction	13
2.2	Historical Perspective	13
2.2.1	The Colonial Period	13
2.2.2	The Post Colonial Period	13
2.3	Land Tenure and Administration	14
2.3.1	Pre-Colonial Era	14
2.3.2	Colonial Era	14
2.3.3	Post-Colonial Era	16
2.3.4	Urbanization in Kenya	17
2.4	Post-Independence Land Policy, Legislation and Administration	18
2.4.1	Land Tenure	18
2.4.2	Customary Land Tenure	19
2.4.3	Public Land Tenure	19
2.4.4	The Current Situation	19
2.4.5	Impacts of Land Tenure Systems on Sustainability	20
2.4.6	Njonjo Land Commission	21
2.4.7	Ndungu Land Commission of Inquiry	22
2.4.8	Formulation of Land Policy	23
2.5	Objectives of the National Land Policy	23
2.5.1	Land Policy Principles	24
2.5.2	Outputs of National Land Policy	25
2.5.3	Guiding Values for Policy Development Process	25
2.6	Land Management Strategies and Practices	26
2.6.1	The National Perspective	26
2.6.2	Land use Planning	26

2.6.3	Environmental Management Implications	27
2.6.4	Land Information Management Systems	27
2.7	Environmental Assessment	28
2.7.1	Strategic Environmental Assessment	28
2.7.2	Cumulative Environmental Assessment (CEA)	29
2.7.3	Radiation in Environment	30
2.8	International Agreements Relating to Land In Kenya	38
2.8.1	Multilateral Environmental Agreements (MEAs)	38
2.8.2	Regional Environmental Agreements (REA)	45
2.9	Outlook	48
CHAPTER THREE: LAND-USE AND AGRICULTURE		**49**
3.1	Introduction	49
3.2	Agricultural Practices	49
3.2.1	Crop Production Practices	50
3.2.2	Impacts of Agricultural Practices	54
3.2.3	Efforts Towards Sustainable Agriculture	55
3.3	Livestock Production	56
3.3.1	Contribution to the Economy	56
3.3.2	Demand and Supply Situation	57
3.3.3	Emerging/Non-Conventional Livestock	58
3.3.4	Bee Keeping	58
3.3.5	Fodder Crops	59
3.3.6	Conflict Management and Cattle Rustling	59
3.4	Fisheries Production	59
3.4.1	Inland Fisheries	60
3.4.2	Coastal and Marine Fishery	61
3.4.3	Aquaculture	61
3.4.4	Mariculture	62
3.4.5	Fish Products, Processing, Marketing and Infrastructure	62
3.4.6	Constraints in Fish Production	63
3.4.7	Efforts Towards Sustainable Utilization of Fisheries	63
3.5	Alien and Invasive Weeds	64
3.5.1	Prosopis	64
3.5.2	Water Hyacint	64
3.5.3	Striga Weed (witch wee)	66
3.5.4.	Lantana Camara	66
3.5.5	Environmental Impacts of Invasive Alien Species	66
3.6.	Agrochemicals	67
3.6.1	Introduction	67
3.6.2	Types and Classification of Agro-chemicals	67
3.6.3	Agrochemicals Standards	68
3.6.4	Trends in Agrochemical Use	69
3.6.5	Effect of Agrochemicals use and their Disposal	70
3.6.6	Obsolete Agrochemicals and their Disposal	71
3.6.7	Efforts Towards Sustainable Use of Agrochemicals	72
3.7	Arid and Semi-arid Lands (ASALs)	72
3.7.1	Production and Land use Systems	72
3.7.2	Livelihood Systems	74

3.7.3	Encroachment of ASALs	75
3.7.4	Carrying Capacity and Stocking Rates	77
3.7.5	Water Resource Management and Development	77
3.7.6	Land Tenure Systems in the ASALs	77
3.7.7	Impacts of Refugees in ASALs	78
3.8	Market Access	78
3.9	Outlook	80

CHAPTER FOUR: LAND USE AND BIOLOGICAL DIVERSITY **83**

4.1	Introduction	83
4.2	Forest Biodiversity	83
4.2.1	Status	83
4.2.2	Forest Types	84
4.2.3	Forest Threats and Challenges	84
4.2.4	Consequences of Deforestation	86
4.2.5	Responses	87
4.3	Wildlife Biodiversity	88
4.3.1	Population Distribution and Trends	88
4.3.2	Challenges and Threats	90
4.3.3	Responses to Challenges and Threats	95
4.4	Agricultural Biodiversity	95
4.4.1	Crop Genetic Resources	96
4.4.2	Animal Genetic Resources	97
4.4.3	Threats and Challenges	98
4.4.4	Responses	99
4.5	Dryland Biodiversity	99
4.6	Aquatic Biodiversity	102
4.6.1	Wetlands	102
4.6.2	Threats to Aquatic Ecosystem	105
4.6.3	Response Measures	107
4.7	Technological Development and Technology Transfer	108
4.8	Access and Benefit Sharing	110
4.9	Indigenous Knowledge and Biodiversity Management	113
4.10	Below Ground Biodiversity	115
4.11	Outlook	116

CHAPTER FIVE: LAND USE AND WATER RESOURCES **119**

5.1	Introduction	119
5.2	Water Resources	119
5.2.1	Water Catchments and Drainage Basins	119
5.2.2	Groundwater	124
5.3	Shared Water Resources	126
5.3.1	Shared Aquatic Ecosystems	126
5.4.	Water Availability and Utilization	130
5.4.1	Water Availability	130
5.4.2	Water Demand and Supply Status	130
5.4.3	Types of Water Uses	131
5.4.4	Water Abstraction	132

5.4.5	Catchment Degradation	133
5.4.6	Efforts Towards Sustainable Utilization of Water	133
5.5	Water Quality	133
5.5.1	Sources of Water Pollution	133
5.6	Water Harvesting	135
5.6.1	Efforts Towards Sustainable Harvesting and Utilization of Water	137
5.7	Drought and Floods	138
5.7.1	Drought	138
5.7.2	Floods	140
5.8.	Outlook	141

CHAPTER SIX: LAND-USE AND ENERGY RESOURCES **143**

6.1	Introduction	143
6.2	Types and Sources of Energy	143
6.3	Status of the Energy Resources	144
6.3.1	Biomass Energy	145
6.3.2	Petroleum	147
6.3.3.	Electricity	147
6.3.4	Renewable Energy Sources	147
6.4.	Impacts of Energy Resources on Land Use	148
6.4.1	Impacts of Energy Resources on Land Use	150
6.4.2	Impacts of Biomass Energy on Land Use	151
6.4.3	Impacts of Petroleum Consumption on Land Use	151
6.4.4	Implications of Electricity Demand and Supply on Land-use	152
6.4.5	Impacts of Other Renewable Energy Sources on Land-use	153
6.5	Energy Consumption Patterns, Demand and Supply	154
6.6	Unexploited and Potential Energy Sources	156
6.7	Threats to Energy Resources	157
6.8	Energy-Based Pollution and Waste	157
6.9	Environmental Impact Assessment and Audit	159
6.10.	International Agreements	160
6.11	Outlook	161

CHAPTER SEVEN: INDUSTRY, MINING, TRADE AND SERVICES **163**

7.1	Introduction	163
7.2	Industry and Environment	163
7.2.1	Agricultural Production/Agro-Based Industries	164
7.2.2	Manufacturing Sector	164
7.2.3	Industrial Potential	166
7.2.4	Industrial Production Technologies	166
7.2.5	Status of Industries that Have Adopted Cleaner Production Technologies	168
7.2.6	Impacts of Industry on Environment	168
7.2.7	Environmental Standards and Regulations	168
7.2.8	Institutional Arrangements for Enforcement	169
7.3	Mining, Quarrying and Sand Harvesting	169
7.3.1	Introduction	169
7.3.2	Status of Mining in Kenya	172
7.3.3	Constraints/Challenges	175
7.3.4	Rehabilitation Efforts	179

7.4.	Trade	180
7.4.1.	Types of Traded Agricultural-based Products	181
7.4.2.	Impacts of Agricultural Production on Land Use	183
7.4.3	Fishery	183
7.4.4	Agribusiness	183
7.5.	Services	183
7.5.1	Telecommunication	183
7.5.2	Water, Sewerage and Health Services	185
7.5.3	Road Transport	185
7.5.4	Air Transport	185
7.5.5	Railways	186
7.5.6	Waterways And Ports	186
7.5.7	The Financial Sector and Business Support Services	186
7.5.8	Tourism Services	187
7.5.9	Hotels	188
7.5.10	Laundry Services	188
7.4.11	Hawking	188
7.6	Dumping, Counterfeits and Substandard Goods	189
7.6.1	Counterfeit and Substandard Goods	189
7.6.2	Impacts of Counterfeit and Substandard Goods on the Environment	189
7.6.3.	Trade and Genetically Modified Organisms	190
7.6.4	Constraints to Trade	191
7.6.5	Impact of Trade on Land Use	191
7.6.6	Measures and Strategies for Improving Trade	192
7.6.8	International Agreements	193
7.7	Outlook	193

CHAPTER EIGHT: POPULATION DYNAMICS AND HUMAN SETTLEMENTS ON LAND USE **195**

8.1	Introduction	195
8.2	Population Dynamics	195
8.2.1	Population Size and Growth Rates	195
8.2.2	Age-Sex Composition	196
8.2.3	Population Distribution	198
8.2.4	Fertility	199
8.2.5	Mortality	199
8.2.6	Migration	199
8.2.7	Impacts of Population Dynamics on Land Use	200
8.2.8	The Impact of Refugees on the Environment	201
8.2.9	Responses to the Impact of Population on the Environment	202
8.3	Human Settlements and Infrastructure	203
8.3.1	Characteristics of Human Settlements	203
8.3.2	Settlement Planning	204
8.3.3	Human Settlement Infrastructure	205
8.3.4	Sewerage Systems	206
8.4	Housing	206
8.5	Health and Environment	209
8.5.1	Pollution and Waste Management	209
8.5.2	Radiation	209
8.6	Poverty and the Environment	210

8.6.1	Land Degradation	210
8.6.2	Poverty and Water Resources	211
8.6.3	Deforestation and Fuel Wood Consumption	211
8.6.4	Consumption and Production Patterns	212
8.6.5	Gender and Labour	214
8.6.7	Cultural Practices	214
8.6.8	Poverty Reduction Strategies/Responses	215
8.6.9	International Agreements	215
8.7	Outlook	216

CHAPTER NINE: CONCLUSION **217**

REFERENCES **219**

ACRONYMS **223**

ANNEXES **227**

List of Tables

Table 1.1	MEAs and regional agreements relevant to land	5
Table 1.2	Carrying capacities of ecological zones	9
Table 2.1	Comparison and effects of land policies in colonial and post-colonial Kenya	18
Table 2.2	Comparison of land tenure in Kenya (1980 and 1995)	20
Table 2.3	Institutions using land information management systems (LIMS) and their capacities	28
Table 2.4	Sampling sites and levels of selected heavy metals in Kenyan soils (mg/kg)	31
Table 2.5	Dutch classification of contaminated soils	32
Table 2.6	Approximate clay percentage values for the Kenyan soils (mg/kg)	32
Table 2.7	Activities with cumulative environmental effects	37
Table.3.1	Quantity of main food crops grown in the country in 2003	51
Table 3.2	Quantity of main cash crops grown in the country in 2003	52
Table 3.3	Livestock population estimates	56
Table 3.4	Estimated value of livestock products	57
Table 3.5	Production and demand levels for livestock products	58
Table 3.6	Fish landing by weight, value, number of fishermen and vessels by areas	60
Table 3.7	Lake Turkana fish production by species, weight and value	61
Table 3.8	Lake Naivasha fish production by species, weight and value	61
Table 3.9	Survey of fishing facilities around Lake Victoria (2000)	63
Table 3.10	Examples of alien invasive species in Kenya	65
Table 3.11	Some of the indications for different chemical groups	68
Table 3.12	Importation of different categories of pesticides from 1994 to 2004	69
Table 3.13	Total annual fertilizer consumption by crop types (metric tonnes)	70
Table 3.14	Quantities of obsolete pesticides (POPs)	71
Table 3.15	ASAL districts classified by extent of aridity	73
Table 3.16	ASAL characteristics - agricultural production/ production constraints	73
Table 4.1	Types and sizes of various plantations	84
Table 4.2	Extent of woody vegetation cover	84
Table 4.3	Changes in wildlife and livestock populations, 1970s-1990s	89
Table 4.4	Status of conservation areas in Kenya	89
Table 4.5	Cases of human/wildlife conflicts in selected districts	92
Table 4.6	Wetlands in selected districts	102
Table 4.7	Species introduced into water bodies	104
Table 4.8	Bio-prospecting activities in various districts in Kenya	113
Table 5.1	Major catchments and river basins in Kenya	123
Table 5.2	Characteristics of major lakes in Kenya	123
Table 5.3	Characteristic of the major rivers in Kenya	124
Table 5.4	Ground Water Resources	125
Table 5.5	Ground water characteristics within the five key basins	125
Table 5.6	Nutrient pollution loads in Lake Victoria	127
Table 5.7	Water demand estimates	131
Table 5.8	Reported incidences of diarrheal disease	135
Table 5.9	Cholera trends, 1998-2004	135
Table 5.10	Water borne disease outbreak in 2004	135
Table 5.11	Provincial water resource issues	137
Table 5.12	Costs implications related to drought	139
Table 6.1	Energy Supply and Demand Status	146
Table 6.2	Comparison of energy consumption by type in selected districts	150
Table 6.3	Sources and end-uses of household energy in Kenya in 2000	154
Table 6.4	Biomass balances situations by provinces-tonnes/year, 2000	156
Table 6.5	Unexploited potential of various energy resources	157
Table 7.1	Manufacturing sector output and value addition	165
Table 7.2	Distribution of mining and prospecting operations	170
Table 7.3	Number of quarries and materials extracted by district	174
Table 7.4	Abandoned Quarries	177
Table 7.5	Major agricultural exports of Kenya	180
Table 7.6	Total international trade 1998-2002 (Kshs. Million)	189
Table 8.1	Percent of households by main type of cooking fuel by province in 1989 and 1999	201
Table 8.2	The population size and density by province	203

Table 8.3	Growth of urban centres by actual population size, 1962 – 1999	203
Table 8.4	Growth of some selected urban Centres, 1969-1999	204
Table 8.5	Informal settlements in Nairobi City	206
Table 8.6	Per cent of households by main type of wall materials for the main dwelling units	207
Table 8.7	Per cent of households by main types of floor materials for the main dwelling unit	207
Table 8.8	Housing requirements for urban centres	207
Table 8.9	Housing units needed to relieve overcrowding by income group in major urban centres	208
Table 8.10	Number of house units planned for upgrading by income group	208
Table 8.11	Institutional framework for implementing housing programmes	209
Table 8.12	Mean land holding sizes (acres)	211
Table 8.13	Projected demand for fuel wood and construction wood	212
Table 8.14	Wood biomass inventory and current trends	212
Table 8.15	Land utilization for agricultural production	213
Table 8.16	Households receiving advice from extension services	213
Table 8.17	Per cent of working children by age, sex and place of residence in 1999	214

List of Figures

Figure 1.1	Provincesof Kenya	6
Figure 1.2	Zonation of Kenya into high potential areas and ASALs	7
Figure 1.3	Ecological zones of Kenya	8
Figure 1.4	Land cover classes of Kenya	11
Figure 3.1	Pest control product imported in tonnes, 1994 to 2004	69
Figure 3.2	Extent and distribution of ASALs in Kenya	74
Figure 3.3.	Changes in spatial population densities between 1960s and 1990s	76
Figure 4.1	National parks and reserves in Kenya	91
Figure 4.2	Trend of five animal species in Machakos District 1991-2000	92
Figure 4.3	Major wetlands in Kenya	103
Figure 5.1	Major drainage basins of Kenya	121
Figure 6.1	National energy supply by source	144
Figure 6.2	Current electric power supply by source	147
Figure 6.3	Potential extractable wind power	149
Figure 6.4	Simplified geological map of western and central Kenya showing locations of oil fields and prospects	158
Figure 6.5	EIA Study reports by regions, 2004	160
Figure 6.6	Project reports received by NEMA between 2002 - 2005	160
Figure 7.1	Status of EIA and Audit reports received by sector	169
Figure 7.2	Quantity of some industrial mineral production, 2001 - 2003	171
Figure 7.3	Value of industrial minerals produced, 2001 – 2003	171
Figure 7.4	Quantity of gold and gemstones produced, 2001 – 2003	172
Figure 7.5	Value of gold and gemstones produced, 2001 – 2003	172
Figure 7.6	Geological map of Kenya	173
Figure 7.7	Counterfeit in pharmaceutical industry	190
Figure 8.1	Total population of Kenya for census years 1969, 1979,1989 and1999 and projections for years 2001, 2005 and 2008	196
Figure 8.2	Changes in national human population demography, 1948 – 1999	196
Figure 8.3	Comparison of population density by age group	197
Figure 8.4	Population density by province, 1999	197
Figure 8.5	Trends in spatial population distribution and density between 1960 and 1990	198
Figure 8.6	Percentage of income used to procure basic needs	212

List of Plates

Plate 2.1	Dense population in Gucha District	21
Plate 3.1	Agricultural expansion and settlements has led to clearing of indigenous forests (inset)	49
Plate 3.2	Agro-forestry is widely practiced in agricultural areas	50
Plate 3.3	Land degradation in ASALs	72
Plate 3.4	Clearing of dry land forests for cultivation in Baringo district Top: Settlement in a wooded area Middle: Cultivation in newly cleared woodland Above: Woodland opened up for pasture	75
Plate 3.5	Overstocking leads to land degradation in ASALs	77

Plate 4.1	Lion at the Masai Mara National Reserve which has occasionally killed livestock	95
Plate 4.2	Loss of biodiversity through deforestation	100
Plate 4.3	A goat feeding on prosopis species in Baringo district	102
Plate 4.4	Agricultural encroachment into riverine forests	106
Plate 5.1	Water pollution in urban areas	134
Plate 6.1a	Retailing of charcoal in urban centres	145
Plate 6.1b	Wholesale of charcoal is common along major highways	145
Plate 6.2	The Olkaria I geothermal power plant	152
Plate 6.3	The Panoramic view of Olkaria II geothermal power plant	153
Plate 7.1	Machinery fallen into one of the concealed old shafts	176
Plate 7.2	An open cast mine filled with water posing risk to people and animals	176
Plate 7.3	Land degradation on slopes caused by gold mining	176
Plate 7.4	Panning taking place on flowing streams causing contamination of river water	177
Plate 7.5	Woman working in a mining site as an indication of increased poverty levels	180
Plate 7.6	Mining of limestone is an important income generating activity in Wajir District and other parts of North Eastern Province	181
Plate 7.7	Mobile phone transmission station	184

List of Boxes

Box 2.1	Cases investigated by the PCC	38
Box 4.1	The five "water towers" of the country	85
Box 4.2	Cases relating to forest destruction reported to PCC	88
Box 4.3	Cases of human/wildlife conflicts reported to PCC	94
Box 4.4	Prosopis tree species in the ASALs	101
Box 4.5	Investigations on prosopis species by PCC	101
Box 4.6	Threats to riverine forests	106
Box 4.7	Tree biotechnology project	109
Box 5.1	Ramsar sites in Nakuru District	125
Box 5.2	Impacts of flooding in Nyando District	126
Box 5.3	Nakuru flower farms	132
Box 5.4	Cases relating to water pollution investigated by PCC	134
Box 7.1	Mobile phones base stations investigated by PCC	184
Box 8.1	Cases relating to informal urban settlements	205



FOREWORD

The Kenya Government has formulated policies, legislations, plans and programmes to foster quality environment values and promote sustainable development. Some of the instruments for guiding the environment and development agenda are the ***Environmental Management and Coordination Act*** No 8 of 1999 and the ***Economic Recovery Strategy on Employment and Wealth Creation, 2003 – 2007***. Additionally, ongoing review of sectoral statutes is intended to harmonize environmental and development issues as well as make them sensitive to physical, environmental and socio-economic concerns. Harmonization of public policies will enable us to reduce potential conflicts, while increasing efficiency in environmental management.

Kenya is a major player in international environment initiatives. In this connection, we have been honoured to host two major United Nations agencies – the United Nations Environmental Programme (UNEP) NA UB-Habitat. Kenya is also party to a number of Multilateral Environment Agreements, including the implementation of the Millennium Development Goals (MDGs). The Government is committed to achieving the targets under the MDGs by the year 2015, most of which have a bearing on the environment. Our ability to achieve these targets will 'eradicate extreme poverty and hunger' and 'ensure environmental sustainability' as stipulated in MDGs 1 and 7.

The initiatives should increase awareness on the value of the environment and its inherent contribution to development processes. It is important to note that the 2004 Nobel Peace Prize was awarded to our own, Prof. Wangari Maathai, in recognition of her contribution to enhanced environmental protection. It was also a recognition that sustainable environmental management contributes to resolution of conflicts and peaceful co-existence of people everywhere.

The State of Environment (SoE) Report is an important tool in facilitating informed decision-making and in providing benchmarks upon which progress in environmental management and sustainable development are measured. The theme for the 2005 SoE Report – ***Land Use and Environment***, addresses an important national priority concern. Timely interventions on some of the identified issues should stop and even reverse negative environmental impacts.

I commend the National Environment Management Authority (NEMA), for spearheading the preparation of this report in accordance with statutory requirements.

I am confident that collaboration between the Government and all other stakeholders in the implementation of identified issues will enhance public health and safety and enable every in this great country to enjoy the benefits of a clean and healthy environment.

Hon. Stephen Kalonzo Musyoka, EGH, MP
Minister for Environment and Natural Resources

PREFACE



The National Environment Management Authority (NEMA) presents the second national State of Environment Report, 2004 in accordance with the provisions of the Environmental Management and Coordination Act (EMCA) No. 8 of 1999.

The theme for the 2004 State of Environment report - *Land-use and Environment* ñ is timely and is a deliberate effort to address specific sectoral environmental challenges facing the country, with a view to identifying potential practical solutions.

The Authority appreciates the importance of land as a resource on which social and economic activities are based for the well being of mankind and Mother Nature. However, unsustainable land use practices continue to adversely impact on land productivity and the quality of the environment. The report therefore provides an analysis of all sectors of the economy relating to land use and the environment. It highlights the key concerns, identifies potential interactions and possible actors.

The Authority will utilize the information provided in this report to address requirements of the Millennium Development Goals (MDGs) to enhance the integration of environmental concerns into all development policies, plans and programmes. Further the 2004 SoE report will help the Authority in the effective implementation of activities as presented in the just completed NEMA Strategic Plan 2005-2010.

Various parts of the country have experienced changes in land use due to immigrations of people from high potential to marginal lands. As a result, some areas have experienced pressures arising from competing and often-conflicting land uses leading to land degradation, deforestation, destruction of water catchments, human/wildlife conflicts, environmental disasters and resource use conflicts.

It is my hope that this report will guide the relevant stakeholders in implementing future activities relating to land use and environment. Through this report, NEMA has endeavoured to show how environmental concerns could be integrated into development plans and programmes. The report should also provide inputs for inclusion in national and district development plans and strategies.

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

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I acknowledge with great appreciation the completion of the second national State of Environment (SoE) Report for Kenya, 2004. The report which focused on a single theme namely *Land use and Environment*, has contributed a new approach to issues of the environment as they relate to land. The information available provides new options in the formulation of land related policies ensuring the integration of environmental concerns into development plans and programmes.

I take this early opportunity to thank all the authors involved in the drafting of the 2004 SoE report. This is the product of long hours of hard work over several months of the report preparation. Special appreciation goes to the Experts from the various lead agencies that constituted the different drafting task forces for their invaluable efforts in collecting and collating data and information from within and outside their respective institutions.

I applaud this obvious show of dedication and commitment from our partners. This single activity has enabled National Environment Management Authority (NEMA) to forge stronger linkages and collaboration with other stakeholders in the environmental management.

Further, I thank the NEMA staff who played a key role in convening the different taskforces and coordinating the gradual development of the report. Their consistency and keen follow-up on the process enabled the completion of the report in time. My gratitude is extended to the NEMA Board of Management for its technical and policy guidance during the entire SoE preparatory process.

Finally, I wish to thank the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP) for their technical and financial support to this process.

I wish to reaffirm NEMA's commitment to continue informing Kenyans every year on the state of our environment.

Ratemo W. Michieka, PhD, EBS
DIRECTOR GENERAL

EXECUTIVE SUMMARY

INTRODUCTION

This is the second national State of Environment Report (SoE) for Kenya. The report has been prepared in accordance with the provisions of the Environmental Management and Coordination Act (EMCA) of 1999. The SoE Reporting remains the most effective tool of presenting environmental information to support decision-making processes affecting the environment. Further, the SoE report provides baseline information necessary for monitoring progress in the implementation of national policies, Millennium Development Goals (MDGs) and sustainable development in general. This SoE report whose theme - Land use and Environment - provides valuable information on drivers, pressures, status, concerns and responses is divided into nine chapters namely: Introduction, Land Policy; Agriculture; Biological Diversity; Water Resources; Energy Resources; Trade, Industry, Mining and Services; Population and Human Settlements; and conclusion. The pressures, concerns and responses relating to each chapter are analyses as they affect land use and the environment.

The theme was chosen because land is a fundamental resource in this country on which all the other socio economic activities are based. Land is the mother nature of environment.

Land Policy and Environment

Chapter Two highlights issues related to land policy and the environment. Land as a resource supports all life forms and most human activities. Most people view land as the sole source of livelihood. The social, cultural, economic and political underpinnings are therefore related to land resource access and use.

The chapter analyses the historical development of land policy in the country during pre-colonial, colonial and post-colonial periods and impacts on the environment. It also looks at land use planning as an integral part of rural and urban development programmes. The use of top down approach has been cited as the major bottleneck in land use planning. The chapter also highlights the various land use types, tenure systems and stresses on the need to integrate environmental concerns into land use planning.

The strategic environmental assessment (SEA) as a tool for assessing the impact of policies on the environment is also highlighted and it is recommended that all policies to be subjected should SEA as provided for by Section 42 of the Environment Impact Assessment and Audit Regulations of 2003. The cumulative environmental assessment (CEA) is also analysed recommended for use in assessing the various activities that contribute to cumulative impact on the environment.

The Multilateral Environmental Agreements (MEAs) are analysed for these impacts on land and environment, focusing on how they enhance the r the management of the environment and natural resources. The chapter also presents the status of MEAs in terms of signing, ratification and identification of the focal point institutions locally. It reports on progress in

their implementation through various activities to meet the country's obligations and maximize on potential benefits.

Land-use and Agriculture

Agriculture is the backbone of Kenya's economy, generating over 60% of foreign exchange earnings and supporting over 80% of the country's population. Land suitable for arable agriculture is about 12% of the total land area of the country. The remaining 88% is arid and semi-arid lands (ASALs) which is generally a fragile ecosystems not suitable for crop production. The country continues to experience food deficits particularly the major staple foods such as cereals used by most communities. Other sectors of agriculture such as horticulture and floriculture are steadily becoming dominant contributors to the economy.

Organic farming is gaining ground in the country as more consumers appreciate the benefits of such foods. In recognition of the importance of organic farming, the Government has established within the Ministry of Agriculture a section on herbs, spices, medicinal and aromatic plant species (MAPS) to propagate organic farming.

To intensify agricultural production, the use of agrochemicals has increased over the years. In 2004, the country imported about 6,200 metric tonnes of agrochemicals that included insecticides, herbicides and fungicides. However, inadequate agricultural extension services has resulted in poor handling and misuse of agrochemicals in many areas, often causing death of livestock and serious injury to human health and safety. ASALs support 50% of the total livestock production in the country, which is a major source of livelihood to pastoral communities. The livestock production is depended on proper management of rangelands, especially movement of pastoral communities and their livestock in search of water and forage. These movements often take in these communities into other districts or across national borders. However, major challenges to livestock production is land degradation, resource use conflicts and insecurity posed by cattle rustling.

In the fisheries sector, fresh water fish dominates the industry with Lake Victoria contributing almost 50% of the total weight of fish landings. There is great potential in development of marine fisheries which is greatly hampered by inadequate fishing gear, particularly for the lucrative deep sea fishing. There is also need to intensify surveillance of fishery activities within the Exclusive Economic Zone (EEZ).

The activities associated with crop, livestock and fisheries production have varied impacts on human and environmental health and safety. The factors with potential to significantly affect human and environmental health and safety include, inappropriate agricultural practices, agrochemicals, biotechnological developments and the inability to control introduced alien species.

In improving crop production, it is necessary to strengthen environmentally friendly agricultural practices such as organic farming, environmentally safe irrigation and horticultural practices and safe use of agrochemicals. There is also need to incorporate assessed risks in the application of biotechnologies in the development of crop varieties and livestock breeds for high yields, resistance to pests and diseases as well as drought tolerance.

In recognition of the need to revitalize the agricultural sector, the Government launched the Strategy for Revitalizing Agriculture, 2004-2014. The main objective of this strategy is to transform Kenya's agriculture into a profitable, commercially oriented activity that will provide food security, enhance livelihoods and quality employment.

Land-use and Biological Diversity

Kenya is endowed with rich biodiversity which has been utilized in various forms for development of its economy and in sustaining socio-cultural systems. Population growth, poverty, change of land use and land degradation has increased the demand for biodiversity products. The situation has necessitated the need for urgent responses to address emerging issues.

The forest cover has declined over several decades due to various factors such as forest excisions, encroachment for settlement and agricultural activities, illegal logging and destruction of catchment areas. This has resulted is reduced forest cover to a meager 1.7% of the total land area, far below the minimum 10% cover recommended internationally for a country. To improve forest biodiversity, the Forest Bill 2005 addresses principles of sustainable forest management using participatory approaches to ensure benefits sharing, privatization of forestry enterprises, employment creation, enhanced income generation and expanded forest cover.

Wildlife biodiversity is an important resource in the country for the tourism industry, research and education. About 8% of the country's total area is devoted to wildlife conservation, in parks, reserves and sanctuaries, with wildlife also dispersing into surrounding areas seasonally. Over the last three decades, there has been a general decline in wildlife numbers with some reaching endangered levels such the rhino and elephant. This has been caused by human encroachment into wildlife areas prompting human/wildlife conflicts and competition for forage and water between wildlife and livestock.

A number of policies and strategies have been put in place to address the above challenges, including the Forest Bill 2005, Wildlife Act, EMCA (1999) and Economic Recovery Strategy for Employment and Wealth Creation (2003-2007), with the necessary institutional frameworks. Subsidiary legislation under EMCA, will enhance protection, access and benefits sharing accruing from biological diversity. The country has also ratified several international multilateral agreements (MEAs) relating to biodiversity. Efforts to domesticate MEAs are underway in order to strengthen the implementation of relevant provisions through national laws.

Land-use and Water Resources

Provision of water is a critical component in sustainable development. However, degradation of watershed areas is on the increase resulting in diminished water resource availability.

The country has five major drainage basins, namely Lake Victoria, Rift Valley, Athi/Sabaki River as well as Tana River and Ewaso Ngiro North River. However, only Lake Victoria and Tana River basins have surplus water resources. The other three basins have water deficits and often rely on inter-basin water transfers to meet their basic water demands.

The total annual surface and ground water potential is 19,590 and 619Mm^3 respectively. However, the annual demand has grown from 2,073 Mm^3 in 1969 to 3,874 Mm^3 in 2000 and is expected to reach 5,817Mm^3 in 2010. Only about 12% of the country has reliable rainfall while 88% (ASAL) experiences erratic rainfall and evapotranspiration rates higher than the amount of rainfall received. The supply of safe drinking water is very low, with only 40% national coverage. About 90% of the urban population has access to safe water compared to 35% in the rural areas.

The increasing destruction of water catchment areas occasioned by encroachment through human settlements and poor land use practices has subsequently led to extensive soil erosion in both high potential areas and ASALs. As a result of landslides, floods, siltation, droughts and desertification process have been experienced in some areas of the country.

Water quality is closely linked to type of use (industries, agriculture, recreational and domestic) and land use practices. The resulting impacts include increased pollution and reduced water quality, which may lead to disease outbreak such as cholera, typhoid, other infections and exposure to hazardous chemicals.

The Government has put in place programmes uniquely designed as risk management instruments for early warning, contingency planning, mitigation and quick response mechanismsgto water related disasters. The Drought Recovery Programme has enabled initiation of various projects, namely Drought Management Project (DMP), Drought Preparedness, Intervention and Recovery Project (DPIRP), Emergency Drought Recovery Project (EDRB) and Arid Lands Resource Management.

Land-use and Energy Resources

Energy is a driver to economic development whose availability is crucial to the achievement of development objectives. Six major categories of energy sources have been identified, namely biomass, fossil fuels, electricity, solar, wind and others, all of which are at different levels of exploitation. The main sources of energy are biomass (68%), petroleum (22%) and electricity (9%). Most energy resources, though locally available, require external technologies in terms of hardware for their production and conversion, imposing heavy demands on the meagre foreign exchange.

Other renewable energy sources include solar, wind and small hydropower plants, power alcohol, biogas and municipal waste energy. However, only solar, wind and small hydropower plants are currently being harnessed.

Energy requirements impact profoundly on other competing land uses such as agriculture, forestry, human settlements and infrastructure. Hydropower generation exerts considerable pressure on water resources for other uses, displaces human population as well as taking up land from other uses. Although geothermal energy generation is considered comparatively environmentally safe, a comprehensive analysis of potential impacts should be undertaken to mitigate risks.

The government has instituted measures, which are meant to forestall or minimize the environmental effects of energy production and use. The National Development Plans have consistently highlighted the need to ensure a balance between energy development and environmental protection. The current energy policy (Sessional Paper No. 4 of 2004)

emphasizes the need for integrated energy planning to ensure that all other significant sectoral concerns are addressed, including protecting and conserving the environment.

Other issues that need to be addressed in the energy sector include building a critical institutional and human capacity to effectively address current and future challenges to achieve greater efficiency in the energy sector; providing incentives to increase efficiency in power generation; and conduct environmental audits consistent with the energy policy and EMCA.

Trade, Industry, Mining And Services

Trade, industry, mining and services contribute tremendously to the Gross Domestic Product (GDP) as it employs people in both the formal and informal sector, with the manufacturing sector accounting for 13% of GDP since 1978. However, the sector activities impact negatively on land and the environment.

The volume of trade and industrial production have benefited significantly from recent regional and international trade agreements such the African Growth and Opportunity Act (AGOA), Common Market for Eastern and Southern Africa (COMESA) and the East African Community (EAC). The level of industrial development and population growth has increased pressure on utilization of natural resources, water resources, air quality, disaster management, waste management and transport.

Liberalization of trade has resulted in the influx of sub-standard imported products most of which are used and disposed off within shorter periods as compared to the genuine products of this has had a significant impact on the environment through increased waste.

Kenya's industrial establishments are concentrated around Nairobi, Mombasa, Kisumu, Nakuru, Eldoret, Nyeri, Thika and Athi-River with the agro-based industries predominantly scattered in high potential agricultural areas. Industrial activities include food processing, leather tanning, cement and building materials, textile, paints, furnishes and lacquers, wood and wood products, soaps and detergents, floriculture, tobacco and beverages, coffee processing, tea processing, pulp and paper, petroleum refining and related products, plastics and rubber, printing and packaging, metallurgical (iron, and steel, metal fabrication), pharmaceutical, mining and quarrying, and chemical industries.

Efforts to promote industrial development are on-going as articulated in the industrial policy. The policy addresses a variety of inter-related economic, social and environmental objectives, especially poverty alleviation and efficient use of renewable and non-renewable resources.

Various initiatives have been undertaken to ease pressure associated with industrial production such as emissions, effluent discharge and solid waste management. These include promotion of cleaner production technologies, strategies for technology transfer and acquisition, enforcing environmental standards, regulations and laws.

Mining production grew by 11% between 2002 and 2003. The impacts of mining on land and the environment are enormous as evidenced by un-rehabilitated mines and quarries countrywide. EMCA 1999 provides for rehabilitation and restoration of used and abandoned mines.

Environmental Impact Assessment (EIA) and Environment Audit (EA) have been employed in enterprises as a management tool. The cumulative and collective impact of 1.3 million micro and small scale enterprises (MSEs) is a challenge as no modalities for EIA had been instituted.

The service sector including tourism, communications and retail trade continue to affect the environment through the generation of waste, pollution, land degradation and loss of biodiversity as well as socio-cultural erosion. NEMA continues to use environmental management tools such as standards, EIAs and Audits to enforce compliance.

Trade and environment provisions in the World Trade Organization (WTO), which cover market access, standards, labeling schemes and capacity building, affect Kenya's external trade. NEMA will enforce the provisions of EMCA which relate to trade and environment to ensure competitiveness of Kenyan products in the international market.

Population Dynamics and Human Settlements

The national inter-censual growth rate declined from 3.4% in 1969 to 2.9% in 1999. By international standards, a population growth rate of 3% and above is considered high. Regional conflicts have over the years made Kenya home to over 200,000 refugees, living in two main camps namely Daadab (Garissa District) and Kakuma (Turkana District). The refugee population has exerted additional pressure on natural resources in the country's fragile and vulnerable ecosystems.

The net effect of increasing population coupled with influx of refugee is a decrease in the capital natural resource base available to support livelihoods of the people.

The population of urban centres, which was 7.8% of the total population in 1962 increased to 27% by 1999. Most urban centres lack approved physical development plans and are characterised with slum informal settlements, whose main features are inadequate infrastructure, housing, roads, educational and health facilities.

Water pollution, waste management and poor sanitation pose serious environmental challenges. For a large number of Kenyans, inadequate access to basic means of livelihood (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. The demand for wood-fuel is posing a major threat to existing forest resources and biodiversity. This trend is unlikely to change in the foreseeable future without alternative renewable energy sources.

The overriding goal of the National Population Policy for Sustainable Development is to improve the welfare and the quality of life of the individual, the family and the nation as a whole. Human settlement planning and management is guided principally by the Physical Planning Act of 1996, EMCA (1999) and Environmental Impact Assessment Regulation of 2003. These legal instruments should enhance the development of quality human settlements and sustainable use of natural resources.

CHAPTER ONE

INTRODUCTION

1.1. BACKGROUND

1.1.1. Global Perspective

The United Nations Conference on Human Environment held in Stockholm, Sweden in 1972 put environment on the global agenda for the first time. Since then, issues relating to the environment have experienced slow but steady growth in both recognition and priority. The United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992 reaffirmed the need to integrate environmental concerns in development activities. The concept of Sustainable Development as development that 'meets the needs of the present generation without compromising the ability of future generations to meet their own needs' was adopted by the conference, whose main outcome - Agenda 21 continues to guide Sustainable Development activities.

Countries worldwide have since adopted the State of Environment (SoE) reporting as the most effective method of providing timely, reliable and relevant information to support decision-making and policy formulation for sustainable development. SoE reports are therefore invaluable tools for generating information on various aspects of the environment for effective implementation of Sustainable Development

The United Nations Environment Programme (UNEP) prepares the Global Environmental Outlook (GEO) and regional environmental outlooks giving the global and regional status of the environment respectively. The GEO fourth edition (GEO-4) will be completed in 2007, while the GEO Year Book for 2004/05 has already been released. At the regional level, the first African Environmental Outlook (AEO-1) was prepared in the year 2000. Preparation of the second AEO edition (AEO-2) is ongoing.

It is important to recognise that the 2004 Nobel Peace Prize was for the first time awarded to an environmentalists, Prof. Wangari Maathai, the current Assistant Minister for Environment and Natural Resources in the Government of Kenya. The award was not only an honour to Kenya, but also a recognition that the environment is a key tool for peace and security (GEO, 2004/5). This has further strengthened the recognition that an ecologically viable system contributes to social, economic and cultural development.

1.1.2. National Level

Kenya continues to implement Agenda 21 to support sustainable development through the integration of environmental concerns into the national development policies, plans and programmes. The country is further committed to meeting the targets set out in the United Nations Millennium Development Goals (MDGs).

The goals have identified a number of targets to be attained by the year 2015. The MDGs aim to:

- Eradicate extreme poverty and hunger;
- Achieve universal primary education;
- Promote gender equality and empower women;
- Reduce child mortality;
- Improve maternal health;
- Combat HIV/AIDS, malaria and other diseases;
- Ensure environmental sustainability; and
- Develop global partnership for development.

The implementation of MDGs is being coordinated by the Ministry of Planning and National Development (MPND). Most MDGs have a bearing on the environment and the National Environment Management Authority (NEMA) is committed to working closely with all the relevant lead agencies to ensure the integration of environmental concerns into various aspects addressed by the MDGs.

According to the Environmental Management and Coordination Act (EMCA) No. 8 of 1999, the Authority is mandated to produce a State of Environment (SoE) Report every year as a tool for presenting environmental information to support decision-making. The Authority prepared the first SoE Report for Kenya in 2003. The report provides baseline information on all aspects relating to the environment, creates awareness on the importance of the environment and related issues; identifies potential impacts/negative and positive) and suggests interventions; provides information for the preparation of environmental actions plans at all levels; provides the basis for resource mobilisation; and strengthens linkages and collaboration between NEMA and lead agencies on environmental management.

The SoE report provides important information that will serve as a benchmark for future assessments on progress made towards achieving the set targets of some key national priority issues such as MDGs, Economic Recovery Strategy for Employment and Wealth Creation (2003-2007) and Poverty Reduction Strategy Paper (PRSP).

1.2. THE 2004 SOE REPORT PREPARATORY PROCESS

1.2.1. The Theme and Relevance

Land is one of the three pillars of development, besides capital and labour (human resources). Land therefore provides the basis on which social and economic activities are carried out to cater for the well being of mankind. The 2004 SoE report focuses on a single theme, *Land Use and Environment.* Land use is the interplay of activities and inputs by people on a land cover unit, which may cause change of habitat (Gregorio and Jansen, 2000). Land use establishes direct linkage between the actions of people and their environment.

The theme allows the report to address environmental challenges specific to land and identifies potential practical solutions/interventions. Further, the theme facilitates analysis of the interaction between land use and the environment across various sectors of the economy.

The following are some of the major uses of land and their contribution to the economy:

i) Rural and urban settlements
ii) Agricultural activities such as livestock, crop production and fisheries.
iii) Infrastructure such as transport and communications, power distribution, sewerage systems and water supply.

iv) Industrial, commercial and mining developments as well as services.
v) Conservation of biodiversity and other natural resources.

Although the country lacks a comprehensive land policy, there are a number of statutes governing land management. However, there is an on-going process to review the existing policies that impact on land and environment with a view to developing a comprehensive land policy.

The preparation of this report has contributed to the development of the land policy and the integration of environmental concerns into that policy. This should enhance the harmonization of public policies in addition to reducing potential conflicts in environmental management.

The theme addresses disasters related to land use practices, especially those associated with to degradation of ecosystems, reduced productivity and weakened coping mechanisms. The disasters have also triggered migrations of people to other areas causing change of land use and eroding the gains made in infrastructural development

This Report takes cognizance of the current global approach towards environmental conservation as a means to achieving sustainable development and enhancing livelihoods of the people. The term 'Environment for Development' is now the underlying principle in the implementation of sustainable development. Thus, as the country balances the delicate nexus between development and environment, it will not only address the impacts of human activities on environment, but also the impacts of the changing environment on the livelihoods of the people.

1.2.2. Methodology

The preparation of this report was undertaken through a participatory process with activities at both national and district levels. Guidelines for preparing the report were developed by the SoE Steering Committee and approved by NEMA's Board of Management for both national and districts levels to enhance synergy. The guidelines included report outline and relevant data/information requirements for various sections of the report.

At the national level, six thematic taskforces were established with representatives from relevant lead agencies, to prepare chapters of the national report. Secondary data and information was collected and collated including case studies used to illustrate different issues. The national process also utilised information from the district SoE reports to enrich the national report.

At the grassroots level, regional training workshops were conducted to disseminate the guidelines to all the districts countrywide for the preparation of the district SoE reports. Districts SoE reports are available for reference at NEMA headquarters.

The DPSIR (drivers, pressure, state, impact and responses) framework was applied in preparing the reports. The framework is widely used globally and is seen as the most effective way to structure, analyse and present environmental information in a logical and focussed format to support decision-making (UNEP, 1989). A brief explanation of the different components of the DPSIR model is provided.

Driving Forces: Drivers are causes either natural or human-induced that influence the alteration of state of environment – positively or negatively. These constitute natural occurrences (earthquakes, volcanic activity, etc) and human induced factors. Driving forces determine basic trends in major sectors such as agriculture, energy, industry, tourism and transport.

Pressures: These constitute a wide range of external factors caused by human activities affecting the environment. These include economic, political, cultural and gender-related factors influenced by societal developments such as demographic, production and consumption, population, poverty, urbanization, industrialization, technological developments, governance, conflicts, trade, globalization, finance and information. Certain policies are also known to cause pressure on the environment.

State: This refers to observable values of the environment. A single or combination of indicators can be used to identify and measure state of different components of the environment.

Impacts: Describes the effects of a change in a specific environment likely to affect the functioning of an ecosystem or human health and safety. Impacts may be positive or negative with intensive or relative magnitude.

Responses: Refers to actions undertaken or proposed to address impacts on components of the environment, including assessment of effectiveness.

1.2.3. Scope of The 2004 SoE Report

The report analyses issues relating to land use across all major sectors of the economy. It consists of nine chapters, namely:

Introduction;
Land Policy and Environment;
Land Use and Agriculture;
Land Use and Biological Diversity;
Land Use and Water Resources;
Land Use and Energy Resources;
Land Use, Trade, Industry, Mining and Services;
Land Use and Population Dynamics; and Human Settlements; and
Conclusion.

Case studies received and investigated by the Public Complaints Committee (PCC) have been incorporated. These cases were used to enrich the specific chapters. The PCC as a public environmental watch-dog provides a forum for solving environmental problems affecting the public. The cases cover various aspects of land and land related activities that have had a direct bearing on the environment.

The report analyses some multi-lateral environmental agreements (MEAs) that relate to land and land-based activities to which Kenya is a party. The efforts undertaken towards the domestication of such MEAs is also highlighted. Other regional and sub-regional agreements are discussed to show the potential for collaboration between Kenya and

Table 1.1. MEAs and regional agreements relevant to land

MEAs	Regional Agreements
Convention on Biological Diversity (CBD)	Bamako Convention on the Hazardous Wastes within Africa
Cartegena Protocol on Biosafety	African Convention on the Conservation of Nature and Natural resources
United Nations Framework Convention on Climate Change (UNFCCC)	Tripartite Environmental Management Program for Lake Victoria
Kyoto Protocol to the UNFCCC	
United Nations Convention to Combat Desertification (UNCCD)	Nile Basin Treaty (1929)
Convention on International Trade in Endangered Species (CITES).	Regional Co-operations
Convention for the Protection of the World Cultural and Natural Heritage	
Convention on the Wetlands of International Importance especially as Waterfowl Habitats (Ramsar Convention)	
Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)	
United Nations Convention on the Law of the Sea (UNCLOS)	
Basel Convention – Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal	

1.3. COUNTRY PROFILE

Kenya covers an area of 587,000 km^2 of which 576,000 km^2 comprises of land surface and 11,000 km^2 water. The current administrative structures consist of eight provinces (Western, Nyanza, Rift Valley, Nairobi, Central, Eastern, Coast and North Eastern) and 71 districts (Figure 1.1).

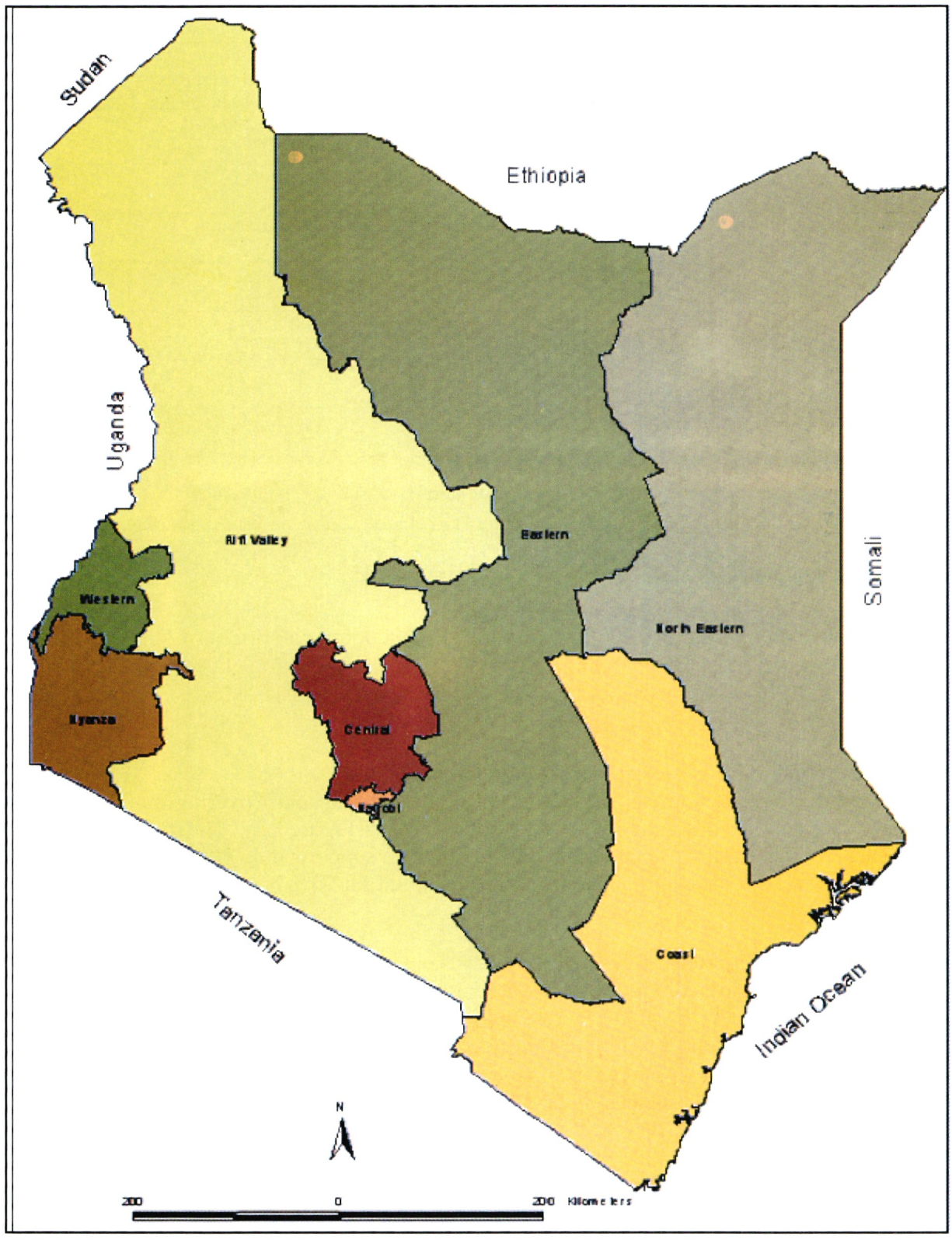
1.3.1. Zonation of Kenya into High Potential and ASALs

The land surface area comprises medium potential agricultural lands covering about 12% of the country's surface area and supports 80% of the population (Figure 1.2). The remaining 88% of land surface area is arid and semi lands (ASALs) which supports only 20% of the population. However, ASALs is home to 50% of the livestock and 80-90% of wildlife resources in the country (Figure 1.2).

1.3.2. Carrying Capacity

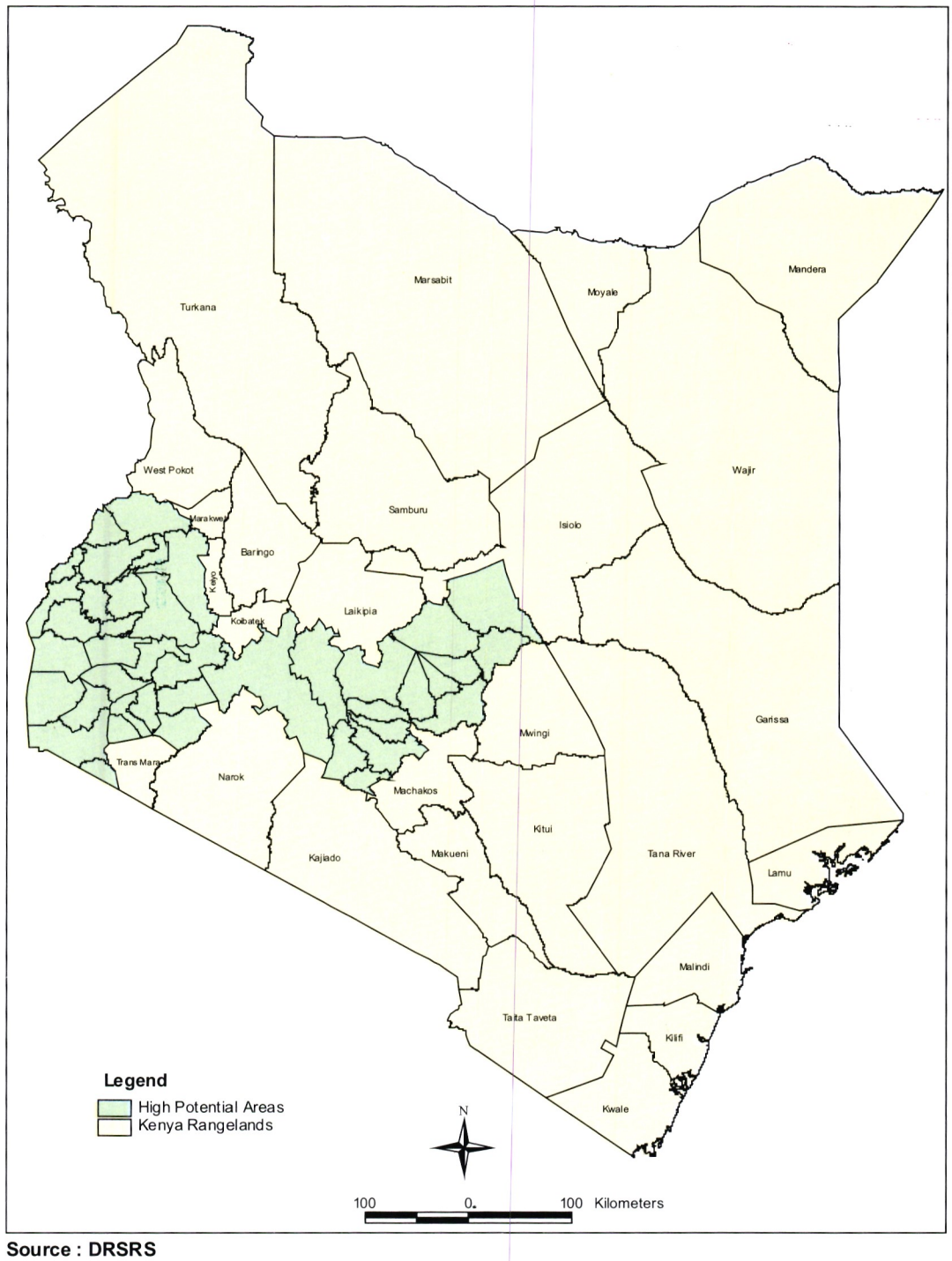
Kenya has seven agro-ecological zones that represent major ecosystems as well as productivity and suitability of land (Pratt and Gwyne, 1977). The different zones and their spatial extent are illustrated in Figure 1.3. Agro-ecological zones 6 and 7 together cover 352,000km^2, while zones 4 and 5 cover 114,000km^2, comprising 68% and 20% of the country's total land area respectively (DRSRS data records).

Figure 1.1. Provinces of Kenya



Source: DRSRS Records

Figure 1.2. Zonation of Kenya into high potential areas and ASALs



Source : DRSRS

Source: DRSRS Data Records

1.3.2. Carrying Capacity

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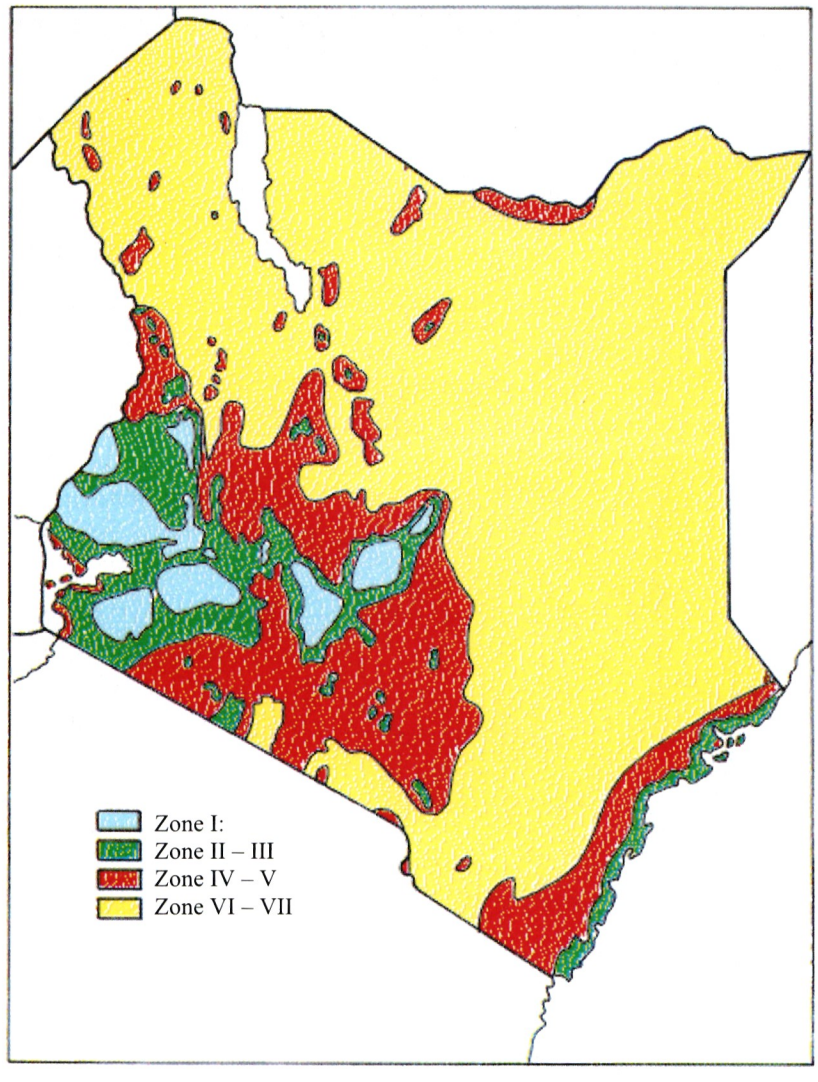
Figure 1.1. Provinces of Kenya

Figure 1.3. Ecological zones of Kenya



Source: Pratt and Gwynne, 1977; GoK, 1992

Legend:
Zone I: Afro-alpine moor land 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.

The carrying capacities of various agro-ecological zones have been computed (Table 1.2). Carrying capacities describe the number of animals an area can sustain at optimal levels of production assuming good range conditions. The carrying capacity is an expression of biomass of one Tropical Livestock Unit (TLU) equivalent to 250 kg of one mature zebu cow, 10 sheep, 12 goats or two donkeys. This provides an important indicator of land productivity and suitability which prescribes the type of land use suitable to any specific area.

Table 1.2. Carrying capacities of ecological zones

Zone	*Carrying Capacity*
I	0.5 ha/tlu
II	0.8 ha/tlu
III	2.1 ha/tlu
IV	4.5 ha/tlu
V	1.0 ha/tlu
VI	3.0 ha/tlu

Source: Pratt and Gwynne, 1977

However, land use practices have not conformed to the recommended carrying capacities of the ecological zones. It is expected that the proposed land policy will incorporate ecological principles to guide land use practices. The application of strategic environmental assessment (SEA) and environmental impact assessment (EIA) provided for in the EMCA 1999 should enhance the integration of environmental concerns in land use practices.

1.3.3. Population

Kenya's population stands slightly over 32 million as per the projections for 2004 *(Population and Household Census 1999)*. About 68% of the population live in the rural areas and depend mainly on agriculture. However, the population density is unevenly distributed. Population density was estimated at 49 persons per km^2 in 1999 up from 37 persons per km^2 in 1989. Density in North Eastern Province was the least at 8 persons per km^2. Among the urban settlements, Nairobi has the highest density of 3,079 persons per km^2.

The growth rate was estimated at 2.9% in 1999 with 50% of the population below 15 years of age. The growth in human population has increased pressure on the natural resource base. This has resulted in migration from high potential lands to marginal ones. The regions experiencing noticeable emigration are Central and Nyanza, while those receiving proportionaly large immigrants include Laikipia, Kajiado and Narok.

Conflicts over natural resource use have been on the increase, due largely to shortage of pasture/forage and water supply. Resource use conflicts have caused destruction of property and displacement of persons. This has clearly demonstrated the nexus between environment and socio-economic well-being of societies heavily dependent on natural resources.

1.3.4. Poverty and Environment

Poverty remains the single most critical barrier to the socio-economic development of any country. It hinders access to basic needs such as health care, nutrition and education. In Kenya, 56% of the population earn less than US$ 1 per day with higher incidences among urban populations.

Major causes of poverty include poor economic performance, low agricultural productivity, unemployment and low income, HIV/AIDS pandemic, landlessness, poor physical infrastructure, gender imbalance and poor governance. Other causes are natural disasters, human/wildlife conflicts and effects of climate change such as drought. Poverty results in unsustainable use of natural resources and overall degradation of the environment. Given that the Kenyan economy is based on natural resources, poverty eradication remains the greatest challenge to sustainable development.

1.4. LAND COVER CLASSIFICATION

Land cover is the observed bio-physical phenomenon on the earth's surface that includes vegetation and man-made features (Gregorio and Jansen, 2000). Land use and cover represents a clear manifestation of human activities and their associated modifications. The assessment/modelling and monitoring of how land cover changes over time is very critical in projecting changes, effects on human wellbeing and ecological balance. Mapping is widely used in classification of land cover types.

The mapping of global land cover classification was conducted through the Africover Programme initiated by the Environment and Natural Resource Services of the Food and Agriculture Organization (FAO) (Gregorio and Jansen, 2000). The exercise adopted an agreed reference base for international applications. The land cover for the African continent has been mapped including the East Africa region through the Africover-East Africa Project. The Department of Resource Surveys and Remote (DRSRS) is the national focal point for the Africover database.

The land cover classification for Kenya indicated a broad range of habitats with low shrub lands dominating the country (Figure 1.4).

Chapter 2 discusses issues of land and environment which lays the basis this State of Environment Report.

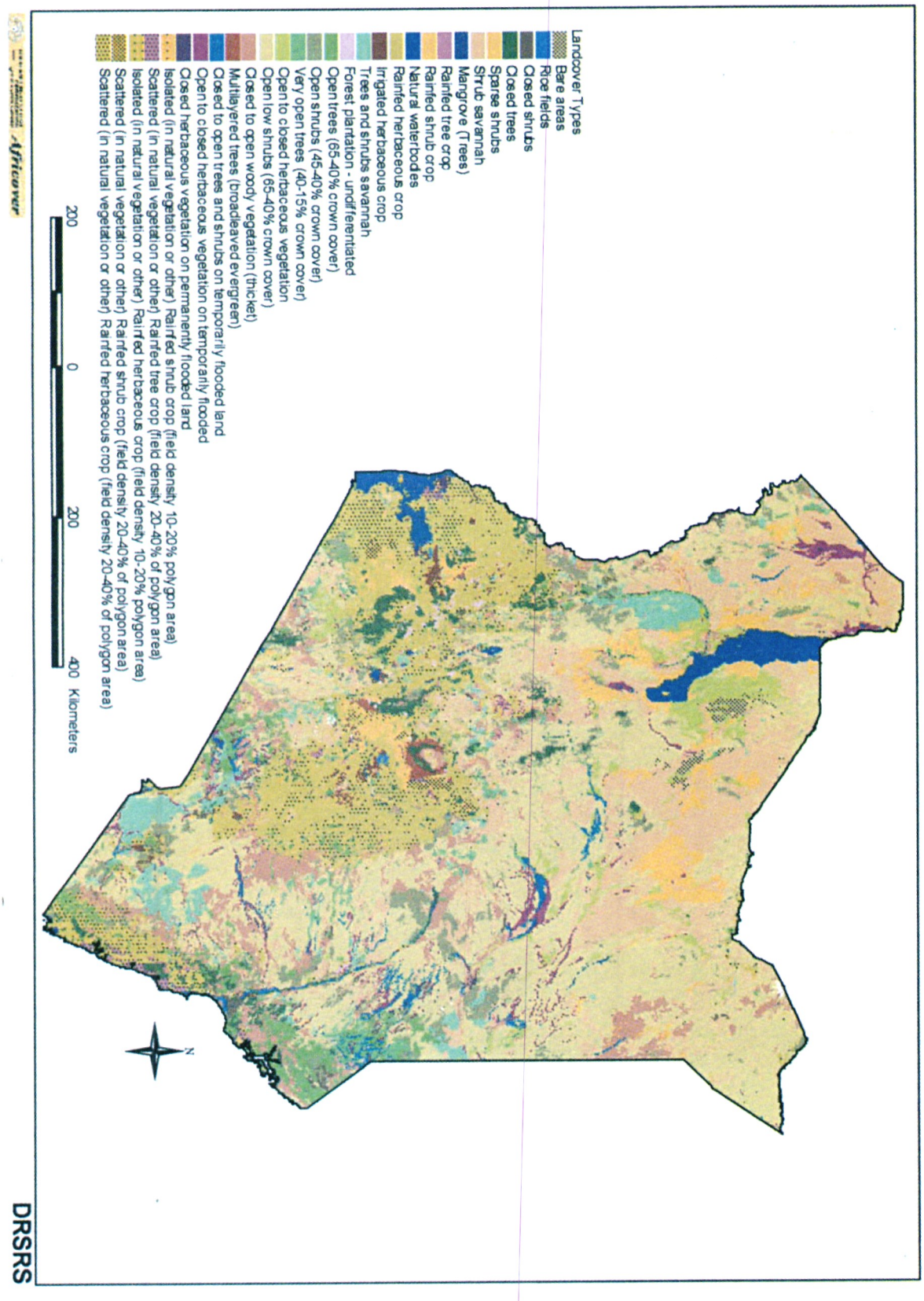


Figure 1.4. Land cover classes of Kenya

CHAPTER TWO

LAND POLICY AND ENVIRONMENT

2.1. INTRODUCTION

Land is the basic commodity that supports all life forms. In Kenya, most people consider land as the only resource endowment. Land encompasses soils, surface topography, underlying deposits, climate, water, plant and animal communities. The results of human activities, reflected by changes in vegetative cover or by structures, are also regarded as features of land. Changing one of the factors, such as land use, has potential to impact on other factors, such as flora and fauna, soils, surface water distribution and climate.

Land registration in Kenya in the pre-colonial, colonial and post-colonial eras has had major impact on land and the environment. Land use and access has shaped land registration over time. This section highlights some of the land registration changes that have transformed Kenya's landscape over the years, from the traditional to present land regimes (Table 2.1).

2.2. HISTORICAL PERSPECTIVE

There has never been a comprehensive land policy in Kenya. However, various land regimes have always provided direction and guidelines on how land is used and accessed.

2.2.1. The Colonial Period

Kenya was declared a British Protectorate in 1895. By 1905 the Colonial Office was preoccupied with the recovery of 6.6 million investments in Kenya Railway from Mombasa to Kisumu. This led to the renting of land assets. The government alienated about 2.7 million acres (1.1 million ha.) in some of the most arable land referred to as the "White Highlands". Many of the indigenous people were forced to settle in native reserves.

The White Settler community aped the temperate agronomy of Europe with disastrous results. New breeds were introduced with imported technology. These changes in land husbandry and cultivation have had significant impact on land and related natural resources.

2.2.2. The Post Colonial Period

After independence in 1963, the national development agenda was guided by "Sessional Paper No.10 of 1965 on African Socialism and its Application to Planning in Kenya". The paper recognized poverty, ignorance and disease as major constraints to development.

In the colonial period, Europeans and Asians controlled the economy. The independent government's first task was to Africanize the economy, including transferring land from settlers to Africans. A number of initiatives were undertaken, such as the first transfer of large-scale farms to African individuals, partnerships, companies and cooperatives. Under the Shirika (Cooperative) Scheme 43,000ha were settled by 1979, while the squatter settlement schemes had settled about 180,000 families by 1974. The resettlements programmes have

resulted in land parcelization, and later further subdivision, often to uneconomical and ecologically unsustainable levels.

The Special Rural Development Programme (SRDP) under the third National Development Plan (1974-78) had the following objectives:

- To increase rural production and productivity of resources;
- To increase rural incomes and living standards; and
- To increase rural employment opportunities.

The approach failed to recognize vulnerability, fragility and sustainability of land and related natural resources.

2.3. LAND TENURE AND ADMINISTRATION

Land tenure refers to ownership and unsufructuary rights in land among persons or groups of people.

2.3.1. Pre-colonial Era

Land tenure systems in pre-colonial Kenya were mainly influenced by climatic conditions, socio-political organization, cultural values and economic production of various ethnic groups (Kanyinga, 2000). Land was allocated and communally owned by sections of ethnic groups. Individuals had user rights to pasture, water and salt licks, among other environmental resources (Musyoka, 2004). Access to land was specific to a function, such as cultivation, grazing, hunting or firewood gathering. In a community, a number of people could each hold a right or bundles of rights expressed in various functions (Okoth Ogendo (1991).

Traditional land tenure systems took cognizance of existing physical and biological environment. Shifting cultivation provided a cycle sufficient enough to allow natural regeneration. The same was true of pastoral practice as spatial movement in search of pasture and water created room for natural regeneration. These two systems practiced among Kenyan cultivators and pastoralists were sustainable under the subsistence mode of production. However, commercialization made the systems unsustainable.

2.3.2. Colonial Era

The colonial land tenure system is embodied in colonial and alien laws dating back to 1891 (Musyoka, 2004). The first land regulations provided for land to be leased on 21-year lease and such grants were only made to benefit white settlers. The various land policies and directives on land matters had major environmental ramifications.

The Crown Lands Ordinance of 1902: The Crown Lands Ordinance was enforced on 27th September 1902. This repealed Section 7 of 1897 Regulations that prohibited any sale of land that would adversely affect indigenous people's interests.

> "The commissioner may grant leases of areas of land containing native villages or settlements without specifically excluding such villages or settlements, but land in the actual occupation of natives at the date of the lease shall, so long as it is actually occupied by them, be deemed to be excluded from leases... Any land within an area leased, which has been in occupation of natives, shall, on ceasing to be so occupied, pass to the leases".

The Crown Land Ordinance of 1915: The Crown Land Ordinance of 1902 was repealed and succeeded by the Crown Land Ordinance of 1915, which declared all land in the Protectorate to be Crown Land and therefore subject to the Governor's powers of alienation. This dispossessed Africans of all land, including sites they occupied. Grants under this ordinance were made on leasehold terms to settlers as follows:

- Agricultural land for a term of 999 years;
- Township plots for any term not exceeding 99 years for business, industrial or residential purposes;
- Special purposes (other than agricultural) land was leased for a term not exceeding 99 years;
- Temporary occupation licenses were granted for special purposes such as quarrying, grazing or for temporary residential development.

The indigenous Kenyans forwarded their grievances to a land commission, chaired by Sir Carter in 1930.

The Carter Land Commission: The Carter Land Commission was appointed to define the extent of the 'White Highlands' and African Reserves. The Commission advised that, upon compensation being paid, all African rights relating to land outside African reserves to be extinguished. On future land needs, the Commission recommended that power be vested in the Governor to make available certain areas of Crown Lands for African use and enjoyment as the need arose. This was achieved through restructuring and defining by order-in-council the boundaries of African Reserves, European highlands and African leasehold areas. These recommendations were effected through the Native Land Trust Ordinance of 1938.

The Native Land Trust Ordinance: Under the Ordinance all areas formerly known as Native Reserves were re-designated 'Native Land' and removed from the Crown Land Ordinance of 1915 (Okoth Ogendo, 1991). The native reserves were areas deemed unsuitable for European settlement and their boundaries were demarcated along ethnic lines (Kanyinga, 2000). Its administration was placed under the Native Trust Land Board and the Highland Trust Land Board for the African reserves and White highlands respectively.

The alien laws grossly ignored both the principles and practice of indigenous land regimes, and marginalized Africans in low unproductive arable land (Musyoka 2004). Marginalization led to pressure on the land carrying capacity as restrictions were imposed on acquiring land rights elsewhere. The limited land resources led to emigration to more marginal lands creating pressure on the resources, consequently leading to environmental degradation.

The Swynerton Plan: The land related issues triggered political upheavals, which climaxed in the Mau Mau rebellion of 1950s. In response, the colonial government initiated land reforms in the African reserves, referred to as the Swynnerton Plan of 1954. The plan focused on securing individualized tenure to stimulate farm investment, agricultural growth and the emergence of a land market. This was an agricultural policy whose implementation began in Central and Nyanza provinces as core areas of African reserves, later expanded nation-wide. These areas were facing environmental degradation and declining productivity. The plan therefore focused on increasing agricultural productivity, environmental and resource conservation. The main tenet of the plan was to replace customary tenure system with private land ownership in form of individualized holdings akin to White settlement areas.

Land consolidation through adjudication and amalgamation was started to operationalize the process. Land adjudication and consolidation is still an on-going process (Kanyinga, 2000).

The Swynerton Plan was not able to solve the land issues, especially redistribution or inequalities in ownership between settlers and Africans, or between and within various African communities (Kanyinga, 2000). The colonial government responded to this by establishing settlement schemes for displaced persons from White highlands in the low potential areas of Makueni and Machakos districts in Eastern Province: Shimba Hills and Gedi in the Coast Province; and Olenguruone in Rift Valley Province, among others (Okoth-Ogendo, 1991 and Musyoka, 2004). Most of the areas were infested with tsetse flies and prone to human wildlife conflicts resulting in disease and loss of human life and livestock. The individualization of land rights ultimately replaced the communal land regimes and encouraged commoditization.

The Struggle for Independence (Mau Mau Movement): The Mau Mau movement was a revolutionary response to oppression and mainly land expropriation and exploitation of Kenya's human and natural resources. The struggle for independence, fought on land rights was worn in December 1963. Kenya was liberated from the British administration. However, though independence was fought on land rights, Kenya inherited the existing colonial land reforms (Musyoka, 2004).

Kenya's land policy has consistently championed particular interests (Olima, 1997). During the colonial era, the interests of colonialists and colonial officials determined the land policy; while in post-independence Kenya, it is the interests of public officials, influential politicians and the rich that have always determined land policy.

The land policy in Kenya influenced by the landed minority has a large number of squatters, both in the rural and the urban centres. Squatter or informal settlement is a major concern in environmental management. In urban centres, like Nairobi, Mombasa and Kisumu over 60% of the population live in informal settlements occupying a paltry 5% of the total urban land. The same scenario can be witnessed in the rural hinterland where most people do not own land, but are squatters in environmentally sensitive areas, such as forest reserves, riparian reserves and flood prone areas. Attempts to resettle the landless in settlement schemes has aggravated environmental degradation, especially in major water catchment areas such as the Mau Complex, Mt. Elgon and Mt. Kenya ecosystems.

2.3.3. Post-Colonial Era

The resettlement programme that started in 1961 during the colonial era continued after independence. The Million-Acre Scheme had by 1971 settled 29,000 African families on high-density plots and 5,000 families on larger low-density farms. Through these schemes, over a million Kenyans were settled on farms measuring 10-40 acres that were categorized as low-density holdings of 40 acres (16ha.), high-density holdings of 25 acres (10 ha.) and 'squatter settlement schemes' where the allocation was 10 acres (4 ha.) per beneficiary. Theoretically, every landless Kenyan did qualify to get land irrespective of gender or tribe. (Musyoka, 2004). However, less than 5% of the population benefited from the resettlement schemes (Republic of Kenya, 1999).

The post independence human settlement has not been sustainable, as the number of squatters has increased proportionally with population increase. Some settlement schemes were created in important habitat areas such as Mt. Elgon (Chepyuk), an important water catchment area (Mau Complex), Kinale Forest, Mt. Kenya, among others. The Minister for Lands and Settlement, Hon. Noah Ngala, during a National Water Conference in 2002 remarked:

"Some of the once forested thick canopies have been turned into human settlements. These landscapes no longer offer their once revered role of 'water catchment areas', the lost canopy can no longer collect water."

Encroachments of human settlement on water catchment areas have aggravated water availability for downstream users and also water reservoirs.

Sustainability approaches should be contained in the proposed land policy, regional environmental planning, strategic environmental assessment of major policies such as resettlement programmes and periodic environmental monitoring.

2.3.4. Urbanization in Kenya

Urbanization in Kenya dates back to the emergence of settlements along the Coast to service foreign traders mainly Arabs and Portuguese (Ojany and Ogendo, 1973). Pre-colonial cities developed along caravan routes (Obudho, 1983). The European and Arab involvement in caravan trade led to the expansion of these centres as part of urbanization process in Kenya. Urbanization in the interior of Kenya was mainly due to colonial influence, especially the development of white highlands and the construction of the Kenya-Uganda railway. The settler farmers formed clubs and hotels, resulting in urban nuclei. These served well as places where farmers exchanged their commodities, goods and acquired farm implements and household wares.

Urbanization process revolved around administrative and commercial activities. This had emerged as non-African settlement and propagated the principle of segregation, citing environmental principles such as health concerns. Environmental health was a major zoning ordinance governing planning design. These were contained in the 1948 Planning Ordinance, well applied in most towns such as Nairobi and Kisumu.

Europeans restricted settlements of Africans in towns and their residences were kept temporary in high-density areas, where only bachelors were encouraged. Rural-urban migration was restricted. This restriction was lifted after independence and perhaps explains the increased rural-urban migration witnessed today.

The Government embarked on industrialization and provision of trunk infrastructure in urban centres thus making them attractive employment areas and centres of modern lifestyle. Rapid urbanization required more housing facilities. Population growth in urban areas has been increasing at the rate of 7%; this has given rise to the development of informal settlements. Informal settlements currently house 60% of the urban population, while only occupying only 5% of the land in Nairobi, Mombasa and Kisumu. Most urban planning policies and standards have only favoured the high-income settlements.

Most local authorities have failed to provide appropriate infrastructural facilities leading to urban decay and environmental degradation. Notable environmental concerns include

settlement on flood prone areas, loss of valuable biodiversity, encroachment of wetland and riparian reserves, uncollected garbage and water contamination (Hayombe, 1997). A study of urban sprawl in Nairobi by UN Habitat and UNEP (2003) observed that in Kasarani Division alone, 52.76 ha. of natural environment was transformed into built environment annually (Hayombe, 1999).

2.4. POST-INDEPENDENCE LAND POLICY, LEGISLATION AND ADMINISTRATION

Post independence Kenya entrenched individualization of land tenure, the main aspect of the Swynerton Plan of 1954, through the enactment of the Registered Land Act (Cap 300). Under the Act, land held under customary tenure was transformed into individual/private land tenure. The Land Adjudication Act (Cap 284) was amended to take care of group rights in pastoral areas. Group rights were therefore registered under Land/Group Representative Act (Cap 287) to maintain status quo in pastoral areas.

In urban areas, the colonial Town Planning Legislation before its repeal in 1996 was the main regulator of land use zoning. The repealed legislation ushered in the Physical Planning Act (Cap, 286). Public land administration is governed by the Land Act (Cap 280) for public land, while the Trust Land Act (Cap 288) administers the customary and communal land. Land administration has therefore not been systematic but varied from one type of land regime to another. There is definitely a need to formulate a comprehensive national land policy.

Table 2.1. Comparison and effects of land policies in colonial and post-colonial Kenya

Land Policy	Effects of Land Policy on Tenure System
Colonial Policy ▪ Prevented Africans from acquiring private land. ▪ Made it easy and relatively efficient to control and administer the natives. ▪ Protect European settlements in outlying areas from invasion by pastoral communities. ▪ Make labour recruitment easier **Post Independence Policy** ▪ Re-distribution of land. ▪ Re-settlement (e.g. million acre scheme). ▪ Incorporation of African political elites into the land owning class. ▪ Realize economic development through agricultural production (poverty alleviation).	▪ Undermined Africans land laws e.g English law recognized individual ownership while Africans perceived land as communal assets. ▪ Destabilized agricultural production by displacement of African communities. ▪ Land to conflict among different ethnic groups due to population pressure and competition for land for different use. **Effects of Land Policy** ▪ Fragmentation of land holdings. ▪ Individual ownership of large tracts of land. ▪ Created squatters and landlessness ▪ Created inter-ethnic land resource conflict. ▪ Created many and confusing land laws. ▪ Created poor land use practices. ▪ Encouraged unequal distribution of land. ▪ Encouraged development of individually owned land.

2.4.1. Land Tenure

Land tenure in Kenya falls into three broad categories i.e. community or customary land tenure, private or individual land, and public or state land (Tables 2.2).

2.4.2. Customary Land Tenure

Under customary tenure, land is owned by the community and is held in trust for them by county councils. The community is only allowed to use the land under certain conditions as may be agreed on by the particular community.

A number of factors have had far reaching effects on community land tenure. Some of these are the 'fixity' of trust land units, population growth, the process of tenure reform and the resilience of Customary Law. Under the colonial reservation of native lands, territorial fixity restricted members of particular ethnic groups to prescribed land units, while at the same time preventing encroachment or immigration by others. This meant that cross-ethnic land transactions could not develop. Internal land rights conflicts intensified and political agitation for expansion of ethnic territory were common.

Population growth rate has remained high, leading to increased demand for land resources. This phenomenon has led to:

- Constant sub-division of land reserved for members of a community,
- Increased land pressure in many areas especially the Kisii highlands, Western Province (Vihiga), Meru highlands, Taita-Taveta highlands and Central Province; and
- Radical transformation of land rights systems in order to accommodate increased demand for land, which led to the Land Adjudication and Consolidation Programme, in Trust Lands areas outside ASALs.

The private land tenure system confers exclusive ownership of land to an individual. This form of ownership is registered under specific laws and is guaranteed by the constitution. Private land tenure was introduced in a bid to transform land rights ownership in Trust Lands. This move was also applied in areas containing government land through the creation of settlement schemes programmes, where land was sub-divided into small units and vested in individuals. The public land tenure vests land in the state to serve public interest.

2.4.3. Public Land Tenure

The colonial government declared all land that had not been reserved for natives or Trust Land as Crown Land. On attaining independence, government land was vested in the President. The major problem that arose with this land tenure was whether the land was to be held in trust for the people or was the private property of the government. Developments over the years indicated that the government regarded such land as private property to be disposed at will. This interpretation has been extended to unregistered trust land areas even though the constitution and the Trust Land Act (Cap 288) provide that these lands be administered by the Commissioner of Lands strictly as trustee for their customary inhabitants. Consequently, the government has proceeded to make grants thereof without regard to the public interest. This resulted in land reserved for public purposes becoming vulnerable to misallocation.

2.4.4. The Current Situation

The consequences of the above developments are:

- Community or customary land tenure is disintegrating. In the process, land rights for women and children have been compromised and sensitive ecological systems disrupted.
- The registration of individual land rights under the Land Adjudication Programmes is not always consistent with the people's perception of their land rights. In some cases, titles

- Conferred by registration are challenged by customary rights. The pursuance of individual land ownership also led to the continuous sub-division of large tracts of land bought by companies and co-operative societies, especially in Laikipia, Nakuru, Uasin-Gishu and Trans-Nzoia districts. The sub-division of such land had no regard to the viability of the resultant units.
- The continued expansion of urban areas into agricultural settlements has led to uncontrolled sub-division and conversion of agricultural land.
- The excessive disposal of government land and Trust Land has created severe shortages in public utility land, especially in urban centres. In most cases, open spaces, recreational grounds and even land for social amenities have been alienated.

2.4.5. Impacts of Land Tenure Systems on Sustainability

Each of the three land tenure systems has positive and negative effects on the environment. Under community land tenure, those communities with well-established guidelines on land use were able to impose sustainable practices on water catchments, hilltops, forests and shrines. However, where there were no communally supervised guidelines, there was wanton destruction of such facilities.

Under private land tenure, continuous sub-division of agricultural land is evident, together with conflicting land uses e.g. conversion of agricultural land to commercial and industrial user leading to pollution in agricultural areas. Under public land tenure, the government and local authorities have in some situations conserved the environment through preservation of forests, parks and reserves. However, there is evidence of disposal of sensitive public land resulting in environmental degradation. Plate 1 illustrates heavy settlements in high potential agricultural land in Gucha district.

Table 2.2. Comparison of land tenure in Kenya (1980 and 1995)

Type of Tenure	1989 (sq. km)	1995 (sq. km)	1995 (%)
Government Land	**117,878**	**116,088**	**19.9**
Forest land	9,125	9,116	1.6
Other government reserves	1,245	1,970	0 3
Townships	1,911	2,831	0.5
Alienated land	37,013	38,546	6.6
Un-alienated land	34,858	28,598	4.9
National parks	22,653	24,067	4.1
Open water	11,073	10,960	1.9
Freehold land	**7,135**	**8,731**	**1.5**
Smallholder schemes	5,016	6,615	1.1
Other government reserves	2,119	2,116	0.4
Trust land (not for registration)	**34,965**	**59,625**	**10.2**
Forests	7,092	7,084	1.2
Government reserves	443	492	0.1
Alienated land	1,398	1,812	0.3
National reserves	13,915	33,397	5.7
National Parks	9,285	13,691	2.4
	2,832	3,149	0.5
Trust land (for smallholder registration)	**425,341**	**397,366**	**68.2**
Already registered	27,217	27,279	4.7
Not registered	398,124	370,087	63.5
Total water	11,230	11,230	
Total water	596,549	593,040	1.9

Source: CBS, Statistical Abstract, 1993 and 2000

2.4.6. Njonjo Land Commission

The Government appointed the Presidential Commission of Inquiry into Land Law System on 17th November 1999, famously referred to us the Njonjo Land Commission. The terms of reference were:

a) To undertake a broad review of land issues in Kenya and to recommend the main principles of a land policy framework which would foster an economically efficient, socially and environmentally sustainable land tenure and land use system;

b) To undertake an analysis of the legal and institutional framework of land tenure and land use in Kenya and to recommend a programme for legislation that would give effect to such policies;

c) To recommend guidelines for a basic land law and complementary legislation and associated subsidiary legislation that would address land-related matters.

Plate 2.1. Dense Population in Gucha District



Apart from the Njonjo Land Commission, the Constitution of Kenya Review Commission (CKRC) also collected views on land matters. Subsequently, it formulated principles to guide formulation of a National Land Policy and the Constitutional Framework for Land Administration and Management (Kenya Land Alliance, 2003).

The major findings and recommendation of the two commissions were:

a) There is lack of comprehensive policy to guide development, use and administration of both urban and rural land;
b) Most citizens have lost confidence in the system of land administration due to inappropriate land transactions, allocation and too much power vested in the President and the Commissioner of Lands;
c) The sanctity of the title should be tied to the legitimacy of the procurement process; and
d) Land should be categorized into three tenure regimes: public, commons and private. Trust land should become commons, held under customary or public tenure.

CKRC also proposed a major institutional restructuring resulting in the establishment of a National Land Authority to oversee functions of departments of Lands, Survey, Physical Planning, Land Adjudication and Settlement. Such an authority should be entrenched in the Constitution with guaranteed security of tenure. It recommended that the National Land Policy should address some of the following concerns (Kenya Land Alliance, 2003)

- System of land registration and land tenure;
- Categories of land (Government, Trust and Private land);
- Mechanism of delivery of land at acceptable cost;
- Land use and land use planning;
- Holding ground;
- Public utility plots;
- Forests, wetlands and natural resources;
- Range, arid and semi-arid land management;
- Agricultural land and land control boards;
- Absentee landlords;
- Gender concern in land ownership;
- Squatters in rural areas and informal settlements in urban areas;
- Extension of leases and renewal of leases;
- Setting apart trust land;
- Compulsory acquisition;
- Settlement of land disputes;
- Historical injustices to communities in their land;
- Foreshore plots and land from receding oceans and lakes;
- Consolidation and adjudication;
- Settlement Schemes and Settlement Fund Trustee;
- Protected areas;
- Customary tenure;
- Historical sites and monuments;
- Land survey and preparation of official records; and
- Land Information System and computerization of land records.

2.4.7. Ndungu Land Commission of Inquiry

This Commission was set up in 2004 to look into the irregular allocation of land. One of the key recommendations was the setting up of a Land Titles Tribunal that would authenticate land ownership and set up an Advisory Task Force to implement the report. Other key recommendations include (*Daily Nation*, December 24, 2004):

- The President be stripped of the power to allocate land;

- All illegally acquired title deeds should be cancelled;

- People who illegally acquired land should be made to pay it and be prosecuted;
- Public officials involved in grabbing land be sacked and prosecuted;
- All land records be computerized and new titles should be issued to restore public confidence.

Establish a tribunal of experts with powers to declare any registered title valid, illegal or irregular. Members of the tribunal will include the Permanent Secretaries in the Ministries of Lands, Local Government, Environment and Natural Resources as well as the directors of Kenya Anti-Corruption Commission and Criminal Investigation Department.

The Cabinet directed that all recommendations be implemented in full.

2.4.8. Formulation of Land Policy

Kenya does not have a comprehensive National Land Policy and hence important issues such as land administration, access to land, land use planning, restitution of historical injustices, the institutional framework, land information management systems, environmental concerns, conflict/dispute resolution, public land allocation and the informal sector are inadequately addressed. Other problems arise from lack of a comprehensive strategy for the management of emerging informal urban settlements. The resolution of disputes relating to land management will minimize conflicts and enhance national unity in diversity.

Three developments have strongly influenced the desire for a coherent and comprehensive policy for use, access and conservation of land in Kenya. Firstly, Chapter 7 of the Zero Draft Constitution prepared by the Constitution of Kenya Review Commission (CKRC) proposes far reaching changes to current constitutional provisions on land and property. Secondly, the 'Njonjo Commission' report outlines a number of important new policy principles and institutional changes for the land sector. Combined, the draft constitution and the Njonjo Commission report provide a firm basis and the point of departure for the elaboration and finalization of a National Land Policy. Thirdly, the *Economic Recovery Strategy for Wealth and Employment Creation, 2003-2007* commits the government to developing a clear time bound action plan for implementing the recommendations of the Njonjo Commission. The National Land Policy (NLP) will be shaped by the outcome of the constitutional review process, which is still underway. The NLP process is geared towards clear definition and determination of the following core issues:

a) Secure land tenure;
b) Land administration;
c) Effective mechanisms for resolution of land disputes;
d) Land fragmentation;
e) Governance in land administration; and
f) Harmonization of land tenure regimes.

2.5. OBJECTIVES OF THE NATIONAL LAND POLICY

The overall objective of the National Land Policy is to provide for sustainable growth, investment and the reduction of poverty. The specific objectives are to develop a framework

policy and law designed to ensure the maintenance of a system of land administration and management that will provide:

a) All citizens, particularly the poor, with the opportunity to access and beneficially occupy and use land;
b) The economic, socially equitable and environmentally sustainable allocation and use of land;
c) The efficient, effective and economical operation of the land market; and
d) Appropriate regulatory arrangements for the productive, sustainable use and equitable distribution of land.

2.5.1. Land Policy Principles

Land policy principles have been developed to address the essential values, which should guide land management and administration. The identified principles, which are not exhaustive, have been drawn from CKRC, the Commission of Inquiry into the Land Law System in Kenya (Njonjo Commission) and the proceedings of the National Civil Society Conference on Land Reform and the Land Question.

These principles have been summarized as follows:

a) Access to land should be guided by:
   i) Security of land rights for all land holders, users and occupiers;
   ii) Reasonable legislative and other measures that enable citizens to gain access to land on an equitable basis irrespective of gender or age and devoid of discriminatory practices;
   iii) Development of terms under which foreigners should access land; and
   iv) Economic and social empowerment of citizens, especially the poor and the landless.

b) Land ownership should be guided by:
   i) Terms under which land should be vested;
   ii) Incidents of category of land ownership;
   iii) Ownership and transmission rights guidelines; and
   iv) Rights that reflect inherent and progressive social values.

c) Control of Land should be guided by:
   i) An ultimate land controlling authority;
   ii) Terms under which the state should control and regulate land for public interest;
   iii) Just, fair and prompt compensation for loss of rights in land;
   iv) Protection of individual rights as the state exercises its rights for definition of terms under which public land held in trust by the state should be controlled, disposed of and improved on;
   v) Definition and principles of security of land rights (state, individual and community); and
   vi) Harmonization of state and individual rights.

d) Land use should be guided by:
   i) Decent livelihood and shelter for all;
   ii) Integrated and sustainable management system;
   iii) Community participation in resource utilization and management;

iv) Exploitation practices that have environmentally, economically and culturally sound benefits; and
v) Institutionalizing planning as a value in land management.

e) **Management of Land** should be guided by:
i) A land information system that guarantees accountability, transparency, efficiency and cost effectiveness in land administration;
ii) An independent, expeditious and just system for the resolution of land disputes and historical injustices.

f) **Land markets** should be guided by:
i) Protection of disadvantaged group land rights against oppressive forces of land market through intervention by the state;
ii) Conducive and favourable land markets that encourage investments; and
iii) Public education on land rights.

2.5.2. Outputs of National Land Policy

The National Land Policy should provide:
a) A mechanism for the proper administration and management if land;
b) Reliable mechanisms for resolving land disputes;
c) A harmonized, simple and cost-effective framework of land laws;
d) A legal and institutional framework for secure land tenure, including customary tenure and common property resources;
e) A mechanism for managing pastoral commons as a specific category of land;
f) A mechanism for developing and implementing a functional land information system;
g) Mechanism that ensure gender equity in land allocation and ownership;
h) Mechanism for conservation and protection of the environment;
i) A mechanism for the resolution of historical injustices;
j) A framework for land use planning as a critical component of the National Land Policy; and
k) Guidelines for the regularization of informal sector.

2.5.3. Guiding Values for Policy Development Process

Development of a comprehensive and coherent land policy should be guided by a clear definition of the roles and responsibilities of various actors, which are:
a) Facilitative
b) Consultative
c) Participatory
d) Interactive
e) Inclusive
f) Consensus building
g) Timely and professional
h) Transparent
i) Gender sensitive
j) Innovative

The land policy formulation process commenced in March 2004. It has gone through various stages such as stakeholders workshops, institutional visits and regional workshops where critical issues related to land have been deliberated.

2.6. LAND MANAGEMENT STRATEGIES AND PRACTICES

2.6.1. The National Perspective

Land is the main capital, which must be conserved and used sustainably. In this connection, policy-making and planning must be performed at the national or sub-national level, and implemented at the local and individual land user levels.

At the national level, it is necessary to determine the nature, the incidence and, more particularly, the causes of environmental degradation. The causes may be natural, or human-induced destruction of the natural ecosystem and its replacement by unstable agro-ecosystems. The destruction may be as a result of a combination of various factors.

In accordance with the Sessional Paper No. 6 of 1999 on Environment and Development the Government is committed to ensuring that the use of natural resources meets the needs of the present generation without comprising the ability of the resource base to meet those of future generations. The overall national goal is to integrate environmental concerns into the national planning and management processes and provide guidelines for environmentally sustainable development. However, the policy notes that present land use practices often disregard land potentials, carrying capacitie and limitations of land resources as well as their diversity and distribution (Republic of Kenya, 1999).

In this connection, there is need to understand the life-support capabilities of resources, environmental stress, marginality and resistance of natural or human-made induced processes such as desertification, or sedimentation, pollution and environmentally appropriate technologies. The objective will be to maximize the use of local resources, lower factor costs and causes of pollution.

2.6.2. Land Use Planning

Land use planning broadly addresses the question of land matters, which require *inter alia* policy directions for its establishment. It is an effective tool for land management as it takes cognizance of distributional equity in access, ownership and security, adjudication and settlement, legal dimensions, land administration and land rights. It further enhances the sustainable use, control, environmental sustainability, efficiency, transparent and cost effective administration.

In Kenya, land use planning is achieved through regional and local physical development plans and local farm management systems. Spatial planning involves the systematic and comprehensive consideration of the fundamental organization of both natural and human resources. The Physical Planning Act (Cap 286) provides for the preparation of a Regional Physical Development Plan (Section 16) and a Local Physical Development Plan (Section 24) respectively. Section 29 of the Act (Cap 286), empowers local authorities:

a) To prohibit or control the use and development of land and building in the interests of proper and orderly development of an area;
b) To control or prohibit the subdivision of land or existing plots;
c) To consider and approve all development applications and grant all development permissions;
d) To ensure proper execution and implementation of approved physical development plans.
e) To formulate by-laws to regulate zoning in respect of use and density of development; and

f) To reserve and maintain all land planned for open spaces, parks, urban forests and green belts in accordance with approved physical development plan.

2.6.3. Environmental Management Implications

Regional Physical Development Plans focus on a sub-region, which at times is homogenous in terms of natural resource endowment, socio-economic and cultural underpinnings. Regional plans enhance protection and conservation of water catchment areas as well as a large span of biological habitats such as migratory corridors.

Local physical development plans prepared for towns similarly support the protection and conservation of green belts, arboreta, riparian reserves and sensitive ecological areas such as wetlands. The plans promote environmental quality in towns. Other plans such as action plans, advisory plans, subdivision schemes and/or part development plans are site specific and are detailed enough to indicate fragile and sensitive environments that require conservation and protection.

Land Authority Services Delivery Action Plans (LASDAP) prepared by respective local authorities are effective implementation tools upon which residents participate in project identification, budgeting and implementation. These LASDAPs are funded through the Local Authority Transfer Fund (LATF). Lack of implementation of most plans therefore will be addressed through this process in every local authority.

2.6.4. Land Information Management System

Land Information Management System contains database that uses geographically (spatially) referenced data as well as non-spatial data and includes operations or procedures that support spatial analysis (Table 2.3). The data in a LIMS are organized to yield useful knowledge such as map models with geographical extent, land and land based inventory (land use, land cover, underground resources and land suitability), ownership, tenure, valuation, taxation and fees, land availability, accessibility and encumbrances (restrictions, easement and way-leaves). Other useful knowledge that LIMS has includes land values, physical development, infrastructure and utilities, marine and fresh water resources, topography and geomorphology, soil types, geology and climate. LIMS has also functional capabilities for data capture, input, update, manipulation, transformation, visualization, combination, query, analysis, modeling, output and timely retrieval of information.

There is need to acquire and install appropriate LIMS technologies to address land management issues. LIMS provides high technology for use in data capture, storage, processing, administrative, economic and legal management. Users of LIMS are many and range from existing or prospective landowners or occupiers to lawyers, surveyors, physical planners, administrators, environmentalists, researchers, valuers, real-estate managers, NGOs and agencies at all levels of Government.

Table 2.3. Institutions using land information management systems (LIMS) and their capacities

Status of Land Information Management Systems		
Institutions	***Capacity***	***Role of LIMS in Environmental Management Policy Formulation***
Department of Survey of Kenya	▪ Cadastral survey plans (FR) ▪ Preliminary index diagram (P.I.D.) ▪ Deed plans ▪ Boundary plans (e.g. forest boundaries) ▪ Registry Index Maps (R.I.Ms.) ▪ Survey computations ▪ Field data collection	▪ Identification of land reference number, parcel number, deed plan number. ▪ Identification of boundaries on the map. ▪ Planning for the present and for the future. ▪ Determination of areas and physical extent.
Department of Lands	▪ Ownership ▪ Title numbers ▪ Rates and rents	▪ Reduces disputes ▪ Reduces loopholes in environmental management. ▪ Security/guarantee to development and planning for the future.
Department of Physical Planning	▪ National plans ▪ Local plans ▪ Part development plans	▪ Proper present and future planning ▪ Proper land use planning
Department of Land Adjudication	▪ Number of settlement farms ▪ Number and names of allotees	▪ Poverty alleviation ▪ Reduction of landlessness
Local Authorities	▪ Infrastructure ▪ Water pipes ▪ Sewer lines ▪ Power lines ▪ Roads ▪ Pavements etc.	▪ Planning of drainage and wastewater disposal. ▪ Land use ▪ Land cover ▪ Spatial or Physical planning ▪ Waste disposal.
Kenya Power and Lighting	▪ Capacity of power generation and supply ▪ Power way leaves	▪ Generation of power for irrigation.
Other Institutions ▪ Universities ▪ Parastatals etc.	▪ Land use maps ▪ Population	▪ Various databank of relevant land information ▪ Training

2.7. ENVIRONMENTAL ASSESSMENT

2.7.1. Strategic Environmental Assessment

The Strategic Environmental Assessment (SEA) is a formalized, systematic and comprehensive process of evaluating the environmental impacts of a policy, plan, programme and its alternatives, including the preparation of a written report on the findings of that evaluation, which findings should be reviewed by the responsible Authority.

SEA includes prediction and evaluation of social, economic and health impacts as well as environmental impacts. SEA provides decision makers with information (and often recommendations) on the anticipated consequences of their choices. SEA is therefore a proactive management tool with technical input, which integrates environment concerns at the higher level than EIA.

SEA is provided under Section 6 of the Environmental (Impact Assessment and Audit) Regulations, 2003. The regulations require that lead agencies should in consultation with the Authority (NEMA) subject all proposals for public policy, plans and programmes for implementation to a Strategic Environmental Assessment. SEA therefore determines which

of the proposals are the most environmentally friendly and cost effective when implemented individually or in combination with others. The assessment carried out under this regulation shall consider the effect of implementation of alternative policy actions taking into consideration the following:

a) Use of natural resources;
b) Protection and conservation of biodiversity;
c) Human settlement and cultural issues;
d) Socio economic factors;
e) Protection and conservation of natural physical surroundings of scenic beauty as well as those of built environment of historic or cultural significance; and
f) Government and all the lead agencies shall in the development of sector or national policy, incorporate principles of strategic environment assessment.

Policies and plans related to land which should be subjected to SEA:

a) Proposed Land Policy
b) Sessional Paper No.10 of 2000 on National Population Policy for Sustainable Development
c) Existing and Proposed Forest Policy
d) Kenya National Biodiversity Strategy and Action Plan
e) National Action Programme for Combating Desertification
f) National and District Development Plans
g) Strategy for Revitalization of Agriculture (2004-2014)
h) Poverty Reduction Strategy Paper for the Period 2001-2004
i) Agriculture Policy
j) Wildlife Policy
k) Water Policy
l) Health Policy
m) Industrial Policy
n) Housing Policy
g) Energy Policy

The regional authorities should also subject their programmes to SEA.

2.7.2. Cumulative Environmental Assessment (CEA)

The Draft Constitution of Kenya, Chapter 8 on Environment and Natural Resources proposes the protection of the environment through measures that maintain a clean, safe and healthy environment including establishment of systems of environmental impact assessment, environmental audit and monitoring of the environment and encouraging public participation.

EMCA, 1999 Parts VI and VII (Sections 58 through 69) requires EIA and EA on projects prescribed in the Second Schedule of the Act. Seemingly, minor activities within projects and communities (open air markets, jua kali garages, informal dumping site, solid waste disposal, etc), which are not indicated in the Second Schedule, may lead to cumulative impacts on environment, hence the need for their monitoring and assessment through CEA process. Some of these cumulative activities are discussed herein and indicated in table 2.7.

Table 2.4 lists some of activities and micro-projects that generate waste with potential for cumulative environmental impacts within Kenyan urban centres and rural areas. Some of the cumulative impact indicators are also discussed.

Housing Stress: Research indicates that people earning incomes in the lowest 60%, use on average 63% of the income to pay rent, making them go without adequate clothing and food. This has pushed people to live in slums, which do not have infrastructure like water and sanitation.

Heavy Metal Loading: Heavy metal loading and contamination in the soils and water bodies is a significant indicator of cumulative effects from various micro-land use activities such as unregulated light industries and jua kali sites. A study on heavy metal contents in Kenyan soils was assessed from industrial towns of Central and Western Kenya. The metals included cadmium (Cd), chromium (Cr), copper (Cu), manganese (Mn), nickel (Ni), lead (Pb) and, zinc (Zn). Soil samples were taken from areas suspected to be polluted with heavy metals. These included sites near ceramic, leather tanning, paper, paint, chemical, textile and cement industries. The studies were conducted in Nairobi, Athi River, Thika, Nakuru, Eldoret, Webuye, Kisumu and Embu (Table 2.4).

The results were recalculated and reported following the Dutch Environmental Standards of Heavy Metals (as per Soil Protection Act) on basis of OM content and Clay % (Table 2.5). Six (6) industrial towns out of eight (8) considered are polluted by at least one of the heavy metals. However, there are no standards and guidelines concerning heavy metals contamination of soils.

The Persistent Organic Pollutants (POPs): Persistent Organic Pollutants (POPs) are significant indicators of cumulative effects on environment. Kenya is a signatory to the Stockholm Convention which seeks to eliminate or restrict products and use of the following POPs: aldrin, endrin, dieldrin, chlordane, DDT, toxaphane, mirex, heptachlor, hexachlorobenzene, PCBs, dioxins and furans. The identified main sources of POPs in Kenya are the use of pesticides (expired pesticides), industrial sources (manufacture, mining, and power/electricity) and by products of combustion including burning of wastes.

2.7.3. Radiation in Environment

Radiation is a form of energy resulting from cumulative effects of various human use of technology and natural resources. Radiation is energy that travels in the form of waves or particles and has been a natural part of the earth's environment. However, hazards and risks to the public and the environment need to be protected from the harmful and avoidable effects of exposure to radiation.

Table 2.4. Sampling sites and levels of selected heavy metals in Kenyan Soils (mg/kg)

Site	Sample no.	Cd	Cr	Cu	Mn	Ni	Pb	Zn
	Limits							
Kikuyu	1a	2.72	19.9	10.2	1272	5.83	46.9	164
	1b	2.58	19.9	9.29	1321	5.01	53.3	93.8
Kangemi	2a	-	2.54	3.25	213	0.93	34.8	24.3
	2b	1.09	23.9	12.8	3554	7.95	57.3	103
Roysambu	7	1.63	1194	17.6	3203	5.72	42.6	82.2
Clayworks	8	1.88	17.1	15.6	1636	11.0	43.2	185
Chiromo	3a	0.98	8.26	6.73	2889	2.30	40.5	97.7
	3b	0.79	10.6	7.43	3285	4.37	60.0	108
Kamukunji	4a	1.41	15.9	40.1	6330	10.5	198	264
	4b	0.68	13.5	46.9	4035	8.18	195	414
Dandora D.	5	1.03	15.5	49.6	8598	9.60	953	459
Ceramic ind.	9	0.51	26.0	222	8175	28.2	230	455
Robbialac	10	0.95	22.3	26.5	7936	15.2	169	595
Kenpoly	11	0.54	12.6	24.1	4871	14.1	20.1	417
Ind. Area	18	2.26	66.6	268	4034	42.8	2584	1251
Farming 1	19	1.06	219	452	4106	88.4	382	2112
Farming 2	20	-	18.2	19.1	7955	19.9	31.4	220
Esso depot	21	-	5.12	4.65	910	0.07	10.3	71.8
Uhuru Park	45	0.90	26.0	11.1	2116	17.3	18.2	161
Jevanjee G.	46	-	26.7	18.4	6113	25.6	82.6	214
Ruai	6a	0.08	59.9	28.5	3005	3.84	178	228
	6b	0.46	18.7	19.6	3603	2.87	139	139
Athi R. 1	12	1.11	13.8	17.4	5139	14.2	19.2	179
Cement F.	13	-	17.6	20.9	6356	17.5	17.9	122
	14	-	14.7	15.1	1746	10.4	9.09	99.4
	15	-	21.2	42.4	1132	15.6	32.0	87.3
A. tannery	16	0.92	19.4	19.9	3444	17.2	12.1	176
Athi R. 2	17	0.38	15.4	18.5	2729	13.8	12.8	126
L. Nakuru	22	0.43	-	4.65	960	-	13.7	137
E. batteries	23	0.40	27.1	34.3	7078	11.4	107	7569
Eldoret								
Ken knit	24	0.51	74.1	18.2	8402	34.9	31.7	180
Raymond	25	-	77.3	25.9	2846	26.2	132	299
Rivatex	26	1.33	74.2	25.0	3714	42.9	9.40	181
	27	0.57	63.6	32.7	8286	44.0	46.6	902
EATEC	28	0.24	45.0	59.7	3438	33.7	55.7	1042
Eld Town	29	0.70	55.0	29.0	4009	28.3	68.6	204
Webuye P.	30	-	105	39.7	1389	34.4	11.2	58.2
	31	-	130	34.1	2106	45.3	22.8	53.3
	32	0.51	111	48.7	1261	41.8	60.9	117
Webuye S.	33	2.09	226	54.4	2662	47.5	59.4	54.8
Panpaper	34	0.76	23.5	7.54	167	8.96	12.5	23.9
Kisumu								
Kicomi	35	1.25	22.9	51.1	9033	30.0	72.8	219
T. Centre	36	1.14	12.7	30.5	9032	11.8	97.8	225
L. Victoria	37	3.16	49.9	630	6383	63.4	499	823
Sunset	38	1.26	15.3	17.5	9145	15.0	73.5	148
Embu RC	39	3.18	32.1	21.1	4334	37.7	28.7	224
Njukiri F	40	3.88	11.4	9.6	23.73	11.8	32.5	221
Embu T.	41	1.11	27.4	15.9	4741	26.7	12.9	227
Thika								
Kelchemicals	42	-	90.6	26.1	2050	19.0	443	158
Kensack	43	3.36	68.8	383	3661	23.3	65.6	393
Metal box	44	3.34	39.9	18.3	9149	33.4	75.9	153

Source: Gachini (1995)

Table 2.5. Dutch classification of contaminated soils

	Soil mg/kg dry matter				
Element	A	B	C	New-B	New-C
Cr	00	250	800		380
Cd	0.8	5	20		12
Cu	50	100	500		190
Ni	50	100	500		210
Pb	50	150	600		530
Zn	200	500	3000		720
Mn	?	?	?	?	?

A= reference (target value); B= test value for further investigations; C= clean-up action
New-B value = (A+C)/2 – trigger value.

A-values are based on OM content of 10% and clay content of 25%. A special formula for each element in the Kenyan soils was used assuming OM of 4% and sample clay% 4). Results are presented in table below.

Table 2.6 Approximate clay percentage values for the Kenyan soils (mg/kg)

Site	Sample no.	Clay	Cr	Ni	Cu	Zn	Cd	Pb
Kikuyu	1a	45	140	55	44	191	0.8	99
	1b	45	140	55	44	191	0.8	99
Kangemi	2a	15	80	25	26	101	0.6	69
	2b	45	140	55	44	191	0.8	99
Roysambu	7	10	70	20	23	86	0 6	64
Clayworks	8	35	120	45	38	161	0.7	89
Chiromo	3a	35	120	45	38	161	0.7	89
	3b	35	120	45	38	161	0 7	89
Kamukunji	4a	35	120	45	38	161	0.7	89
	4b	10	70	20	23	86	0 6	64
Dandora D.	5	10	70	20	23	86	0 6	64
Ceramic ind.	9	15	80	25	26	101	0 6	69
Robbialac	10	10	70	20	23	86	0.6	64
Kenpoly	11	50	150	60	47	206	0 8	104
Ind. Area	18	15	80	25	26	101	0.6	69
Farming 1	19	18	86	28	28	110	0 6	72
Farming 2	20	70	190	80	59	226	1.0	124
Esso depot	21	10	70	20	23	86	0 6	64
Uhuru Park	45	60	170	70	53	236	0 9	114
Jevanjee G	46	25	100	35	32	131	0.7	79
Ruai	6a	20	90	30	29	116	0.6	74
	6b	15	80	25	26	101	0 6	69
Athi R. 1	12	60	170	70	53	236	0 9	114
Cement F.	13	10	70	20	23	86	0 6	64
	14	15	80	25	26	101	0 6	69
	15	15	80	25	26	101	0.6	69
A tannery	16	60	170	70	53	236	0 9	114
Athi R. 2	17	60	170	70	53	236	0.9	114
L. Nakuru	22	25	100	35	32	131	0 7	79
E. batteries	23	10	70	20	23	86	0.6	64
Eldoret								
Ken knit	24	10	70	20	23	86	0.6	64
Raymond	25	10	70	20	23	86	0 6	64
Rivatex	26	5	60	15	20	71	0.5	59
	27	5	60	15	20	71	0.5	59
EATEC	28	20	90	30	29	116	0.6	74
Eld Town	29	12	74	22	25	92	0.6	66
Webuye P.	30	16	82	26	27	104	0.6	70
	31	20	90	30	29	116	0.6	74

	32	22	94	32	31	122	0.6	76
Webuye S.	33	15	80	25	26	101	0.6	69
Panpaper	34	25	100	35	32	131	0.7	79
Kisumu								
Kicomi	35	24	98	34	32	128	0.7	78
T. Centre	36	20	90	30	29	116	0.6	74
L. Victoria	37	10	70	20	23	86	0.6	64
Sunset	38	8	66	18	22	80	0.5	62
Embu RC	39	50	150	60	47	206	0.8	104
Njukiri F	40	50	150	60	47	206	0.8	104
Embu T.	41	25	100	35	32	131	0.7	79
Thika								
Kelchemicals	42	8	66	18	22	80	0.5	62
Kensack	43	5	60	15	20	71	0.5	59
Metal box	44	30	110	40	35	146	0.7	84

External exposure to radiation arises from diverse artificial and natural sources. Natural sources of radiation are cosmic rays from outer space, primordial or terrestrial radionuclides believed to have been produced when the matter of which the universe is formed first came into existence several billion years ago (Mustapha 1999).

Concentrations of radionuclides in environmental materials depend on geographical location, distribution of naturally occurring radioactive materials, uptake and retention by environmental agents forming the food chain and dispersal into the air. Various forms and/or components of radiation sources on land-based activities are herein discussed.

Naturally Occurring Radioactive Materials (NORMs): Rocks and sand used for building and construction purposes are mined extensively throughout the country. Such rocks, sand and attendant soils contain varying concentrations of potassium, rubium, radium, thorium and their contribution to internal and external radiation doses may be significantly high if they are extracted from high radiation background areas. Areas with high background radiation include Mrima Hill in Kwale, Cost Province; Ruri, Luwala Hill south of Tuige and Homa mountains in Western Kenya and Usaki near Homa Bay in South Nyanza (McCall, 1958; Heinrich, 1958; Patel, 1991).

Other studies on natural radioactivity in building materials indicate that quarrying of stones and sand exposes miners, not only to external radiation, but more so to radioactive dusts. The study recommends epidemiological surveys into incidences of health effects of radiation exposures among quarry workers (Mustapha et al).

Although the concentration of NORMs is generally low, higher concentrations may arise as a result of technological intervention by man. Such activities include production and application of phosphate fertilizer, non-radioactive ore mining and water treatment facilities, among others. The basic principle of the guidelines for handling and control of NORMs is that the same radiation exposure standards that apply to regulated radioactive materials should also apply to naturally occurring radioactive materials.

Any land use policy must therefore embrace and incorporate the aspect of naturally occurring radioactive materials, particularly in areas of elevated radioactivity, to safeguard against re-concentration, unwarranted public exposure and environmental contamination. It is therefore of

outmost importance that land with elevated radioactivity be properly surveyed, mapped and be placed and protected under a statutory legal notice.

Radiation for Improving Productivity in Agriculture: Stable and radioactive isotopes can be used as 'tags' at molecular level to monitor how plants use essential nutrients. Such techniques allow scientists to determine the exact nutrient and water requirements of a crop in particular conditions, making it possible to find sustainable alternatives for that area.

Isotopic techniques have three main strategies including sustainable agriculture intensification on the most suitable arable land, conversion of marginal lands to appropriate land uses, reducing and/or eliminating the extensive grazing of low-productivity rangelands and restoration of degraded lands and ecosystems.

Insect pests are another serious threat to productivity as they devastate crop yields and transmit disease to both crop and livestock. There are concerns that reliance on pesticides to maintain yields not only has negative impacts on the environment, but may also lead to insects developing resistance to the pesticides themselves. Nuclear science has been used to develop environmentally friendly alternatives for pest control. One of the most successful techniques is the sterile insect technique (SIT).

Facilities have been established for applying isotope techniques in soil/plant studies concerning the efficient use of fertilizers both organic and inorganic. Capability now exists (under KARI) for N-15 and P-32 soil/plant research. Isotope-aided studies have been undertaken on nitrogen fixation, fertilizer application strategies and the potential of phosphate rock as a source of phosphorus for plants. Production of high yielding, drought resistant cultivers of high quality through the use of nuclear and *in vitro* techniques for major food and oil crops, is underway.

The National Veterinary Laboratory has improved its capability to diagnose and monitor animal disease through nuclear techniques. Integrated area-wide management of the tsetse is an ongoing project where an irradiator facility is being set up at the Kenya Trypanosomiasis Research Institute (KETRI).

Improving productivity in agriculture in a sustainable manner is today a realistic target. Nuclear science offers proven techniques that can and are being used to improve productivity, while conserving valuable resources needed now and in the future.

Radiation for Improving Human Health: Good nutrition depends not just on having enough food to eat, but also on the proper amount of essential nutrients. Micronutrient deficiency is a major public health challenge. Nuclear and isotopic techniques are being used to address nutritional problems specific to a region. Data acquired with these nuclear tools are being used to review national policies and to set nutritional guidelines tailored to local conditions and needs.

Nuclear techniques are also being used to address important health problems at the heart of the sustainable development challenge. In many instances, these techniques offer unique and cost effective means, over conventional methods, to prevent, diagnose and treat a wide variety of diseases and conditions that affect health.

Medical exposures contribute the highest man made radiation doses to the Kenyan population. The extent of radiation practices in both the public and private health sector is significant with both diagnostic and therapeutic techniques involved. The trend is on the rise due to the ever-growing population demand. Location and set up of such practices is regulated and such regulations should be ever more stringent. Radioactive wastes arising from medical radiation facilities is of environmental concern and priority should be given to the safety of such radioactive wastes.

Isotope Hydrology: Isotope hydrology is a nuclear technique that uses both stable and radioactive environmental isotopes to trace the movements of water in the hydrological cycle. Isotopes can be used to investigate underground sources of water to determine their source, how they are recharged, whether they are at risk of saltwater intrusion or pollution, and whether they can be used in a sustainable manner.

Isotope hydrology is a nuclear technique used to assess, harness and dramatically increase investment in water access, especially ground water which is a cornerstone of social-economic development of ASALs.

With the prospect of growing water scarcity looming, decisions on where to extract water, how much of it to use, and how to manage it must be based on sound and reliable information, to protect this resource for future generations. Isotope hydrology is an important tool being used around the world to provide the information needed to make the right decisions.

Nuclear Technology in Industry Applications: Nuclear techniques are used in industries applications, especially in process quality control (industrial nuclear gauges), road construction, oil well logging and moisture nuclear gauges, and non-destructive testing.

Radiation in Research: Research institutions undertake various research activities with radioactive materials varying in radioactivity strength from micro-curies to kilocuries. Operations as well as wastes arising out of such operations need to be under regulation to safeguard public and environmental safety. Release of radionuclides into the environment will result in ambient environmental contamination, which will subsequently result in the contamination of the food chain. Stringent operational regulatory controls must therefore be put in place to safeguard against accidental releases while promoting and enhancing the accruing benefits.

Mobile Telephones and Health Effects: Mobile telephones have revolutionalized the telecommunications industry. Communication between a mobile phone and the nearest base station is achieved by microwave emissions from the antenna. Concerns have been raised about the mobile phone whose antenna is in the handset. In this case, the antenna is very close to the users' head during normal use of the telephone and there is concern about the level of microwave emissions, which the brain is exposed to. There are two sources of radiofrequency (RF) exposures from the mobile phone system:

a) Base station antennae; and
b) The mobile phone or handset.

The exposure from the antennae is continuous (but lower), irradiates the whole body and exposes an entire community. Exposure from the handset to the head is more intense, is only for intermittent periods and tends to be of concern to the user. Although the chronic but low

phones are different scenarios, the scientific basis for assuming there is sufficient or insufficient evidence for a health hazard is the same for both. When tissue is exposed to sufficiently high levels of microwave, tissue is heated and damage may occur. The Radiation Protection Board has proposed amendments to the Radiation Protection Act so as to regulate non-ionizing radiation (NIR).

Managing Radioactive Waste: Any activity that produces or uses radioactive materials generates radioactive waste. Mining, nuclear power generation and various processes in industry, defense, agriculture, medicine, and scientific research produce radioactive waste and/or by-products that include radioactive waste.

Radioactive waste can be in the form of gas, liquid or solid form and its level of radioactivity can vary. Radioactive waste can remain radioactive for a few hours, several months or even hundreds of thousands of years.

Proper disposal is key to protecting public health and safety and the quality of the environment. Because it is so hazardous and can remain radioactive for so long, finding suitable disposal land for radioactive waste is difficult. Depending on the type of waste to be disposed, the disposal site may remain active for a very long time.

Radioactive waste disposal practices have changed substantially in the last two decades. Evolving environmental protection considerations have provided the impetus to improve disposal technologies, and in some cases clean up facilities that are no longer in use. Designs for new disposal facilities and disposal methods must meet environmental protection and pollution prevention standards that are stricter than originally foreseen at the beginning of the atomic age.

Non-Ionizing Radiation: The modern world is full of devices, which, either directly or indirectly act as sources of non-ionizing radiation (NIR). These sources produce NIR in electromagnetic (EM) spectrum of wavelengths/frequencies ranging from 100nm to static fields.

In general, NIR tends to be less hazardous to humans than ionizing radiation (ionizing radiation has a wavelength less than 100nm or a photon energy greater than 12.4 electron volts). However, depending on the wavelength/frequency and irradiance (power density) value, NIR may present human and environmental hazards. The hazards of NIR can best be understood by considering the EM spectrum as three broad categories:

a) Optical radiation (100nm to 1mm);
b) Microwave radiation (300GHz to 300MHz); and
c) Radiofrequency and lower frequency radiation (300MHz to static fields).

Table 2.7. Activities with cumulative environmental effects

Generators	Type(s)	Status	Cumulative impacts	Response/ Policy	Recommendation
Jua kali	Oil, acid, rubber	Inventory of jua kali yards/ garages	Pollute water, soil, flora, fauna, poor health	Public health, NEMA regulations	CEA/A; containerization, 4Rs
Open markets		Inventory	"	NEMA regulations	Bio-degradable
Factories (Ind)	Chemicals	Types, quantity	"	NEMA regulations	Polluter pay for clean up, CP
Factories (single)	Printing	Types, quantity	"	NEMA regulations	Polluter pay for clean up
Dumping sites	Effluent/ disease vector	Designated/ non designated	"	NEMA regulations	Site location, sort waste
Domestic leakage	Effluent/ disease vector	Blocked sewers	"	Public health, NEMA	Water and Sewer services privatise, polluter pay
Flood hazard	Waterborne disease vectors	Bi-annual (Nyando, Wajir, Bundalangi)	Land degradation, poor health	Min Water, MoA, Public health	Dykes, drains, catchment protection & conservation
Mobile telephony	Used cards/ phones & accessory, radiation from masts	1,000,000/ month	Nuance/ aesthetic, degradation, radiation	NEMA regulations	Return, recycle, re-use, reduce (4R), polluter pay; promote phone back initiative
Current slums and expansion	Effluent/ disease vector	Current acreage and annual growth	Pollute water, soil, flora, fauna, poor health	Physical planning/ Public health	Rehabilitation/ upgrading, housing policy, infrastructure
Plastic bags	Blockage, nuance	Annual consumption	Pollute water, soil, flora, fauna, nuance, aesthetic	NEMA regulations, Cleaner production (CP)	4Rs, use bio – degradable material, promote CP
Horticulture	Chemicals	Coverage, types and quantity of chemicals	Pollute water, soil, flora, fauna, poor health	BEP/ BAT/ GAP	BEP/ BAT/ GAP
Commercial farms	"	"	"	"	"
Hospitals	Medical waste	Types, no incinerators	Pollute water, soil, flora, fauna, poor health	Public health	Incinerators
Food Kiosks	Effluent/ disease vector	Used oils, detergents, faecal	Pollute water, soil, flora, fauna, poor health	Public health	Planning, infrastructure
Invasive/ unpalatable species and inappropriate plants	Plants, fish, animals,	*Prosopis* sp, Hyacinth, Nile perch, Eucalyptus, *Ipomea hilderbrinti, Lantana camara*	Poverty, land degradation, Pollute water, soil, flora, fauna, poor health	Research KARI, KETRI, KEFRI, KEMRI, KEVEVAPI KEPHIS	Border entry control, rehabilitation
Regional Refugee	Effluent, fuel wood,	influx in camps in NE, Coast, Nairobi -eastleigh	Pollute water, soil, flora, fauna, poor health, Land degradation	UNHCR, Home Affairs, NGOs	Facilitate conflict resolutions and Peace initiatives in the Region
Local refugees	Effluent, fuel wood,	Camps at schl, mkt centres	"	Lands, Home affairs	Facilitate conflict resolutions and resettlement

Inadequate iddle and low income Housing	Indecent housing "House stress"for 2M income earners	Lowest 60% ofincome earners spend 64% on rent (nil investment)	Negative development economics (traffic jams, unproductive - late/ absent workers)	Shift from affluence to slums (Buruburu – Umja – Dandora – Kayole – Njiru)	Investor friendly land tenure policy for middle and low income housing; amalgamate 14 land Acts to one
Exhaust / combustion engines, generators	Air, noise, Acid rain, ozone layer	Noise in decibels, air and water pollution loads, UV rays	Pollute water, soil, flora, fauna, poor urban health,	NEMA regulations, Traffic police, factory inspection	Ban lead in fuel, enforce traffic for smoke, serviceable machines (vehicles)
Jails, schools, children/ remand homes, Slaughter houses	Air, noise, air/waterborne disease	Overcrowded jails, remand, schools	Poor health, pollution, land degradation	Home Affairs, Physical planning	Community service, family values

Complaints from the public relating to land-use were received and investigated by the Public Complaints Committee (PCC) during the 2004 period (Box 2.1).

Box 2.1. Cases investigated by the PCC that related to land-use

The cases are reported to PCC by affected parties including members of the public. The investigations were undertaken either on site assessment/observations, scientific analysis or by consultative meetings. The nature of cases investigated relating to land use include:

a) Uncontrolled mining and quarrying activities;
b) Sand harvesting mainly in Eastern Province;
c) Uncontrolled and unregulated agricultural activities leading to soil erosion for example, in Upper Matasia of Ngong Hills, Kajiado district;
d) Inefficient irrigation schemes causing salinization of the soil and siltation of water masses, e.g., irrigation schemes in Baringo;
e) Overstocking resulting in over exploitation of natural resources in arid and semi arid areas;
f) Subdivision of land in peri-urban areas, e.g., Kitengela, Ongata Rongai and Kasarani; and
g) Poor waste disposal mainly in urban areas, especially in Nairobi, Nakuru, Kisumu, Mombasa, Malindi and Eldoret.

The Committee established that both planned and unplanned land use activities contribute to environmental degradation. Complaints affecting planned land use activities were related to non-conformity with the provisions of EMCA 1999. The committee noted that lack of clear policies on land use was a major contributing factor to activities that cause adverse effects on environment. Inadequate enforcement of existing laws and regulations has also contributed to poor enforcement and environmental management. The Committee therefore recommends that the relevant institutions should formulate and implement an integrated land resource policy supported by sustainable land management practices.

2.8. INTERNATIONAL AGREEMENTS RELATING TO LAND IN KENYA

2.8.1. Multilateral Environmental Agreements (MEAs)

Kenya's commitment to implement global and regional environmental agreements that influence land use can be ascertained by her acceptance, accessions and ratifications. The following provides an illustrative profile and commitment. The Multilateral Environment Agreements (MEAs) are legal instruments that are utilized to enhance the global responsibility in the management of the environment and natural resources.

Convention on Biological Diversity (CBD)

The purpose of this Convention is to ensure the conservation and sustainable use of biodiversity. It came into force on 19th December 1993; it has 188 parties, 168 of whom are signatories. Kenya signed the Convention on 5th June 1992 and ratified it on 26th July 1992. The National Environment Management Authority (NEMA) acts as the national focal point with regard to this Convention.

The implementation of the CBD impacts on land in many ways. For example, the designation of reserves or protected areas for preservation of flora or fauna, restricts use of such land. The provisions of the Convention have been integrated in many laws of Kenya.

Firstly, the Environmental Management and Co-ordination Act (EMCA) of 1999 provides for the conservation of biodiversity. NEMA in consultation with lead agencies is charged with maintaining an inventory of biological diversity; determining which components of biological diversity are endangered, rare or threatened with extinction, establish national plans on the protection and sustainable use of biological diversity and access and sharing of benefiting arising from genetic resources. The conservation of our biological diversity can be attained in the natural habitat of the species (*in situ)* or outside that habitat (*ex-situ*).

The Fisheries Act (Cap) 378 regulates the fishing industry in all areas including lakes, rivers and marine habitats. The protection of biodiversity in such areas is achieved in several ways. Section 5 of the Act empowers the Director of Fisheries to gazette closed seasons for designated areas, species of fish, methods of fishing and fishing gear used. The Director can also limit the amount, size, age and species of fish that may be caught, landed or traded. These measures permit sustainable use of this biodiversity while ensuring that the species flourishes.

The provisions of the CBD are domesticated in the Wildlife (Conservation and Management) Act, (Cap 376) which mandates the Kenya Wildlife Services (KWS) to manage and conserve wildlife for the benefit of Kenyans in terms of cultural, economic, aesthetic and scientific gains. They are also domesticated in the Forest Act (Cap 385), which Act provides for the conservation and management of flora and fauna in lands declared by the Minister to be forest or natural reserves. Any activity on such land is regulated and controlled so as to ensure that utilization of the resources is not at the expense of the natural biodiversity.

The Seed and Plant Varieties Act (Cap 326) regulates seed development, transfer, importation and use. The Act's scope includes seed testing, certification, cross-pollination and importation. Plant varieties are indexed in accordance with the CBD as new varieties are developed. The use of specific plants and seed varieties on land is regulated by the Act. The Act also seeks to deal with the grant of proprietary rights (intellectual property rights) to persons breeding or discovering new varieties.

The Plant Protection Act (Cap 324) aims to preserve plant varieties, by preventing and controlling pests and diseases that are likely to damage the faunal diversity. Section 3 of the Act empowers the Minister to make regulations that assist in the control of pests and diseases. The onus of applying the regulations is placed on the owner or occupier of land. The Plant Protection Order and the Plant Protection Rules enumerate pests and diseases that fall within the ambit of control of the Act.

The lead agencies are as vast as the domestication laws. They include NEMA, KWS and the ministries in charge of Forests and Agriculture

Cartagena Protocol on Biosafety

This Protocol is complimentary to the Convention on Biological Diversity. The objective of the Cartagena Protocol is to create a balance between the benefits that accrue from biotechnology, while safeguarding the environment and human health from the potential harmful effects that biotechnology may pose. The Protocol adopts the preventive and precautionary approaches as is envisaged by Article 1 to the Protocol which provides *inter alia*

> *"...to contribute to ensuring an adequate level of protection in the field of the safe transfer, handling and use of living modified organisms resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity, taking also into account risks to human health, and specifically focusing on trans-boundary movements."*

The Protocol was adopted on 29th January 1999 and ratified by Kenya on 24th January 2002. It has 111 parties, 103 of whom are signatories. The national focal point for the Protocol is the National Council for Science and Technology. The provisions of the Protocol are captured in EMCA (1999). Section 53(2) (d) and (e) require NEMA in consultation with relevant lead agencies to prescribe bio-safety measures necessary to regulate biotechnology as well as measures to regulate the development, access to and transfer of biotechnology.

The provisions of the Protocol require that activities on land be restricted where a biotechnological risk exists. For instance, farming of certain modified plant varieties may be prohibited, or rearing of a certain breed of animal may be restricted where this is likely to result in negative impacts on the environment or human health.

United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC was adopted on 9th May 1992 and came into force on 21st March 1994. The Convention has been ratified by 189 states. Kenya ratified it on 30th August 1994. The primary purpose of this Convention is to establish methods to minimize global warming and in particular the emission of green-house gases.

Sections 78-85 of the EMCA provide for measures to preserve air quality by controlling air pollution, which could result in climate change. Any owner or operator of a trade, industrial undertaking or an establishment likely to cause air pollution must apply for an emission license to NEMA, which is also empowered to order the proprietors to carry out an environmental impact assessment study or environmental audit where it is deemed necessary to conduct one. Emissions that cause air pollution in contravention of the emission standards prescribed are prohibited.

The UNFCC informs land use in so far as activities on land are required to be designed to have a minimum negative effect on factors that may result in climate change. Factories that release greenhouses gases in their operations may eventually be required to close down. Agricultural activities that require the use of chemicals likely to contribute towards global warming such as pesticides and acaricides may also be prohibited.

Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC)

The Kyoto Protocol requires signatories to reduce their greenhouse gas emissions levels to 5% below 1990 levels by the year 2012. The Protocol came into force on 16th February 2005, after it received the pre-requisite signatures. However, with the United States, Australia, China and India not being signatories, the future of the protocol looks uncertain. NEMA is the national focal point for this Protocol.

United Nations Convention to Combat Desertification (UNCCD)

This Convention was adopted on 17th June 1994 in Paris and came into force on 26th December 1996. Its purpose is to address the problem of the degradation of land by desertification and the impact of drought, particularly in arid, semi-arid and dry semi-humid areas.

Kenya ratified the Convention on 24th June 1997. The provisions are domesticated in several Acts of Parliament. Section 46 of EMCA requires District Environment Committees to identify areas that require re-forestation or afforestation as well as to mobilize local communities to carry out these activities. Section 48 empowers the Director General of NEMA to enter into a contract with a landowner to register such land as a forest after consultation wit the Chief Conservator of Forests.

The Forest Act (Cap 385) is dedicated to the creation, preservation and sustainable use of forests. The declaration of land as forest or natural reserves is the chief conservation mechanism.

The Agriculture Act (Cap 318) also encompasses the principles of the UNCCD particularly in Part IV of the Act –*Preservation of the Soil and its Fertility*. Section 48 of the Act empowers the Minster to issue regulations prohibiting, preventing or controlling the clearing of forests for cultivation and deforestation amongst other practices. The Director of Agriculture as per Section 50 of the Act may issue Orders for re-forestation or afforestation to the owner or occupier of a specific piece of land. NEMA is the focal point for the Convention.

The obvious effect of the Convention on land use in Kenya is the extent to which land is utilized for tree planting, nurturing of tree nurseries or the reservation of forests on the one hand while limiting alternative land use activities for example clearing forests for cultivation, human settlement, development of infrastructure or set up of business enterprises.

Convention on International Trade in Endangered Species (CITES)

This Convention was adopted on 3rd March 1973 and came in to force on 1st July 1975. The purpose of the Convention is to regulate the international trade in wild plants and animals that are at risk of extinction as a result of trade. The Convention seeks to control trade not only in live species, but also in dead specimen and their derivatives.

CITES identifies the species that it protects and classifies them into three categories, those that are currently at risk of extinction, those that probably may be at the risk of extinction if the trade in them is unregulated and finally those that member states have listed since they are under managed control and require the co-operation of other states in order to succeed.

The Kenya government ratified CITES on 13th December 1978. The lead agency is the Kenya Wildlife Service. The Convention is domesticated in the Wildlife (Conservation and Management) Act (Cap 376). Section 40 of the Act prohibits the importation of any trophy, or un-manufactured ivory or rhinoceros horn. Importation of this nature can only be done through a customs port of entry.

The strict controls on exportation of certain species of flora such as *Aloe vera* may result in farmers of these species destroying their crops in instances where a ready international market for the same is not available to absorb this crop. The resultant effect is that the indigenous species may become extinct as farmers revert to using their land for other types of crops.

Convention for the Protection of the World Cultural and Natural Heritage

This Convention was adopted in Paris on the 21st November 1972. The Convention currently has at least 178 signatories. Its primary purpose is to preserve cultural and natural heritage, which includes monuments, architectural works, cave dwellings, painting and natural formations that are universally outstanding. Kenya ratified the Convention on 5th June 1991. The National Museums of Kenya is the national focal point.

The provisions of the Convention are captured in the Antiquities and Monuments Act (Cap 215), which aims at preserving national heritage. Section 2 of the Act defines an antiquity as any movable object other than a book or document made or imported into Kenya before 1895. Human, faunal or floral remains in Kenya dating back to the benchmark date of 1895 are also deemed to be antiquities.

In order to discharge the requirements of the Act several institutions have been established, including the National Museums of Kenya and the Kenya Cultural Centre. The impacts of this Convention include the existence of monuments such as Fort Jesus in Mombasa, or the archaeological remains on sites such as Oloregesaile, which are now reserved for this purpose only.

Convention on the Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention)

The Convention was adopted in the town of Ramsar, Iran on 2nd February 1971; it came into force on 21st December 1975. Kenya ratified the Convention on 5th June 1990. Wetlands are broadly defined to include marsh, fen, 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 tide does not exceed six metres.

The implementation of the Convention on Wetlands is guided by its mission statement, which is *"the conservation and wise use of wetlands, by national action and international cooperation as a means to achieving sustainable development throughout the world."* This means ensuring that activities which might affect wetlands will not lead to the loss of biodiversity (with emphasis on waterfowl) diminish the many ecological, hydrological, cultural or social values of wetlands.

The provisions of the Convention are integrated in EMCA (1999). Section 42 of the Act requires that an Environmental Impact Assessment report must be prepared before any project on or likely to impact on wetlands is carried out. The objective of this practice is to

protect and preserve the wetlands by pre-determining the impact of a project, so as to either reject it, restrict it by imposing conditions or establishing mitigating measures for the same. The approach is a precautionary one. The Kenya Wildlife Service is the lead agency for the Convention.

The Ramsar Convention has influenced and continues to influence land use in Kenya. Implementation of the provisions of the Convention has ensured that wetlands ecosystems have received significant protection. This has lead to the overall upkeep of the wetlands and in some cases the protection of unique waterfowl such as the pink flamingo found in Lake Baringo, Lake Naivasha and Lake Nakuru. This increases tourism activities in these wetlands thus influencing land use through the establishment of tourist lodges, restaurants, campsites and other recreational activities.

The realization of the provisions of the Ramsar Convention also influences land use by activities that are dependent on the water resources from the wetlands such as farming and animal husbandry. Draining of wetlands to increase farmland is prohibited.

Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)
The Convention was adopted on 23rd June 1979, but came into force on 1st November 1983. The Convention is intended to ensure that migratory species of wild animals spelt out in Appendix I and II, to that Convention are protected from extinction. The Convention requires inter-governmental co-operation to ensure that the species are allowed to migrate as their nature and their habitat is preserved.

The Convention was ratified by Kenya on 1st May 1999 and its lead agency is the Kenya Wildlife Service. The provisions of the Convention are domesticated in the Wildlife (Conservation and Management) Act. Part III of the Act provides for a safe habitat for wildlife, which is achieved by creation of national parks, national reserves and sanctuaries. This allows for the perpetuation of wildlife.

The Wildlife (Conservation and Management) Regulations control access to the park, hunting, and trade in wildlife trophies as well as other activities carried out in the demarcated areas. The Third Schedule to the Act outlines protected animals that receive special attention in their management; they include the very young, disabled, albinos and species that are at risk of being endangered.

The Bonn Convention directly influences land use in Kenya in so far as the domestication statute provides for the segregation of land to be used as national parks, reserves and orphanages. A classical case in point is NEMA's attempt to protect the migratory corridor used by the wildebeest in their historical annual migration from the Maasai Mara in Kenya to the Serengeti National Park in Tanzania, which is currently being encroached upon by human settlements.

United Nations Convention on the Law of the Sea (UNCLOS)
The Convention was adopted on 10th December 1982 in Montego Bay, Jamaica and came into force on 16th November 1994. Kenya ratified the Convention on 2nd March 1989. The UNCLOS superseded the 1958 Geneva Conventions, which included:

- Convention on the Continental Shelf.
- Convention on Fishing and Conservation of the Living Resources of the High Seas

- Convention on the Territorial Sea and Contiguous Zone.
- Convention on the High Seas.
- Optional Protocol of Signature Concerning the Compulsory Settlement of Disputes - Law of the Sea.

This Convention was concluded on the understanding that in order to maintain international peace and respect for state sovereignty there is a need to comprehensively and specifically define the territorial boundaries of states, navigational rights and the legal status of resources on the sea bed. The provisions of this Convention are domesticated in the Kenya Maritime Zones Act, which empowers the Minister to limit any provision of the law of the sea to any other international agreement or Convention affecting the maritime zones.

Section 55 of the Environment Management and Coordination Act requires NEMA to prepare an integrated coastal zone management plan based on the report of the survey carried out in consultation with other lead agencies. The Minister is also required under section 55(6) to issue regulations to prevent, reduce and control pollution or any other form of environmental damage in the coastal zone.

This Convention may influence land use in the coastal regions in so far as all activities must be in conformity with the provisions of the Convention. For example, the restrictions may be placed on setting a factory producing certain chemicals or wastes that may damage the ecosystem of the coast and perhaps seep into non-territorial waters or the territorial waters of another state. The Convention may also be of importance in cases where construction of an oil mining station, a port, a habour, a fish farm or a prison is to be built in the sea as has been the practice in some states. The land use must be subject to the limits set by the Convention in terms of breadth of the territorial sea area. The Attorney General's Office is the lead agency for the Convention.

Basel Convention - Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal

The Convention was adopted on 22nd March 1989 and came into force on 5th May 1992. The Convention seeks to put in place measures that reduce the production of hazardous wastes and further to minimize their unlawful transboundary disposal. Dumping in the territories of developing countries was cheaper as their governments were either reluctant or ill equipped to implement policing of hazardous wastes.

Kenya acceded to the Basel Convention on 1st June 2000. Section 91 of EMCA empowers the Standards and Enforcement Review Committee to classify hazardous wastes, whereupon NEMA is required to establish guidelines on the management of the waste. Section 141 of the Act makes it an offence to import, dispose or otherwise manage hazardous wastes contrary to the Act.

Land use is influenced by the application of the provisions of this Convention. The provisions of the Convention call for management of waste that is in line with environmental conservation standards. The use of land as a dumping site for hazardous wastes, for example, should not be haphazard. It should be strategically placed to ensure preservation of environmental quality and human health. As such, any engineered landfills on any land in the country, will not only need to adhere to the national laws on development of such sites, but

must also ensure that it is developed and utilized in conformity with the provisions of the Convention to ensure environmentally sound management of the waste.

2.8.2. Regional Environmental Agreements (REA)

Bamako Convention on Hazardous Wastes within Africa

The Bamako Convention was adopted in Mali, Bamako on 30th January 1991; it came into force on 22nd April 1998. The Convention has 18 parties (ten ratifications and eight accessions). Kenya signed the Convention on 25th March 2004. The Convention has provisions for import, transboundary movement and management of hazardous wastes within Africa. It is intended to fortify the provisions of the Basel Convention in order to protect the African people and their environment against dumping of hazardous wastes. This regional Convention also influences the use of land in Kenya in a similar manner as the application of the Basel Convention.

African Convention on the Conservation of Nature and Natural Resources

This Convention was adopted in Algiers under the aegis of the African Union, on 15th September 1968. The Convention came into force on 16th June 1969. The Convention reaffirms the importance of natural resources both renewable and non-renewable, particularly soil, water, flora and fauna. The objective is to facilitate sustainable use of these resources. Emphasize is on preventive and precautionary measures to conserve and preserve these natural resources.

The provisions of the Convention are contained in the Agriculture Act with regard to soil conservation measures. The Wildlife (Management and Conservation) Act, provides for the preservation of wildlife, especially endangered species in their natural habitat or in game parks, wildlife reserves or sanctuaries.

The impact of this Convention on land use is direct, in that, in order to conserve nature and natural resources the land on which the resources are situated has to be restricted for that purpose. Therefore, in accordance with this Convention tracts of land naturally occupied by flora and fauna will be reserved for protection of this element of nature. Where minerals are naturally occurring, the land area where they are present will be exclusively utilized for facilitation of mining the minerals (which includes building infrastructure). The mining activities must be carried out in line with the principle of sustainability to ensure the non-depletion of the natural resources.

Tripartite Environmental Management Programme for Lake Victoria

This agreement is peculiar to the East African Region. It was signed on 5th August 1994 by Kenya, Uganda and Tanzania. Its objective is to facilitate management of the common waters of Lake Victoria.

The program focuses on restoring a healthy and varied ecosystem in the lake and its catchments to enable the lake sustain human activities such as fishing, farming and tourism. The emphasis is on stable and sustainable development of the lake. As such, land-use within the lake's interface will be regulated by the provisions of the agreement. Encroachment by farmers who till right to the lakeshores will be prohibited in order to prevent siltation into the waters of the lake, use of chemical fertilizers and pesticides on large scale sugarcane plantations may also be minimized to reduce their residue flowing into the lake and direct

discharge of effluent from sewer systems and works around the lake is be prohibited and these systems may be required to find alternative locations on which to be sited.

The responsibility of implementing the agreement is the Ministry of Water and Irrigation, Ministry of Agriculture, Ministry of Livestock and Fisheries, Kenya Marine and Fisheries Research Institute and the Kenya Agriculture Research Institute.

Nile Basin Treaty (1929)

This treaty was intended to regulate the use of the Nile waters between riparian states. The states include Egypt, Ethiopia, Eritrea, Kenya, Sudan, Tanzania, Uganda, Rwanda, Burundi and Congo.

It essentially forbids upstream nations from conducting any activity that threatens the water quotas of Egypt and Sudan. Egypt enjoys the greatest benefit from the river, including irrigation and providing water for its people.

This Treaty has influenced land use in the riparian states significantly. The waters of the Nile have been channelled by some of the member parties, in particular Egypt and Sudan for agricultural purposes. Egypt has placed large tracts of land under irrigation from the Nile, which supports horticultural farming. The other riparian states are however disadvantaged by the treaty such that land that would otherwise be productive is simply lying bare and wasting away for want of irrigation waters.

The East African Community (EAC)

The East Africa Community (EAC) is a regional intergovernmental organization of the republics of Kenya, Uganda and Tanzania, with its headquarters in Arusha, Tanzania. The EAC aims at achieving various goals and objectives within its mandate through "Promotion of sustainable growth and equitable development of the region including rational utilization of the region's natural resources and protection of the environment."

The Community has developed a draft Protocol on Environment and Natural Resources, which commits member states to sound environment and natural resources management. In addition, joint guidelines on Environmental Impact Assessment for Shared Ecosystems, have been adopted by the member states as an annexure to the protocol on environment and natural resources.

Other specific areas of co-operation in environment and natural resources management include biological diversity, climatic change and issues related to pollution and policy arrangement. The EAC Treaty will provide an effective mechanism for the general advancement of the region.

The Inter-Governmental Authority for Development (IGAD)

The Intergovernmental Authority on Development (IGAD) was established in 1986 then as Inter-Governmental Authority on Drought and Development (IGADD). The Authority then focused only on issues of drought and desertification. These are seven Member States, namely Sudan, Eritrea, Djibouti, Ethiopia, Somalia, Uganda and Kenya (Awimbo, Barrow and Karaba, 2004).

In April 1996, on the recommendation of the Summit of Heads of State and Governments, IGAD Council of Ministers identified three priority areas of co-operation among member states as follows:

- Conflict Prevention, Management, Resolution and Humanitarian Affairs;
- Infrastructure Development (Transport and Communications) and;
- Food Security and Environment Protection.

The goal of IGAD is to expand the areas of regional co-operation, increase the members' dependency on one another and promote policies of peace and stability in the region in order to attain food security, sustainable environment management and development. Further, IGAD addresses environmental issues through:

- Harmonization of policies with regard to trade, customs, transport, communications, agriculture and natural resources, and promotion of free movement of goods, services and people within the sub-region; and
- Initiation and promotion of programmes and projects to achieve regional food security, sustainable development of natural resources and environmental protection. It will also enhance efforts of member states to collectively combat drought and other natural and man-made disasters and their consequences.

New Partnership for Africa's Development (NEPAD)

The New Partnership for Africa's Development (NEPAD) adopted by the African Heads of State and Government is an initiative based on a common vision, firm and shared conviction to eradicate poverty and place the continent on the path to sustainable growth and development as well as participate in global economic and political arena. NEPAD recognizes that the range of issues necessary to nurture the region's environmental base and sustainable use of natural resources is vast and complex; and that a systematic combination of initiatives is necessary for the development of a coherent environmental programme.

The NEPAD strategic framework to promote Africa's sustainable development has been developed prepared through a consultative and participatory process under the leadership of the African Ministerial Conference on Environment (AMCEN). The plan is comprehensive, holistic and integrates sustainable development principles (UNEP, 2003).

The plan identifies eight sectoral priorities whose implementation will foster the attainment of NEPAD's goals. These priority areas include infrastructure, human resource development, agriculture, culture, science and technology, mobilizing resources, market access and environment.

Its environment initiatives address a range of cross-cutting issues such as combating land degradation, drought and desertification, conserving wetlands, marine and coastal resources; controlling alien species; climate change; and cross-cutting issues. NEMA hosts and coordinates the implementation of Coastal and Marine resources programme.

2.9. OUTLOOK

Land management and administration is governed by several statutes without a comprehensive guiding policy instrument, among them the Land Act, Land Control Act, Land Adjudication Act, Trust Lands Act and Physical Planning Act. Implementation of these laws has often been contradicting and discriminatory to the landless and marginalized groups.

To address these concerns there is need to formulate a comprehensive National Land Policy that would:

Establish appropriate mechanism for proper administration and management of land including resolution of disputes;

Harmonize relevant legal frameworks for land administration for secure land tenure, including customary tenure and common property resources;

Integrate strategies for conservation and protection of the environment;

Incorporate mechanisms to safeguard the environment against naturally occurring radioactive materials through re-concentration, unwarranted public exposure and contamination.

There is need to acquire and install appropriate Land Information System technologies to address land management issues and to enable existing or prospective landowners or occupiers and other relevant users to access information to facilitate informed decision making in various aspects of land administration.

There is need to provide for and enforce assessment of long term effects on the environment through cumulative environmental assessment and Strategic Environmental Assessment (SEA) in order to evaluate the impact of policies, plans and programmes on land and the environment.

Further, there is need to critically assess the level of domestication of global and regional environmental agreements that Kenya is signatory to, and how they impact on land.

CHAPTER THREE

LAND-USE AND AGRICULTURE

3.1. INTRODUCTION

Agriculture is the most important form of livelihood for the people of Kenya. There are three major agricultural categories, namely crop cultivation, livestock and fisheries production. Agricultural activities have varied impacts on people and the environment. The factors with potential to significantly affect human and environmental health and safety include inappropriate agricultural practices, agro-chemicals, biotechnology and inability to control introduced alien species.

The chapter addresses the above factors and identifies policy interventions, mitigation measures and opportunities for enhanced productivity without compromising the health and safety of people and the potential of the land to meet the needs of future generations.

3.2. AGRICULTURAL PRACTICES

Agriculture is the backbone of Kenya's economy. Its dominance is indicated by several factors including contributing 24.0% of GDP (year 2000); generating over 60% of foreign exchange earnings; providing employment to over 70% of the population; providing raw materials to about 70% of all industries and providing over 45% of the annual government budget.



Plate 3.1. Agricultural expansion and settlements has led to clearing of indigenous forests (inset)

The main policy goals of the sector are to provide food security, raw materials for industry, employment and to generate foreign exchange earnings.

Agricultural land provides subsistence and monetary needs to the country's growing population. The high to medium potential land (HMPL) which is suitable for arable agriculture measures 9.4 million hectares, while the arid and semi-arid lands (ASALS) measure over 48.0 million hectares. Of the 9.4 million hectares of HMPL, 1.1 million hectares is allocated to national parks and reserves, 2.8 million hectares is cropland, 2.8 million hectares is for grazing

(mostly dairy), 2.0 million hectares is forested and 0.5 million hectares is covered by urban centres, homesteads and other infrastructure. About 9.0 million hectares of the ASALs can support some form of agriculture, 15 million hectares is just adequate for livestock keeping, while the remaining 24 million hectares is dry and only suitable for nomadic pastoralism.

Pressure exerted by population growth and agricultural expansion has led to sub-division of land into small uneconomic sizes, encroachment into forests, increased migration into ASALs and subsequent introduction of poor land use practices. This has had adverse environmental impacts including soil erosion, loss of soil fertility, deforestation, loss of biodiversity, overgrazing and desertification. However, ongoing forestry efforts are increasing forest cover, while enhancing food production and security through inter-cropping (Plate 3.1).



Plate 3.2. Agro- forestry is widely practiced in agricultural areas

3.2.1. Crop Production Practices

Main Food and Cash Crops: The main food crops grown in the country are maize, wheat, rice, beans, sorghum, millet, Irish potatoes, sweet potatoes, cassava, arrowroots, peas, grams, barley and yams (Table 3.1). The main cash crops include tea, coffee, sugar cane, pyrethrum, sisal, tobacco, rape seed, sunflower, groundnuts, macadamia nuts, cashew nuts, coconuts, simsim, bixa, castor, soya beans, and horticultural (Table 3.2).

Cultural changes in traditional practices have, to some extent, eroded local knowledge and associated traditional foods. The plants from which traditional foods were obtained are threatened by genetic erosion, loss of traditional knowledge and neglect. Traditional farming systems, which are associated with specific traditional crops, varieties and technologies, are being abandoned in favour of exotic food crops. Some of the main indigenous foods include:

(i) **Leafy vegetables:** *Amaranthus* spp, *brasscae carinata, Cleome gynandra* (spider weed), *Crotalaria* spp, *Solanum nigrum* (black nightshade), *Vigna unguiculata (*cow peas), *Coccinia grandis* (ivy gourd);
(ii) **Cucurbits:** *Cucurbit maxima* (pumpkin);
(iii) **Flavourings/spices:** *Tamirindas indica* (tamarind);
(iv) Pulses/seeds: pigeon pea, lablab bean, bambra ground nut, cowpeas, and sesame;
(v) **Grains:** finger millet, pearl millet, and sorghum;
(vi) **Fruits:** wild custard apple, African fan palm, giant yellow mulberry, Cape gooseberry and Indian plum;
(vii) **Tubers/roots:** Cocoyam;
(viii) **Stimulants:** khat; and
(ix) **Others:** edible fungi, edible birds (e.g. quail, guinea fowl and ostrich). Some communities also eat termites and certain insect larvae, wild animals (antelope, buffalo, rabbit and hare).

Horticulture and Floriculture: Horticulture and floriculture have grown in recent years to become dominant in the agricultural sector. The country is currently the leading exporter of fresh cut flowers to the European Union (EU), controlling about 25% of the EU market. Horticulture is also the second largest foreign exchange earner after tea and is a major employer in the agricultural sector. It is estimated that about three million Kenyans derive their livelihood from the industry. The total marketed value was over Ksh.16 billion in 2003.

Table 3.1. Quantity of main food crops grown in the country in 2003

Crop	Total cultivated area (ha)	Total production (tons)	Yield (tons/ha)
Maize	1,645,316	3,100,000	1.62
Wheat	150,935	285.3	1.89
Rice	13,425	47,748	5.0
Sorghum	145,755	126,433	0.8
Millets	9,359	64,023	0.6
Barley	-	26,645	-
Beans	880,631	535,004	0.5
Cow peas	183,551	109,213	0.18
Grams	80,896	30,949	0.18
Pigeon peas	183,612	109,213	0.4
Irish Potatoes	127,070	1,220,624	7.0
Sweet Potatoes	68,047	574,586	9.0
Cassava	63,685	521,975	6.0
Arrow roots	2,992	21,747	8.0
Yams	570	2,511	5.0

Source: Crop Development Division, Ministry of Agriculture data, (where (-) data not available)

Table 3.2. Quantity of main cash crops grown in the Country in 2003

Crop	Total cultivated area (ha)	Total production (tons)	Yield (tons/ha)
Coffee	170,000	55,000	0.39
Tea	130,340	293,670	2.30
Sugarcane	122,580	400,000	42.73
Cotton	25,955	17,776	0.60
Pyrethrum	25,000	10,943	0.60
Sisal	24,933	25,452	0.90
Tobacco	13,983	13,871	1.2
Sunflower	7,793	8,129	1.0
Groundnuts	26,200	14,094	1.5
Coconuts	37,450	56,937	1.0
Cashewnuts	29,028	11,075	2.0
Soya Beans	1,657	935	0.9
Bixa	5,537	33,000	0.6

Source: Crop Development Division, Ministry of Agriculture records

Farming/Cultivation Practices: Farming involves both manual and mechanical approaches. Manual practices use hand held tools to open up the land for planting and in the control of weeds. This is common among the smallholders who comprise over 90% of the total farm producers. In the large-scale sector, heavy machinery is used in land preparation, planting, weeding, harvesting and control of pests and diseases. The implements used include mouldboard ploughs, tractors, manual and mechanized sprayers and combine harvesters.

Cropping patterns vary from one agro-ecological zone to another and from one farm to another. There are mixed cropping where production is predominantly subsistence in both the high and medium potential areas. Monocropping is predominant in commercial farms. There are large commercial tea, coffee, wheat and barley plantations, among other crops, under monoculture.

Labour in Agriculture: Agriculture is a labour intensive sector in Kenya. Labour requirements are influenced by nature of the activity, locality, type of farm, natural and socio-economic conditions. Subsistence farming is a way of life unlike most occupations. The inter-connection between actual farm work undertaken to produce cash income, subsistence crops and other domestic work makes it very difficult to analyse the amount of labour available on the farm and the actual time required for farm business. Labour peaks are also important, as they are often the cause of inadequate crop husbandry, such as late planting resulting in lower farm returns.

Organic Agriculture: About 90% of small-scale farmers do not apply synthetic fertilizers on food crops. Their access to fertilizers and pesticides is constrained by their low purchasing power and availability at nearest disposal points.

to increased demand for the integration of herbal medicine with conventional medical practices and growing of indigenous crops that require little, if any, application of fertilizers and pesticides. The indigenous crops not only reduce cost of production, but some have known medicinal values.

In recognition of the importance of organic farming, the Ministry of Agriculture has established a section on herbs, spices, medicinal and aromatic plant species (MAPS). Through this initiative, organic farming is being promoted especially in vegetables, flowers and fruits production. Increasing demand for organic farm products is providing an alternative market for agricultural exports to supplement the traditional exports. Organizations such as the Kenya Organic Agriculture Network (KOAN) and the Forum for Organic Resource Management (FORMAT) are involved in the promotion of the industry.

Irrigation: The potential land for irrigation is about 352,400 hectares, while total irrigated land ranges between 65,000 hectares and 85,000 hectares. Only 650 hectares are irrigated from groundwater, while the rest uses surface water.

The National Development Plan (2002-2008) identifies three major types of irrigation that are currently practised in the country and the associated crops grown as:

(i) Smallholder (34,650 hectares) - rice, maize and horticulture;
(ii) Private large-scale (40,700 hectares) - coffee, pineapples, horticulture and seed maize; and
(iii) Public schemes (12,000 hectares)- rice, cotton, horticulture and seed maize.

About 60% is irrigated using surface water (basin, furrow, hose), while about 30% use overhead irrigation (sprinkler) and the remainder are under drip and micro-sprinkler mainly in the commercial cut-flower production (FAO 2004). There is under-utilization of both water resources and irrigation land potential in the country. This present opportunity for expanding irrigation activities for food production and security.

Biotechnology in Agriculture: Biotechnology techniques aim at enhancing the production and use of the resulting goods and services for the benefit of humankind. However, concerns have been raised about their potential impact on the physical environment, human and animal health, values and norms, ownership and control of and access to genetic resources, livelihood, economic and social feature of the poor, and intellectual property rights.

The National Council for Science and Technology (NCST) has coordinated biotechnology activities by initiating the following:

i) Tissue culture production of bananas at Jomo Kenyatta University of Agriculture and Technology, an initiative to produce clean suckers and quick multiplication plants so that there is enough disease-free and clean planting materials in the country.

ii) Recombinant Rinderpest vaccine and *Bt*. Maize, which is being implemented by the Kenya Agricultural Research Institute in collaboration with Danforth Plant Science Centre of St Louis in USA, CIMMYT and ISAAA. These institutions act as developers and promoters of modern biotechnology.

The trials are in confinement under monitoring and inspection by the regulatory agencies Kenya Plant Health Inspectorate Service (KEPHIS), Department of Veterinary Services (DVS), Kenya Bureau of Standards (KEBS), NEMA and Public Health.

The trials are in confinement under monitoring and inspection by the regulatory agencies Kenya Plant Health Inspectorate Service (KEPHIS), Department of Veterinary Services (DVS), Kenya Bureau of Standards (KEBS), NEMA and Public Health.
These biotechnology activities have necessitated the formulation of a biotechnology policy, preparation of a Biosafety Bill and capacity building for policy makers, regulatory agencies and relevant stakeholders. Capacities have been built for the National Biosafety Committee, institutional biosafety committees and regulatory agencies on handling applications for genetically modified organisms (GMOs) as well as monitoring and inspection of GMO activities in Kenya.

Consumption Patterns: Most Kenyans rely on a narrow range of food items, mainly maize. Consequently inadequate production of maize in the country has always resulted in famine situations, especially in the ASALs.

Soil and Water Conservation: Soil erosion is one the most serious problems that affects land productivity. It has affected large areas causing irreversible damage to the land. Rill and sheet erosion are the most serious types of soil erosion and are most common in the semi-arid zones where land has been subjected to annual cropping without conservation measures.

Landslips and mudflows cause soil erosion, particularly in the slopes of the Aberdares ranges and Meru districts where forests have been cleared for cultivation. Wind erosion occurs mainly in ASAL districts such as Wajir, Mandera, Garrisa, Marsabit and Turkana. The magnitude and distribution of soil erosion hazards in Kenya is influenced by rainfall intensity and variability, soil erodibility, slope of the land and soil cover.

Soil and water conservation programmes have been implemented in the country for decades through various initiatives principally spearheaded by the Ministry of Agriculture. These programmes have been aimed at reversing the negative impacts of land degradation, including soil erosion and water run-offs. Although the problem has not been adequately tackled, significant level of awareness has been created among the farming communities.

3.2.2. Impacts of Agricultural Practices

Monoculture: Increasing monoculture practices have had negative impacts on agro-biodiversity. It has contributed to replacement of indigenous landraces thus contributing to the destruction of crop genetic diversity. This has increased susceptibility of crops to pests and diseases; and has led to introduction of new pests and diseases. Examples abound in certain maize growing areas where grain pests such as the grain borer thrive because of monoculture system. Monoculture also exposes the ground to a uniform cover over a large area, making it susceptible to pests and diseases.

Some annual crops have poor ground cover as compared to perennial crops such as coffee and tea. Unless monoculture practices are accompanied by sound soil and water conservation efforts the land productivity will decline.

Increased Cultivation: Increasing the area under crop cultivation implies expansion into the drier and more fragile soils that are easily erodible by both water and wind. Therefore any clearance of the little natural protective cover loosens and exposes the soils to agents of erosion. Further, loss of biodiversity commonly occurs in marginal areas opened up for agricultural production.

especially when not accompanied by adequate periods of fallow, intensive use of pesticides and unsustainable land management practices.

Seeds and Semen: Improving agricultural productivity in the country has been associated with high yielding seeds and semen developed through research. However, adoption of such seeds is not without environmental risks. In addition to reducing biodiversity, their adoption diminishes the local genetic pool, as landraces and indigenous breeds are lost. Imported seeds also carry the added danger of introducing alien weeds, pests and diseases when proper sanitary and phytosanitary inspections are not done judiciously. Under the current liberalized trade regime, the country imports different seeds such as for horticultural crops, wheat, maize and vegetables. Flower and fruit planting materials and semen are also imported with the potential to spread crop and livestock diseases if the relevant regulations are not strictly adhered to.

Materials and Chemicals: Plastic trays, containers, sheeting materials and pots used in the propagation of horticultural crops have negative environmental impacts since they are not biodegradable. Use of methyl bromide in fumigating soils to kill pests (nematodes) is one technology with potential injuries to the environment as methyl bromide is an ozone-depleting substance. However, use of this chemical is being phased out in the country. Similarly, post-harvest handling of grains often requires the use of chemical preservatives. These also have negative environmental consequences.

Planting: Planting materials, especially the certified seeds are normally treated with chemicals to improve their survival rates when planted. Poor handling of such materials have potential to adversely affect human and environmental health.

Processing and Storage: Agricultural processing sometimes carries with it certain dangers to the environment. For example, water sources adjacent to coffee and tea factories are contaminated by residues of the pulping and fermentation processes. Effluents generated by fruits, vegetables and grain processing also contaminate receiving waters.

Some crops require processing before the final sale; and most require storage, whether in processed or non-processed form. Perishable crops such as cut flowers and vegetables for export are therefore refrigerated from the moment they leave the farm until they are sold. Refrigeration technologies used are mainly Chloro-Flouro Carbons (CFC) based. The use of chemicals in storage as well as the use of preservative agents also has potential adverse impacts on the environment.

Packaging: Crops intended for export market are mainly packaged in wooden, cardboard and plastic material. The production of such packaging materials has adverse implications on wood supply and disposal of non-biodegradable plastic materials.

3.2.3. Efforts Towards Sustainable Agriculture

There have been various national initiatives towards sustainable agriculture and rural development. The Government has undertaken a number of policy reviews for the agricultural sector based on the prevailing liberalized market.

The recently launched 'Strategy for Revitalizing Agriculture, 2004-2014' address the broad policy issues articulated in the Economic Recovery Strategy for Wealth and Employment Creation. The main objective of the Strategy is 'to transform Kenya's agriculture into a profitable, commercially-oriented and regionally and internationally competitive economic

The recently launched 'Strategy for Revitalizing Agriculture, 2004-2014' address the broad policy issues articulated in the Economic Recovery Strategy for Wealth and Employment Creation. The main objective of the Strategy is 'to transform Kenya's agriculture into a profitable, commercially-oriented and regionally and internationally competitive economic activity that provides high quality gainful employment to Kenyans.' The strategy identifies the constraints that plague the agricultural sector, including poor institutional governance, inadequate legal framework, limited capacity of private sector to undertake functions previously performed by the government before liberalization, lack of markets and weak marketing systems, poor access to farm credits, high cost of farm inputs, limited public funding for agriculture, inadequate research and extension services and prevalence of HIV/AIDS in the productive labour.

3.3. LIVESTOCK PRODUCTION

3.3.1. Contribution to the Economy

Kenya has a large and diverse population of livestock of which cattle, sheep, goats, camels, poultry, pigs, rabbits, bees and donkeys are the species traditionally used for food, income generation, draught power and socio-cultural functions (Table 3.3). Increasingly, non-conventional livestock are gaining importance towards domestication and these include ostrich, guinea fowl, quails, crocodiles and snakes, which have a potential for exploitation.

Table 3.3. Livestock population estimates

Livestock	Population Estimate (Millions)
Cattle (Dairy)	3.2
Sheep (Zebu)	8.1
Camels	0.8
Goats	10.1
Sheep (wool)	1.2
Sheep (hair)	7.7
Poultry	29
Pigs	0.32
Rabbits	0.42
KTB and other	0.125
Log hives	1.0

Source: Ministry of Livestock and Fisheries Production records

Eighty per cent of Kenya's population is dependent on crop and livestock production as the main source of income. The livestock sub-sector employs and accounts for 50% of the agricultural labour force. The sector also earns the country foreign exchange through export of hides and skins, dairy products, live animals and some processed products.

Livestock production is an activity that is dominant in the ASALs. It remains one of the sub-sectors with the highest potential to contribute to poverty reduction through a wide range of value adding activities. The sub-sector contributed about at KShs.63.4 billion in 2003, accounting for 40.3% of the agricultural contribution to the economy and 10% of the Gross Domestic Product (GDP). However, the true value of the sub-sector's contribution is much higher taking into consideration unrecorded statistics. Other important contributions from the sub-sector are given in Table 3.4.

Linkages between the livestock sub-sector and manufacturing, distribution and other services are valued at KShs.8.6 billion. The sub-sector provides the raw materials for agro industries, and employs 1.75 million people in ASALs and about five million in the high and medium potential districts. This amounts to about 6.75 million people out of the national labour force numbering approximately 13.5 million.

3.3.2. Demand and Supply Situation

The country produces adequate fresh milk, butter, ghee, yoghurt and cheese (Table 3.5). Milk consumption differs between rural and urban areas and also across income groups. Per capita milk consumption for urban areas is 45 litres yearly for "milk-producing" households, and 19 litres yearly for "milk-purchasing" households, while the urban per capita milk consumption is estimated at 125 litres per year.

Table 3.4. Estimated value of livestock products

Industry	Quantity/Volume	Value (in billion of KShs)
Dairy		
Milk	2.8 billion litres	42
Processed Products	Various	1
Red Meat		
Beef	305,000 MT	42.8
Chevron &Mutton	84,900 MT	8.2
Camel Meat	6,600MT	0.8
White Meat		
Chicken	22,100 MT	2.94
Pig meat	16,100 MT	1.79
Egg Production	1.3 billion	7.15
Beekeeping		
Honey	21,700 MT	4.59
Beeswax	3,100 MT	0.07
Emerging Livestock		
Crocodile Skins	3,500 pieces	1.0
Meats	Various	
Fibres, Hides and Skins		
Cattle Hide	1.7 million pieces	1.2
Sheep Skin	1.7 million pieces	
Goat Skin	2.0 million pieces	
Wool	2,067 MT	0.062
Livestock Feeds	389,259 MT	7.8
Gross Value		**121.4**

Source: Ministry of Livestock and Fisheries records

Beef is the major component of red meat and the bulk comes from the extensive ASALs. An estimated 300,000 heads of cattle are slaughtered in Nairobi and other urban centers annually. Some of the animals for slaughter originate from neighbouring countries including Tanzania, Sudan, Somalia and Ethiopia.

Currently, there is adequate supply of pig meat in the market and some products are exported within the region. However, there is a general preference for cattle, sheep and goat meat in the country. There is also adequate supply of eggs and poultry meat except for ducks, geese and turkey products.

Table 3.5. Production and demand levels for livestock products

Product	Estimated Production	Intake Levels Per Capita*	Potential Demand for a 30 Million Population)	Remarks
Milk (billion liters)	2.8	62 litres	1.96	Current consumption levels are higher than average levels in the developing world.
Red Meat (000's metric tonnes)				
Beef	304.5			
Mutton	39.8	7 kg	210 MT	As above
Goat meat	45.1			
Camel meat	8.4	30 kg	90 MT	A balance in the supply and demand situation. Prospects in camel meat
White Meat (000's metric tonnes)	22.1	8 kg	240MT	A huge gap of about 220,000 metric tonnes
Poultry meat				
Pig Meat	16.1	13 kg	390MT	A huge gap of about 374,000 metric tonnes

**** Projected consumption levels by 2020 based on the IMPACT model***

3.3.3. Emerging/Non-Conventional Livestock

The emerging livestock that offers alternative farming enterprise options include ostrich, guinea fowls, quails for meat and feathers and crocodile for meat and skin. These are species that are, by law, designated as wildlife but have become accepted as a new venture in farming and are being domesticated for commercial utilization or as a source of low cholesterol meat. Game farming is progressively increasing in importance due to demand (local and foreign markets) for its products such as eggs, meat, hides and skins. It is also an income-generating venture for farmers.

Emerging livestock are resilient and can survive in the ASAL environments because of their feeding habits. The survival of communities living in marginal areas depends on their ability to manage the difficult environment and diversify into other opportunities that the land can offer. At the moment, farming in emerging livestock is under mainly private ranches, a few groups, associations and financially capable individuals who believe in their potential and wish for a liberalized market locally. Marketing in these products is still highly restricted.

So far, efforts are directed towards strengthening the institutional framework for the sector. Extension service through dissemination of relevant information especially in the production of ostrich, guinea fowl and crocodiles, and awareness creation on utilization of these emerging livestock is in progress.

3.3.4. Bee Keeping

Bee keeping is increasingly becoming an important commercial activity in the country. This is demonstrated through the sale of honey and beeswax, as a source of food, a tool for environmental conservation, provision of employment opportunities in industrial food processing and pharmaceutical industry. The development of modern bee keeping has become a very important activity, particularly in ASALs where other forms of agriculture cannot be

sustained effectively. Honey and beeswax production has increased mainly due to the introduction of new technologies in beekeeping and the use of improved bee keeping equipment such as the Kenya Top Bar Hive (KTB). The current estimated production potential for Kenya is 100,000 metric tonnes of honey and 10,000 metric tonnes of beeswax.

Other hive products include propolis, pollen, royal jelly and bee venom which are important in the pharmaceutical industry. These are yet to be tapped fully and utilized due to inadequate extraction technologies involved.

3.3.5. Fodder Crops

Pasture mainly comprise of legumes and grasses. In ASALs, several legume varieties exist including: Desmodium, Lucerne, white clover, glycine and clitoria. They are important to the soil as they prevent erosion by forming a good soil cover. The roots fix nitrogen in the soil making it fertile. White clover can withstand high stocking rates than the other legumes. The grasses are mainly Nandi setaria, Kikuyu grass and *Themeda triandra.*

Other legumes in the high and medium potential areas include silverleaf desmodium (*Desmodium uncinatum)* and greenleaf desmodium *(Desmodium intortum)*, clovers: Kenya white clover (*Trifolium semipilosum*), white clover (*Trifolium repens*) and subterranean clover (*Trifolium subterraneum*), Glycine: *Glysine wightii* and *Glycine max,* Centrosema *(Centrosema pubescens) and* Lucerne (*Medicago sativa*).

The grasses found in the medium and high potential areas are napier *(Pennisetum purpureum*), guatemala grass (*Tripsacum laxum*), Sudan grass (*Sorghum sudanense*), Kikuyu grass (*Pennisetum clandestinum*), rhodes grass (*Chloris gayana*) – Nasiwa and Elmba varieties, Nandi setaria (*Setaria sphacelata*) and Columbus grass (*Sorghum almum*). All these pastures and fodders play a major role in environmental conservation.

There are multi-purpose trees which are fodder legumes; four major exotic types grown in the high potential areas are *Sesbania sesban, Gliricidia sepium, Leucaena leucocephala* and *Calliandra carlothyrsus.*

3.3.6. Conflict Management and Cattle Rustling

Conflicts over resource use continually undermine livelihoods and wealth creation in ASALs. Insecurity causes human suffering and death, provokes spirals of revenge attacks and turns large tracts of grazing lands into "no-go" areas. Conflict is often the best known but least understood feature of ASAL communities. It is increasingly common for individuals from urban centres who are linked to the market system to steal from rural areas and quickly sell the animals to middlemen in towns. Some of the ASAL districts with recurring incidences of cattle rustling and related conflicts include Turkana, West Pokot, Samburu, Marsabit, Moyale, Marakwet, Keiyo, Baringo, Isiolo, Wajir, Garissa, Mandera, Ijara and Tana River.

3.4. FISHERIES PRODUCTION

Fresh water fisheries account for almost all of annual national production and almost all fisheries production derives from Lake Victoria. Over-fishing and fishing in spawning and breeding grounds have contributed to loss of fish species diversity. Fishing methods that result in the harvesting of juvenile fish and destruction of fish spawning and breeding grounds harm

Fresh water fisheries account for almost all of annual national production and almost all fisheries production derives from Lake Victoria. Over-fishing and fishing in spawning and breeding grounds have contributed to loss of fish species diversity. Fishing methods that result in the harvesting of juvenile fish and destruction of fish spawning and breeding grounds harm the fisheries industry, resulting in reduced fish catches and can lead to the extinction of certain fish species.

Exploitation of fisheries resources in Kenya is unsustainable due to the shift in demand occasioned by increased demand for fish by the local population and export market. Pressure has also been exerted on local fisheries by the destructive fishing methods, habitat degradation arising from non-point source pollution by agriculture (siltation, agrochemicals and eutrophication from fertilizers).

3.4.1. Inland Fisheries

The fishing methods employed by the artisanal fishermen are seining gill nets, cast nets, hand and line hooks, mosquito nets and traditional traps along the shore line extending to five nautical miles offshore. This is also the main spawning ground for many species. Seining, however, is a very destructive method of harvesting fish. The use of fine meshed beach seines destroy the ecosystem and harvest fish eggs, juveniles and brooders. The fishing efforts in the lakes have been increasing steadily over the years with the major catch composition being Nile perch, Tilapia and *Ratreonobla argentea* (Omena). Due to Nile perch fishery, the fishing gears have also changed. The gillnet mesh sizes have increased to 10 inches and above from the original 4" and 5" on average. The use of mosquito nets for Omena has evolved and the use of long lines for the Nile perch fishery has also increased.

The Lake Victoria Fishery: Lake Victoria has the highest concentration of fishermen (mainly small-scale). In the year 2000, the total catch landed by approximately 33,037 fishermen using 10,014 vessels was 192,738 metric tonnes valued at KShs. 7,468,968,000. The lake accounts for about 92% of the total fish production in the country (Table 3.6).

Lake Turkana Fisheries: Fish species of commercial importance include Nile perch, Tilapia, Barbus, Labeo and Clarias (Table 3.7). Fishermen use passive gears like gill nets and long lines for fishing. Canoes, boats and rafts are the major vessels used. Gillnet of mesh sizes five and above are used. Long lines are used to exploit Nile perch and Bagrus species. Pressure on the lake is also due to drought, which render the pastoralists to become fishermen.

Lake Naivasha Fishery: The main species of commercial importance include Tilapia, Crayfish, and Bass (mainly for spot fishing) (Table 3.8). The lake production depends on water levels.

Table 3.6. Fish landing by weight, value, number of fishermen and vessels by areas

Source	Quantity (metric tonnes)	Value'000 KShs.	Number of fishermen	Number of Vessels
Lake Victoria	192,738	7,468,968	33,037	10,014
Lake Turkana	2,108	48,122	112	52
Lake Baringo	463	11,360	55	53
Lake Naivasha	384	16,610	108	83
Lake Jipe/Dams	54	2,163	45	31
Tana River Dams	364	8,878	384	138
Fish farming	967	97,825	N/A	N/A
Other Areas	798	25,644	N/A	N/A

Table 3.7. Lake Turkana fish production by species, weight and value

Species	Metric tonnes landed	Value '000Kshs
L. niloticus	153	5,799
Tilapines	1,060	27,274
Labeo	337	4,585
Bagrus	60	1,083
Barbus	41	720
Citharinus	53	979
Disicodus	356	6,795
Clarias	6	90
Others	42	797
Total	**2,108**	**48,122**

Source: Fisheries Department

Table 3.8. Lake Naivasha fish production by species, weight and value

Species	Metric tonnes landed	Value '000 Kshs.
Black bass	13	700
O. Leucostictus	363	15,763
Tiapia zilli	1	38
Cray fish	7	109
Total	384	**16,610**

Lake Baringo Fishery: In the year 2000, Lake Baringo depicted a cyclic pattern of production, abundance and richness. Tilapia was on the increase early in the year as Clarias and Protopterus declined. During midyear, Protopterus showed an upward trend while Tilapia dwindled. This was attributed to many people opting for fishing instead of agriculture as a result of the drought that prevailed during the year. The low rains led to the high Protopterus (lungfish) and Clarias (catfish) catches that are more adapted to muddy waters. However, all the species showed a decline except for *Clarias* species.

3.4.2. Coastal and Marine Fishery

Fisheries activities are concentrated in in-shore waters. The Exclusive Economic Zone (EEZ) is exploited by distant waters fishing nations (DWFN) and only a few of these vessels call at local ports to declare their catch. The amount harvested from the EEZ is therefore unknown, though there are estimates for the potential.

Fishing off the coast is mainly done by small-scale fishermen; this is known as artisanal fishing. They operate near the shore due to lack of motorized boats that can venture into the deep-sea. Only commercial fishermen owning trawlers operate offshore in the deep sea, including Ungwana Bay and Malindi banks where they are restricted within the six nautical miles from the shoreline. In 1999, 881,000 kg of prawns were caught. This dropped to 770,000 kg in 2000.

3.4.3. Aquaculture

Aquaculture takes place on a small scale in small earthen ponds. They may be fresh water culture or marine culture. The latter is still not well developed. Cold-water culture of trout (*Oncorrhynchus mykiss* and *Salmo trutta)* is mainly concentrated in Mt. Kenya region and

mainly concentrated in Western, Central, some parts of Rift Valley region as well as parts of Coast Province.

3.4.4. Mariculture

Seaweed farming is practiced in the south coast although on a relatively small scale. Other forms of mariculture include crab-farming, prawn farming, oyster culture and crocodile farming.

3.4.5. Fish Products, Processing, Marketing and Infrastructure

Products: The Nile perch, which constitutes more than 50% of the fish caught, is the main export earner, contributing about Ksh.3.8 billion annually. Frozen fillets are exported to the Near East, Europe, USA and Australia. Fish tenderloins from tuna are the main export from the marine waters. The supply and demand situation points to the need for maximum utilization of available fish supplies and products. The challenge facing the industry is to develop wholesome, superior quality, tasty, attractive, and convenient to use fishery products from mince.

The food and Agriculture Organisation (FAO) has initiated a value added products (VAP) project to assist fish processors to produce value added fish products in order to reduce fishing pressures on Lake Victoria, while at the same time saving the fast disappearing Nile perch brought about by excess exports and over-fishing.

Processing: Most fish processing and exporting firms specialize in Nile perch products, while others handle marine products including tuna and octopus squids. The firms compete for high quality fresh Nile perch landed on Lake Victoria beaches and this has resulted in high prices. However, this has impacted negatively on Nile perch marketing and consumption. Firstly, the small-scale fish traders cannot compete fairly due to high quality beach products for Nile perch. Secondly, the high beach prices for Nile perch means that domestic fish consumers cannot afford good quality fish.

Marketing: The main market for fish products is the European Union (EU) and all processing factories have instituted stringent quality control procedures to conform to the EU requirements. The fish industry is now governed directly by at least six sets of standards implemented by several local agencies and EU.

Infrastructure: Fish handling facilities at landing beaches still remain inadequate although fish bandas have been established in major landing beaches to provide shade and facilitate handling and marketing operations (Table 3.9). Fishermen have no easy access to ice that could prolong the shelf life of the caught fish. Costs are prohibitive and it is advisable to locate ice plants close to the fishing villages. Access roads are poor and so is electricity supply. A combination of electricity, roads and refrigeration would render the livelihoods of local fisherfolk as middlemen irrelevant. Fishing vessels are needed for patrols of the EEZ, as there have been illegal foreign fishing vessels in marine waters.

Table 3.9. Survey of fishing facilities around Lake Victoria in 2000

Items	Description	Number
Landing facilities	Landing sites	297
	Banda	97
	Cold rooms	13
	Pontoons/Jetties	10
	Fish stores	15
	All weather road	60
	Boat repair facilities	52
	Net repair facilities	50
	Electricity supply	29
Fishermen	Number of fishermen	33,037
Fishing crafts	Number of fishing vessels	10,014
Propulsion	Number of outboard engines	494
	Number of inboard engines	15
	Number of boats with paddles	6,577
	Number of boats with sails	2,928
	Total Gill nets	125,221
	Beach seines	5,245
	Cast nets	4,418
	Number of hand line hooks	27,789
	Number of long line hooks	972,087
	Number of traps	3,192
	Mosquito nets	11,265
	Other (unspecified)	1,706
Transport boats	Transport boats	409
Derelict boats	Derelict boats	1,884

Source: Fisheries Department Annual report, 2000

3.4.6. Constraints in Fish Production

Fish production is constrained by several factors including fish safety, marketing, quality, poverty, lack of infrastructure, resource decline, conflicts, monitoring and enforcement of regulations, lack of awareness in aquaculture values, cost of feed and cultural habits.

Food safety and quality are crucial in international fish trade since fish are particularly prone to rapid pathogenic contamination. Nearly half of the fish exports originate from developing countries that have limited capacity to invest in the rigorous fish safety measures demanded by importing countries. The main safety concerns are unhygienic handling during and after fish harvest, insufficient refrigeration, substandard processing and poor packaging.

As a result of degradation of the main fish habitats and over-fishing, as well as change in species composition, fish stocks have declined. A marked decline in the Nile perch fishery in Lake Victoria is partly due to the increase in the number of fishermen i.e. from 83,816 in 1990/1991 to 121,941 in the year 2000 in the entire Lake Victoria.

3.4.7. Efforts Towards Sustainable Utilization of Fisheries

Sustainable fish production is being addressed through a number of ongoing initiatives, including the review of the Fisheries Policy and the Fisheries Act, application of closed season, monitoring of vessels and regulation of mesh sizes. The cost of rehabilitating processing facilities and their production lines are significant. Fishermen have invested in newer cleaner boats and preservation facilities. The capacity of fishermen and other workers has been built targeting hygienic fish handling practices. Reduction in number of beaches set to meet infrastructure standards means that fisher-folk from other beaches incur higher production costs trying to reach the standards of the selected beaches.

Value addition in fish processing is a new initiative in Kenya. Assurance of market for the products is mandatory and tax reduction on such products is necessary to enhance competitiveness. There is stiff competition from Asian and South American countries.

3.5. ALIEN AND INVASIVE WEEDS

Alien species enter the environment accidentally from containment or captivity during use in mariculture, aquaculture, horticulture, zoos, the pet trade and scientific research. Invasive alien species are sometimes introduced intentionally as bio-control agents. Unintentional introductions occur due to transport, trade, travel and tourism. Human activities have made it much easier for harmful species to travel. Marine organisms, in particular, frequently travel from one location to another via ships. Some 10 million tons of ballast water are shipped annually, carrying diverse marine species. Ballast water is thus particularly significant for the global distribution of microorganisms and waterborne diseases affecting plants and animals. Examples of alien and invasive weeds, place of occurrence as well as environmental impacts and responses are shown in Table 3.10.

3.5.1. Prosopis

Prosopis was introduced in Tana River, Baringo and other arid and semi-arid districts in the early 1970s with the intention of improving biomass cover and control of soil erosion. It has turned into an environmental and health hazard threatening the fragile ecosystem and the livelihoods of the local communities.

The tree, propagated with good intentions, has established itself in most of the dry areas of the country with adverse ecological and economic impacts. Livestock die upon feeding on the indigestible pods. The wounds inflicted by the thorns are difficult to heal. The tree's invasive nature has led to loss of agricultural land and irrigation channels, further threatening the food security. It has spread to other parts of the country including Garissa, Wajir, Mandera, Isiolo, Marsabit, Moyale and Turkana. Only the pods are eaten leaving the rest of the biomass to rapidly colonize the habitat leading to loss of pasture. The tree grows to a height of 20m, it is drought resistant and thrives best around water catchment and waterways. It has a very deep taproot that spreads rapidly suppressing indigenous vegetation in the semi-arid environment.

The Authority is committed to working towards a solution to the Prosopis menace in collaboration with other bodies, including KEFRI. It is also encouraging communities living in the *Prosopis* prone areas to explore alternative uses of the tree. Establishing alternative vegetation cover to replace it as in the case of Baringo rangeland re-seeding project using indigenous grass species, is suggested as another option.

3.5.2. Water Hyacinth (*Eichornia crassipes*)

Water hyacinth was first recorded in western Lake Victoria in 1989 and the lake's infestation is thought to have originated from the Kagera River. Floating masses block ports and fish landings and disrupt ferries and water intakes. This invasion has spelled at least temporary disaster for some local fishing communities. The Kenyan side of Lake Victoria was estimated to have 400,000ha of water hyacinth by September 1998.

Table 3.10. Examples of alien invasive species in Kenya

Common name	Scientific/ common name	Where commonly found	Environmental Impact	Response
Prosopis*	*Juliflora prosopis*	Baringo, Garissa, Turkana	Reduces area available for agriculture and grazing; kill livestock and poses health hazard	Replacement through alternative vegetation cover, re-seeding using indigenous grass
Water Hyacinth	*Eichornia crassipes*	Lake Victoria	Disruption of water transport, water supplies, fishing, and livelihoods of local communities	Biological, chemical and mechanical control
Striga weed (Witch weed)	Two species: *Striga hermonthica* and *S. asiatica*	*S. hermonthica* found in Western region and *S. asiatica* found in Coastal region	Low yields in cereal crops	Mechanical uprooting, seed dressing, intercropping and crop rotation
Lantana	*Lantana camara*	Western Kenya	Depresses range vegetation, and diversity	Mechanical control through uprooting and burning also biological control using lantana lace bug

'*' Case Study

The effluents from Kisumu City and most villages and small towns on the lakeshore enter the lake untreated. Agricultural practices, the introduction of the Nile perch and lack of sewage treatment, all contribute to plant nutrients being released into Lake Victoria. All these form sources of nutrient in the lake waters that provide a direct stimulus to the growth of the water Hyacinth that has wreaked havoc trade and commercial activities on Lake Victoria.

The Lake Victoria Environmental Management Programme (LVEMP) is pursuing both long and short-term solutions to the lake's problems. Long-term reduction in the water hyacinth infestation is being attempted through the release of biological organisms. The biological control programme is based on the multiplication and release of two weevil species *Neochetina bruchi* and *Neochetina eichorniae*.

Micro-scale enterprises using the weed for crafts, paper-making, furniture, and compost are capable of removing only a very small proportion of the weed and the economics of transporting material that is 90% water from points of infestation to centres of utilisation is prohibitive. Utilisation of the weed as a mechanism for control is thus not economically viable.

In 1997, the water hyacinth infestation along Kenyan shoreline reached crisis proportions resulting in about 70% decline in economic activities at the port of Kisumu. The water hyacinth choked the port and fish landing grounds. The government subsequently

commissioned an international firm with equipment and expertise to mechanically shred the water hyacinth using floating barges, to clear the water hyacinth infestation blocking the port of Kisumu, as a pilot project to establish the desirability of the procedure. Money from the World Bank administered by LVEMP was used for this purpose.

3.5.3. Striga Weed (witch weed)

Striga is a parasitic weed that affects a range of cereal crops in semi-arid areas reducing production by as low as 29% or as high as 100% and thus directly impacting on the livelihoods of especially the smallholder subsistence farmers. There are two common species of the witch weed that affects cereals namely, the purple flowered, *Striga hermonthica* and red flowered *Striga asiatica*. The former is predominant in the western region, while the latter is mainly found in the coastal areas. The most affected crops include maize, sorghum, rice and sugarcane, which account for up to 77% of the farmland in western Kenya. Every year the country looses upto US$53 million to the weed every year with about 200,000 hectares of farmland covered by the weed. The infestation by the weed has been exacerbated by years of monocropping with cereals and the declining soil fertility.

Agronomic recommendations and deployment strategies have been developed to provide a fully operational package of practices that farmers could use to effectively control striga in the infested areas. These include intercropping, crop rotation, up rooting and burning of the weed and rotation of maize (host plant) with other crops that are not hosts of the weed such as sunflower and cowpeas. Since the weed thrives in poor soils, the use of manure and nitrogen-fixing technologies is recommended.

The above control methods often take long before results can be realised. As such KARI has been conducting research on striga management and recently launched a new approach for dealing with the weed called "Clearfield" technology, which is already being tested in Nyahera area of Kisumu district. It is expected to wipe out the weed while improving yields for over 21,000 farmers participating in the demonstration. The new technology is however not based on genetic modifications.

3.5.4. Lantana camara

Although lantana is sometimes used as an ornamental, it is usually considered a weed. It often forms spiny, dense, impenetrable thickets covering large areas of valuable land. The lantana lace bug has been introduced as a biological control agent to combat lantana.

3.5.5. Environmental Impacts of Invasive Alien Species

Effects on ecosystems: Invasive alien species can change light levels, decrease dissolved oxygen in water, change soil chemistry and its structure, and increase surface run-off and soil erosion. Most importantly, alien species can affect ecosystem processes such as nutrient cycling, pollination, regeneration of soils and energy flows. They can also alter the ecosystem regimes. Invaders can compete with native biota, displace them, consume them, act as parasites or transmit diseases, reduce growth and survival rates, cause the decline or extinction of local populations or even entire species, and uproot or damage plants.

Invasive alien species can diminish genetic diversity through the loss of genetically distinct populations, loss of genes and gene complexes and the hybridization or interbreeding of introduced species with native ones.

has already taken place, actions should be undertaken to prevent establishment and spread. Where eradication is not feasible or cost-effective, containment and long-term control measures should be considered.

Collaboration between and within countries is key. The battle against alien invasive species also requires strengthened partnerships between public and private landowners, government, industry, research, and non-governmental organizations.

3.6 AGROCHEMICALS

3.6.1 Introduction

Agrochemicals are chemicals that are used to enhance crop production or to control insect pests, diseases, weeds, rodents, and nematodes. Fertilizers are chemicals that are used to improve soil fertility by addition of plant nutrients like nitrogen, phosphorus, sulphur, potassium and trace elements. They improve physical characteristics of soil, soil pH, organic matter content and water holding capacity.

About 70% of cropped land in Kenya is cultivated by smallholder farmers who apply little or no fertilizer and have been extracting nutrients from the soil without adequate replenishment for many years. Application of fertilizer is a practical alternative to replenish the nutrient reserves, whether in form of organic fertilizer materials or inorganic forms. Inadequate or inappropriate fertilizer application may not get desired crop yields.

3.6.2. Types and Classification of Agro-chemicals

Chemical groups used in Kenya include organochlorines, organophosphates, carbamates, dithiocarbamates, coppers, sulphurs, pyrethroids and microbiol, macrobiol and biochemical biopesticides. The different chemical groups give indications as to toxicity, safety, persistence and points of use (Table 3.11).

Pesticides: Pesticides are classified based on target organism, chemical group, mode of action and formulation. The categories of pesticides that are based on target organism are clearly indicated in the introduction; they include insecticides, fungicides, herbicides, rodenticides, molluscicides, bactericides, nematicides, soil sterilants, hormones and insect repellants and attractants. This classification helps in identifying the safe and effective use of these chemicals.

Pesticides are also classified in accordance with their modes of actions. These are contact, systemic, ingestion, respiratory and soil/ residual acting.

Inorganic fertilizers are classified according to the nutrient supply and the main ones are nitrogenous, phosphatic and pottasic fertilizers that supply nitrogen, phosphorous and potassium, respectively which are required in relatively high quantities. Sulphur, calcium and magnesium as nutrients are required in lesser quantities than the preceding ones hence referred to as secondary nutrients mostly applied as compound fertilizers. Micro-nutrient (required in very small amounts) such as iron, manganese, zinc, copper, molybdenun are necessary for optimal growth and are supplied mainly as foliar feeds. Some fertilizers supply more than one element of the various plant nutrients and are referred to as compound fertilizers.

Formulation and Toxicity: Different formulations have different toxicity levels, which require different application equipment and methods. Generally, toxicity rating is in an ascending order from solid, liquid to gaseous formulation. The known formulations are wet

table powders, suspension concentrates, soluble concentrates, soluble liquids, aqueous, concentrates, flowables, dusts, granules, pellets, fumigants, water dispersible granules, miscible liquids and emulsifiable concentrates.

Table 3.11. Some of the indicators for different chemical groups

Chemical group	Advantages	Disadvantages
Organochlorines	Persistent (residual effect)	• Dangerous to man and environment. • Not recommended for use.
Organophosphates and Carbamates	Medium mammalian toxicity. Quite fast acting Some have low cost	• **Some are dangerous to mammals** • Some kill birds and fish • Broad spectrum i.e. cannot be used selectively in integrated pest management (IPM) strategy
Pyrethroids	Fast knockdown Low mammalian toxicity	• Pests may recover • Broad spectrum
Microbiol Biopesticides	Specific and safe to use Low mammalian toxicity	• Slow action • May have short shelf life • Difficult to produce in large quantities rapidly • Limited availability
Biochemical Biopesticides	May be produced at village level Low Environmental impact Pheromones may be highly specific and safe products	• Slow action and usually incomplete kill • Limited availability
Mixtures	Combine good features of two insecticides	• More complicated to calculate dose and calibrate

Source: Pesticide Initiative Programme COLEACP, 2004

Currently, there are about 700 pesticides registered for use in Kenya. Of these, 35 are biological pesticides, while the rest are synthetic. Biological pesticides are of natural origin i.e. plants, natural enemies and microorganisms. Applications for biopesticides registration increased during the last decade. The biopesticides are more environmentally friendly.

3.6.3. Agro-chemicals Standards

Pesticides: The Pest Control Products Board (PCPB) is a statutory organisation that overseas all matters pertaining to pesticides in the country. PCPB operates under the Pesticides Control Products Act (CAP 346) which regulates the manufacture, importation, exportation, distribution and use of pesticides to control pests and other organic functions of plants and animals and for related purposes.

Fertilizers: The quality of fertilizers is checked by the Kenya Plant Health Inspectorate Services (KEPHIS) at its laboratories. All fertilizers used in the country must meet Kenya's standards set by a Technical Committee comprising of stakeholders from research organizations, universities, fertilizer traders, KEPHIS and Ministry. The standards consider minimum nutrient content and form, particle sizes and characteristics, packaging and labeling, and environmental safety concerns especially as regards heavy metals content. The committee meets regularly to update the standards in line with farmers' requirements and internationally acceptable limits.

The pre-shipment inspection agency appointed by the government ensures that fertilizer destined for Kenya meets national standards before being shipped. Moreover, KEBS also monitors and counterchecks the quality of all fertilizers imported into the country at the port of entry to ensure compliance with national standards.

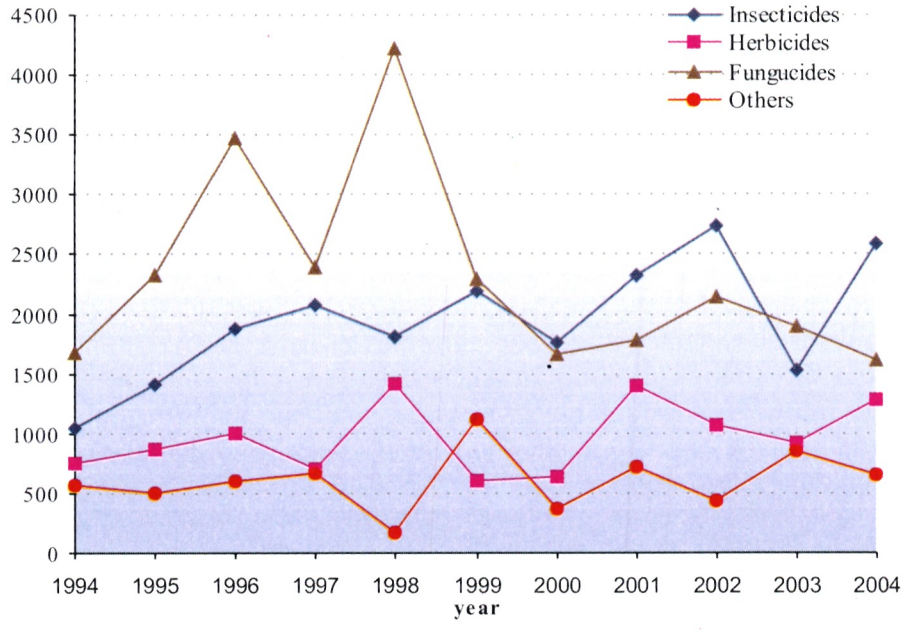
3.6.4. Trends in Agro-chemical Use

Pesticides: Amounts of pesticides used depends on pest infestation, which is also dependant on weather patterns. For example, under continuos wet weather conditions, diseases are more prevalent than insect pests hence higher usage of fungicides, while the opposite is true.

Table 3.12. Importation of different categories of pesticides from 1994 to 2004 (million Kshs)

Year	Insecticides	Herbicides	Fungicides	Others	Total
1994	479.3	286.5	432.8	84.5	1283.1
1995	707	312.1	682.6	74.4	1776.1
1996	1405.4	389.9	1049.1	102.1	2946.5
1997	1164	301.5	827.2	113	2405.7
1998	1196.6	521.3	1358.5	37.7	3114.4
1999	1178	259	891	181	2509
2000	1114.1	298.6	713.9	74.7	2201.3
2001	2201	324	957	154	3636
2002	2030	492	1012	110	3644
2003	1551.3	373.7	1068.1	166.1	3159.8
2004	1800.0	576.9	810.6	785.9	3873.5

Figure 3.1. Pest control products Imported in tonnes 1994 to 2004



Source: PCPB

Importation of pesticides does not have a definite trend over the last ten years (Table 3.12; Figure 3.1). The lowest importation value was in 1994 of Kshs.1,283,100,000 while the highest in 2001 was worth Kshs.4,185,000,000 (Table 3.12).

Fertilizers: Amounts of fertilizers used also depend on the weather (under wet weather conditions more crops area hence high fertilizer need) and method of application (open mechanical applicators use more fertilizers while computerized systems use less fertilizers) (Table 3.13).

Table 3.13. Total annual fertilizer consumption by crop types (metric tonnes)

Consume MT/crop type	Cereals	Other crops	Tea/Coffee	Totals
Time of Application				
a) Planting (Containing nitrogen and Phosphorous)	145,613	47,213	-	192,826
b) Top-dressing (Containing nitrogen, Sulphur, and K (tea/Coffee) or S (Tea)	49,339	32,068	47,213	128,620
Totals	194,952	79,281	47,213	321,446

3.6.5. Effect of Agro-chemicals Use on the Environment

Agro-chemicals pollute both the surface and groundwater sources. Pollution occurs when chemical residues are transferred to surface water via the soil, untreated wastewater and increased run-off resulting from irrigation practices, soil erosion and loss of watershed protection.

Polluted water becomes unfit for human consumption and unable to support plant and animal populations. Pollutants may also bio-accumulate in body tissues to toxic levels over time. Areas of intense horticultural cultivation are most vulnerable, especially around wetlands and watersheds such as rivers and lakes.

Around Lake Naivasha, for example, pyrethroid insecticides have been detected in run-offs and streams; soil sterilants have also been detected. Studies carried out on Lake Naivasha as well as Tana and Athi rivers, all lying downstream from major horticultural, coffee, and tea producing areas have found a wide array of pesticide residues in fish, rendering some of them unfit for human consumption.

Lake Naivasha water shows traces of organo-chlorines and pyrethroid pesticides. This scenario is so despite the fact that organochlorine chemicals have long been banned in agricultural production. While the levels are still low, there is danger of bio-magnification and consequently bioaccumulation in higher animals in the food chain. Water from the lake has the potential to become unfit for human consumption.

Use of methyl bromide is being phased out around Lake Naivasha and a management association was formed to address the environmental challenges around the lake. The Lake Naivasha Riparian Association therefore, works very closely with all stakeholders, including NEMA in this endeavour.

Agro-chemicals pose serious health hazards to the agricultural workers in addition to water pollution. Risks arise from ingestion of chemicals through the use of contaminated containers, drinking water and airborne transfer. Ingestion can cause skin, eye, gastro-intestinal and

respiratory infections. Even where pesticides are relatively safe for humans, they may be acutely toxic to fish, birds, bees and other non-target organisms.

Methods of pesticides application used by many small-scale farmers in the country include hand mixing, hand application, use of twigs and brooms as well as back spraying. Protective measures are rarely taken and most farmers are generally ignorant of pesticide safety practices. Chemical containers are often re-used as receptacles for household and farm products, including food and drinking water. Recognition the poor application practices, the government in collaboration with the Agrochemicals Association of Kenya (AAK) has developed a programme for training farmers on safe and effective use of pesticides. This effort has trained over 800,000 farmers across the country between 1991 and 2004.

Surveys in major horticultural areas have found out that most farmers experience occasional poisoning symptoms after applying agro-chemicals. It has been estimated that pesticides poison 7% of agricultural sector's population in the country every year and that a quarter of the farmers in major horticultural areas regularly suffer from pesticide-related ill health. Organophosphates constitute the most acute danger because of their relative high toxicity.

3.6.6. Obsolete Agrochemicals and their Disposal

Obsolete pesticides are managed by PCPB, which is charged with the responsibility of regulating the importation, exportation, manufacture, distribution and use of pesticides and connected purposes. In addition, NEMA co-ordinates all issues related to risks and hazards that result from hazardous chemicals. Lastly, the Food, Drugs and Chemical Substances Act (CAP 254) deals with chemicals that may contaminate food.

Disposal of pesticides has been a major challenge to most developing countries. Poor pesticides disposal leads to contamination of the environment. PCPB in collaboration with Agrochemicals Association of Kenya (AAK) has established guidelines for safe disposal of pesticides. An inventory prepared in 2003/2004 shows the following estimates of obsolete agrochemicals (Table 3.14).

Table 3.14. Quantities of obsolete pesticides (POPs)

No.	Site	Quantity (metric tonnes)
1.	Kitengela store	400
2.	Mandera	170
3.	Wajir	350
4.	Gaitu (Meru), Naivasha, Nguruman	180
5.	Government Institutions/Co-operatives	400

Source: AAK Inventory of POPs, 2003

There is only one commercial facility for incineration of obsolete chemicals located in Kitengela, but needs some improvement and also standards to control its operations. The contaminated sites in different parts of the country include Kitengela, Wajir, Mandera, Nguruman, Naivasha and Gaitu. It is possible that the chemicals are finding their way to water courses.

3.6.7. Efforts Towards Sustainable Use of Agrochemicals

AAK, the Fresh Produce Exporters Association of the Kenya and the Kenya Flower Council have codes of practices that ensure safe use of these chemicals. In addiction, the ministries of Agriculture, Livestock and Fisheries, and Health in collaboration with AAK have carried out training for stakeholders on safe and effective use of pesticides. Efforts are also ongoing to implement the IPM/ICM strategy in crop production. This ensures that all the available crop protection and nutrition methods are used to help in sustaining agriculture. In addition, the new European standards are being implemented in Kenya on Fresh Produce for export markets. Many producers and exporters are audited on the 14 chapters of EUREPGAP, which ensures that the production of fresh produce exported to Europe is safe to the consumers.

3.7. ARID AND SEMI-ARID LANDS (ASALs)

3.7.1. Production and Land Use Systems

Arid areas receive less than 400 mm of rainfall annually while semi-arid areas receive between 400 and 1000 mm annually. This low and erratic rainfall has exacerbated the afforestation and desertification (Plate 3.2). ASALs which cover about 88% of the country are characterized by strong variations in rainfall, high temperature and high evapo-transpiration rates, yet they support over 50% of the livestock and 80-90% of the wildlife (Table 3.15).

Plate 3.3. Land degradation in ASALs



Key issues in ASALs are land use, water scarcity, encroachment by human population from more humid areas leading to destruction of fragile ecosystems, insecurity and food security (Table 3.16).

Table 3.15. ASAL districts classified by extent of aridity

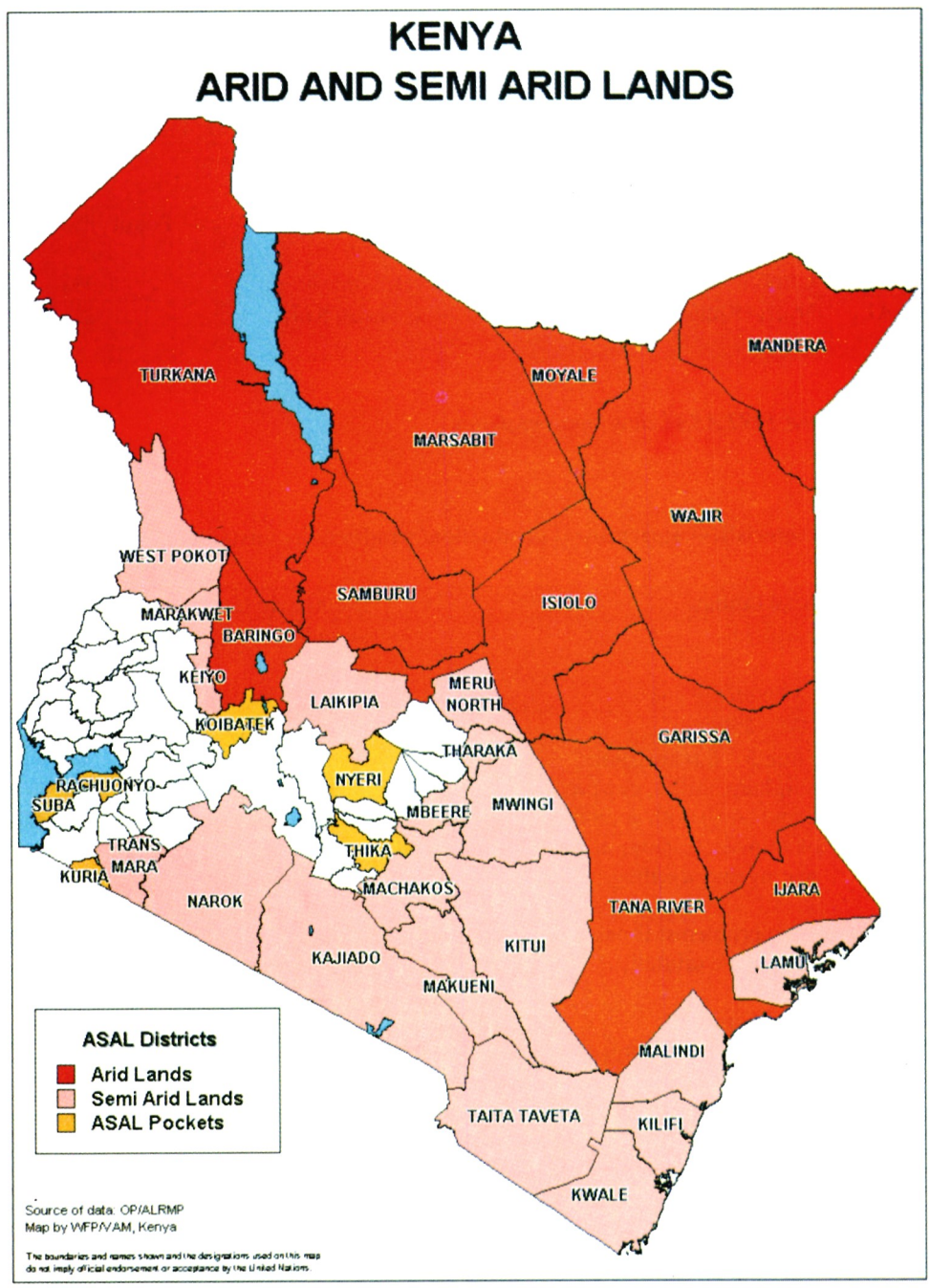
Category	Districts	% Total of ASAL
A. 100% ASAL	Turkana, Moyale, Marsabit, Isiolo, Wajir, Mandera, Garissa, Ijara	62%
B. 85-100% ASAL	Kitui, Makueni, Tana River, Taita Taveta, Kajiado, Samburu	25%
C. 50-85% ASAL	Machakos, Makueni, Mbeere, Tharaka, Laikipia, West Pokot Kwale, Kilifi, Baringo, Meru North	8%
D. 30-50% ASAL	Lamu, Narok, Malindi, Keiyo, Marakwet, Trans Mara	3%
E. 10-25% ASAL	Nyeri (Kieni), Rachuonyo, Suba, Kuria, Thika, Koibatek	2%

Source: Adapted from the 1992 ASAL development policy

Table 3.16: ASAL characteristics- agricultural production/ production constraints

Characteristics	Arid lands	Semi arid lands
Agro ecologica zones	6 and 7	4 and 5
Area of Kenya	352,000 km^2 (68%)	114,000 km^2 (20%)
Rainfall	200 – 550 mm	550 – 850 mm
Agricultural production system and Production constraints	**Zone 5 – 6 transition:** Sorghum, millet, cowpea and green gram (hand hoes) with communally grazed herds of animals. Labour demand for bird scaring and weeding. Main problems: Erosion, infertile soils and inadequate rainfall. **Zone 6 and 7:** Pastoralism predominates especially browsing animals: goats & camels; mobile lifestyle in search of pasture and browse. Exchange livestock for grain and other consumer goods. Also cultivation (increasing cereal cropping in areas where water concentrates), hunting and gathering	**Zone 4:** Maize, beans and cotton (improved seeds and limited use of chemical fertilizer) with local breeds of cattle, goats, sheep and poultry (use of crop residues); Use of animal manure and ox ploughing; seasonally high demand for labour (weeding and harvesting). Main problems: Inadequate rainfall & pests. **Zone 5:** Maize, cowpea and pigeon pea (millet and sorghum would be more appropriate); goats reared (25% do not own livestock); Main problems: Soil erosion, low fertility and frequent droughts.

Figure 3.2. Extend and distribution of ASALs in Kenya



3.7.2. Livelihood Systems

Pastoralism: Pastoral production systems are those in which 50% or more of household gross revenue comes from livestock or livestock related activities. Pastoralists' livelihood is solely dependent on animal products such as milk, blood, meat, hides and skins. It is estimated that 67% of the total red meat in the country comes from ASALs, realized from a livestock population of 8.9 million beef cattle, 5.9 million sheep, 7.7 million goats and 0.8 million camels.

A central strategy of pastoralists is herd maximization, which is their best mechanism of dealing with unreliable and varying availability of natural resources. Key elements of this production system are opportunistic management of the rangelands and mobility of the herds. Pastoralists migrate over long distances often crossing boundaries and borders but following strict rules between different ethnic groups and clans.

Agro-pastoralists: These are more settled pastoralists with permanent crop fields close to their homesteads largely due to the land tenure systems. They keep relatively smaller herds, which enable them to survive when crops fail, as they often do. Such herds also act as food security during severe dry seasons and for strategic continuity purposes for those that survive the drought. Growing crops is mainly the women's task while men move away with their herds in search of pasture. They may return each night or spend several months away during the dry season when pastures are far away. Any surplus from cropping is invested in livestock.

Pastoralists in Transition: In recent times, pastoralists began shifting to agro-pastoralism and becoming more sedentary. Diets have also changed from the traditional milk and blood, to maize meal and other foodstuffs. With the increasing population of the arid districts, due to both natural population growth and immigration, pastoral families can no longer cope with a purely meat and milk diet. Cultivation, land adjudication and wildlife management have contributed to a decline in the dry season grazing areas. Consequently, there has been decreased possibilities to subsist in the pastoral systems. There has therefore been a significant decline in the general size of herds in relation to the number of people supported, probably a ratio of about five cattle per person.



Plate 3.4 Clearing of dry land forests for cultivation in Baringo district (*Top* - settlement in a wooded area; *Middle* – cultivation in newly cleared woodland: *Above*- Woodland cleared for pasture)

Urbanisation: An increasing number of ASAL populations are moving to settle in urban centers in search of better livelihoods and employment opportunities as a result of extreme climatic conditions, punctuated by frequent droughts. Some of these people have ended up in the urban informal settlements, further complicating the already unfavourable living conditions. Many survive out of hawking foodstuffs, household goods, fruits and vegetables or depend on unreliable casual work. Other consequences of these migrations are manifested in increasing cases of crime.

3.7.3. Encroachment of ASALs

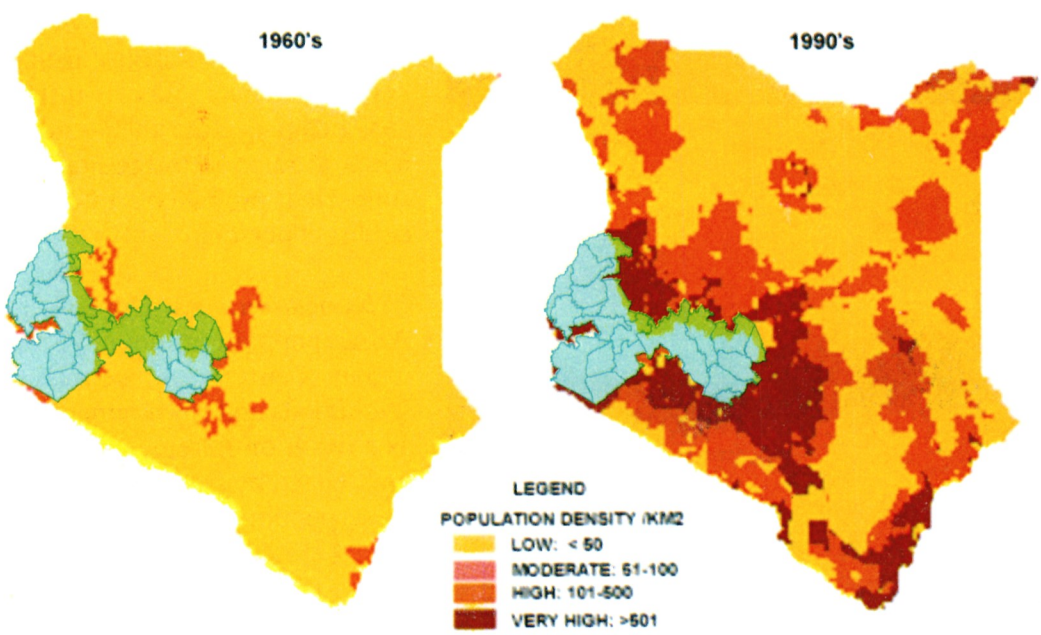
ASALs have continued to be impacted negatively by immigration from other parts of the country. Immigrants introduce new land use practices, some of which are not sustainable in such fragile ecosystems. Further, some of the

introduced practices and demands by the immigrants exert unsustainable pressure on available resources leading to land degradation including the destruction of fragile ecosystems such as wetlands and forests, which are also important livelihood components in ASALs (Plate 3.4).

Wetlands are important habitats in ASALs and serve as watering points. Some of the wetlands, which serve as dry season grazing areas have been invaded by cultivators for commercial agriculture. This denies pastoralists access to dry season grazing, which has for many years served as drought coping mechanism. Under EMCA (1999), such fragile ecosystems should now be identified, documented and gazetted as ecologically significant areas for conservation. Many such ecologically significant areas have been severely degraded and need urgent action to stop the trend.

Figure 3.3 illustrates the spatial spread of human population from the 1960s to the 1990s in Kenya.

Figure 3.3. Changes in spatial population densities between 1960s and 1990s,



Source: DRSRS

Trends on population growth over the years show that the spatial expansion of population has affected mainly the ASALs where land tenure system allows a haphazard settlement pattern. There is therefore need to integrate ASALs into the mainstream of the national economy and thereby raise the standard of living of ASAL population.

In order to ensure sustainable environmental and natural resource management, and in line with EMCA the Government and other stakeholders need to create awareness on environmental costs and benefits and involve communities in environmental conservation activities such as re-afforestation, grazing management, development of permanent water sources in the arid districts, enforcement of environmental standards and use of sustainability indicators.

3.7.4. Carrying Capacity and Stocking Rates

Carrying capacity is the average number of animals a rangeland can sustain over time. It reflects the ability of a rangeland to sustain a particular type of land use at optimal levels of production. Carrying capacity is based on a rangeland, which is in good condition.

The continued land degradation over the years has reduced the carrying capacity in all agro-ecological zones (AEZs). This has led to accelerated soil erosion, especially in ASALs as depicted in Plate 3.5. There is need therefore to adopt appropriate land use practices in order to reverse current trends.



Plate 3.5 Overstocking leads to land degradation in ASALs

3.7.5. Water Resource Management and Development

Water resource availability and its appropriate development and use are key in the sustainable development of ASALs. The development of surface water harvesting structures such as pans and dams will be emphasized, while ground water will be developed based on exhaustive social and environmental sustainability criteria. The drilling of new boreholes will only be undertaken after environmental impact assessments (EIA) are approved. Preference will be given to rehabilitation and operationalization of existing boreholes. The potential for irrigation, especially in the semi-arid areas will be explored based on EIA studies and relevant regulatory measures.

ASALs lack access to clean water for domestic consumption. The poor management of the existing water works and non-existent or poor sewerage systems has further compounded the problem. The government efforts to provide clean water are being supplemented by various actors including the private sector, local authorities and NGOs. To meet the objectives of providing water and sanitation, priority actions will include the protection and management of water catchment areas, the promotion and encouragement of community/private sector based water projects, and the expansion of water development and management by privatized arms of local authorities and other private entities. The government will rehabilitate existing water and sewerage schemes through cost sharing and the full implementation of the Water Act.

3.7.6. Land Tenure Systems in the ASALs

Land holding in the ASALs is currently managed under three legal regimes, namely government land, private land and trust land. Trust land is the dominant tenure system in ASALs; County Councils hold such land in trust for the benefit of residents. However, the legal provisions on rights and interests of residents under the Trust Land Act have often been irremediably extinguished at will through adjudication and allocation to individuals or government institutions. Pastoralists have therefore lost land to large irrigation schemes, national parks and game reserves and military activities to the exclusion of their interests.

Land tenure and land ownership among ASAL communities should therefore be adequately protected through appropriate legal frameworks in order to solve potential inter-ethnic conflicts, as well as provide for an effective system of managing natural resources on a sustainable basis by the communities themselves. Sorting out these land tenure issues in the ASALs is both delicate and intricate and which should be resolved speedily.

3.7.7. Impacts of Refugees in ASALs

Political unrest in neighbouring countries has led to an influx of a large number of refugees into Kenya, who live in refugee camps in ASALs with capacity for over 400,000 people. Currently, there are two main camps, Dadaab in Garissa District and Kakuma in Turkana District. Dadaab is a complex of three camps, namely Ifo, Dagahaley and Hagadera. In Dadaab, most refugees are of Somali origin (131,486) while in Kakuma most are Sudanese (69,479).

The refugee camps have impacted negatively on immediate environment through destruction of natural resources and introduction of inappropriate land use practices, such as cultivation of crops around the camps, indiscriminate felling of vegetation for use as fuelwood, poor management of solid waste, poor sanitation and contamination of water. Consequently, there has been tension between refugees and the local community over the use of the natural resources including water and firewood. Local residents have also complained about preferential treatment of refugees in the provision of social services inside and outside the camps (especially in health and education), alleged discrimination in employment opportunities against local people and inadequate community participation in the development and ownership of facilities particularly when the camps get dissolved/closed.

3.8. MARKET ACCESS

Market access is an umbrella term for measures used to restrict imports. The most common form of such restrictions is tariffs on imported goods. Non-tariff barriers to markets exist and include technical standards, antidumping regulations, import quotas, import licensing and variable levies. Issues dealing with market access at the international level are handled by the World Trade Organization (WTO) of which Kenya is a signatory. The thrust of the national policy on trade is to create an environment that is conducive to promoting Kenyan products in the international market.

The agricultural sector in Kenya has shown mixed performance following liberalization of the economy and implementation of WTO rules. Agricultural markets are fully liberalized with low tariff barriers. Liberalization has also led to abolition of the marketing monopolies that existed for agricultural commodities resulting in low marketing costs. In some cases, uncontrolled imports have depressed incentives for production of some commodities and reduced incomes to farmers. Besides, under the liberalization programmes, the government has reduced expenditure on the agricultural sector and encouraged cost sharing in the provision of services such as animal health and research. This is partly responsible for the poor performance of the sector, resulting in increased poverty with agriculture unable to support peasants meet their basic needs including health and education.

Market access for Kenya's agricultural products is constrained by farm subsidies by developed countries. Kenyan products are, therefore, disadvantaged even in the local market. Another

concern is the deteriorating terms of trade, as the increase in the value of trade is not matched by a corresponding increase in export earnings.

Exports from Kenya enjoy preferential access to certain markets, especially regional markets through her membership in the East African Community (comprising Kenya, Uganda and Tanzania with a population of about 80 million), and the Common Market for Eastern and Southern Africa (COMESA) with a population of about 380 million. Exports and imports within member countries enjoy preferential tariff rates.

The European Union (EU) under the ACP/Cotonou Agreement is Kenya's largest trading partner to which are export products such as industrial products and a wide range of agricultural products including beef, fish, dairy products, cereals, fresh and processed fruits and vegetables enjoy preferential market access.

Kenya qualifies for duty free access to the United States market under the African Growth and Opportunity Act (AGOA). Kenya's major products that qualify for export under AGOA include textiles, apparels and handicrafts. However, with the expiry of the Africa Textile Contract (ATC), Kenya is already experiencing problems in marketing its textile products and already some industries have started laying off thousands of workers. The same problem is feared when EU starts implementing the EUREPGAP code on horticultural produce.

Under the Generalised System of Preferences (GSP), a wide range of Kenya's manufactured products are entitled to preferential duty treatment in the United States of America, Japan, Canada, New Zealand, Australia, Switzerland, Norway, Sweden, Finland, Austria and other European countries. In addition, no quantitative restrictions are applicable to Kenyan exports on any of the 3,000-plus items currently eligible for GSP treatment. Kenya has participated in the multilateral trading system through GATT and WTO with the objective of achieving effective access to markets, and supports the role of WTO in strengthening the multilateral trading system.

Standards: The Kenya Bureau of Standards has developed two standards (KS 1758:2004 and KS1516) to assist trade on sanitary and phytosanitary measures (SPS). The Kenya Plant Health Inspectorate (KEPHIS) is responsible for the implementation of Sanitary and Phytosanitary measures and subjects certain imported agricultural goods to further inspection. KEPHIS also regulates the importation and exportation of plant materials and trade in bio-safety control organisms in accordance with the International Plant Protection Convention.

Domestic Agriculture Subsidies: Kenya removed domestic support to agricultural products before the conclusion of the Uruguay Round of Agreement of WTO. However, developed countries continue to subsidize agricultural products such as sugar, cotton, oil seeds and dairy products. EU subsidies to agricultural products range from 64% to 96%, thus reducing competitiveness of similar products from Kenya. Products from Kenya suffer other constraints including infrastructure (markets, water, electricity, roads, etc), legal and regulatory environment, institutional inadequacies as well as inadequate credit to farmers.

Export Subsidies: Export subsidy regulations were introduced with a major objective of restricting disposal of subsidized surpluses of agricultural commodities in the world market, particularly from developed countries, which accentuate world price instability.

The major trading partners for agricultural commodities for Kenya are the EU countries for coffee, horticulture and tea; Asian countries for tea and coffee, and COMESA countries for tea and processed food products.

Exports: Kenyan exports are dominated by agricultural commodities, particularly tea, coffee, pyrethrum and horticultural products (flowers, fruit and vegetables), which represent around 60% of total exports. Therefore, fluctuations in climatic conditions and in world prices of these commodities strongly affect export earnings. Subsidized export products from developed countries such as cereals affect domestic production of similar products. The EU for example, uses direct export subsidies for her agricultural products, which makes such products relatively cheap in the countries of their destination. This affects locally produced commodities of similar nature. Examples include dairy products, cotton, sugar etc.

3.9. OUTLOOK

Some practices identified in this report present serious challenges and opportunities for agricultural production, land productivity and environmental health. Highlights of these include:

1. There is increasing demand for organic farm products. It is an opportunity which should be pursued through increased investment in terms of credit provision, technical support (research and extension services) and marketing infrastructure.

2. Monoculture is contributing to the destruction of crop genetic diversity and has increased susceptibility of crops to pests and diseases. Considering the significant contribution of agriculture to the economy, it is necessary that monoculture practices should be guided by sound genetic conservation practices.

3. Soil and water conservation practices aimed at reversing the negative impacts of land degradation, especially soil erosion and water run-offs. The results include enhancing crop and livestock production. There is need therefore to develop a more effective soil and water conservation strategy including the provision of adequate technical and financial support.

4. Improving livestock production has been associated with high yielding dairy animals and early maturing meat animals of good weights. Preference for such breeds, most of them exotic, diminishes the local genetic pool, as indigenous breeds are lost.

5. Packaging materials such as plastic and polythene bags, sheeting materials and pots used by various agricultural activities have negative environmental impacts on their environments, since most of them are not bio-degradable. Current efforts to minimize use of plastic and polythene materials as well as control their wastes by NEMA and relevant lead agencies should receive more vigorous support.

6. Chemicals such as fertilizer, pesticides and herbicides have potential to significantly affect environmental and human health and safety. There is urgent need to re-invigorate awareness on proper management of all agro-chemicals to avoid loss of life and poisoning of the environment.

7. Pastoralism is widely practised in ASALs covering most of the northern and southern rangelands. However, increasing sedentarization and insecurity has resulted in poor management of the range resources, especially soils, vegetation and water. It is important to improve security of pastoral communities including developing and supporting resource use conflict resolution mechanisms. It is also necessary to support best practices in range management in collaboration with local communities.

8. There is need to improve infrastructure for livestock movement, holding grounds and marketing. It is also necessary to set up small abattoirs in strategic areas across the ASALs to minimize losses associated with long journeys to market such as deaths, loss of weight, insecurity, cost of transportation and time.

9. The provision of extension and veterinary services should be strengthened, through the collaborative arrangements involving the government, private sector and beneficiary communities. Further, the identified Pastoral Thematic Groups should be supported in accordance to the priorities specified by the Economic Recovery Strategy for Wealth and Employment Creation (2003-2007) aimed at re-invigorating the sector.

10. The promotion of food security depends largely on partnerships between government, civil society organizations and the private sector. The potential areas of partnership include crop and livestock production, commodity marketing, water harvesting for agricultural and livestock production, honey production and other business ventures of interest to local communities.

11. Credit, marketing facilities and structures should be strengthened and expanded through appropriate institutional mechanisms to improve agricultural production and marketing and thereby intensify agricultural production, increase income and enhance food security at all levels.

12. There is need to encourage the application of research and early warning information provided by research institutions and relevant government ministries and agencies such as the Famine Early Warning System (FEWS) and the Drought Monitoring Centre in order to enhance preparedness in managing the effects of drought.

13. Build capacity of farmers through Farmer Field Schools programmes countrywide to enhance the farmers' ability in decision-making to assist in selecting enterprises that best suit their optimal production potential.

CHAPTER FOUR

LAND USE AND BIOLOGICAL DIVERSITY

4.1. INTRODUCTION

Kenya is endowed with a rich diversity of biological heritage, found in terrestrial, aquatic and below ground ecosystems. Over the past several decades, biodiversity has been under increasing demands, some of them unsustainable. Since the Earth Summit in 1992, conservation of the environment including biodiversity has been prioritized upon the realization that utilization of some of these resources is unsustainable, unless concerted efforts are taken, as a matter of urgency, to stop and even reverse the trends.

Dependence on land and land-based resources by majority of the country's population remains a major challenge to sustainable utilization and conservation of the country's wealth of biological diversity. There is need to enforce existing legal instruments for analyzing risks and dealing with eradication and control across all taxonomic groups.

4.2. FOREST BIODIVERSITY

4.2.1. Status

Forests rank high among the country's most important resources, though they only cover about 1.7% of total land area. Most forests are managed as reserves by the Forest Department in accordance with the Forest Act. The closed canopy forests in national parks and national reserves are managed by the Kenya Wildlife Service (KWS) under the Wildlife (Conservation and Management) Act of 1985.

There are also certain forests of cultural and biodiversity significance gazetted as National Monuments under the Antiquities and Monuments Act. They are managed by the National Museums of Kenya (NMK). A significant proportion of trust land (about 100,000ha) is forest-covered, managed by the respective local authorities. There is also forest under private ownership, either as units held individually or as community land.

Forests are continuously impacted on by land use changes. Demand for land to expand agriculture and human settlements are the main driving forces behind declining forest cover. These have led to excision of forests, illegal cultivation and human settlements in forest areas. This problem has been experienced in most forests in the country ranging from the large forest blocks to very small and isolated hilltop forests.

Forests support livelihoods through provisions of food, medicine, wood for construction, fuel-wood and services such as water catchments. Despite their importance, forests continue to be decimated.

Among the five most important forests ecosystems referred to as "water towers", Mau Forest is the most adversely affected by illegal logging with forest cover reduction of 7,084ha between 2000 and 2003. The other water towers are Mt. Elgon, Mt. Kenya, Aberdares and Cherangani forests. The Forest Bill 2005, once enacted, should provide for proper management of land in fragile water catchment forest areas.

4.2.2. Forest Types

Kenya is endowed with a wide range of indigenous forests including montane forests (in central and western highlands), rain forests in Kakamega, lowland forests and mangrove forests on the coast area. In the ASALs, woodlands and bush lands that do not fit into the classical definition of forests form important habitats that provide goods and services associated with forests. Communities in such areas would therefore normally refer to such habitats as forests. These forests are rich in biodiversity with some harbouring high numbers of endemic species.

The country also has large blocks of plantation forests mostly found on gazetted government land mainly in central and western highlands. The commonly planted tree species are cypress, pines and eucalypts.

There is also growing adoption of private forestry in many parts of the country. The Forest Department in conjunction with other stakeholders is promoting tree growing on private land although the data on tree resources on farms is not available. Since the ban on timber harvesting in government forests, on farm forest trees have supplemented the wood demands and will increasingly play a vital role in supplying wood to the timber industry. The only large scale commercially owned and managed plantation is by Kakuzi Company, which has about 40,000 hectares of eucalyptus and grevillea species. Table 4.1 shows area under plantation forest by species in 2003, while table 4.2 shows estimated woody vegetation cover.

Table 4.1. Types and sizes of various plantations

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%)**

Table 4.2. Extent of woody vegetation cover

Vegetation Type	Areas in hectares	% Total Land Area
Indigenous forests	1,200,000	2.10
Industrial plantations	120,000	0.20
Tree cover on farmlands	1,500,000	2.57
Woodlands, bushlands and wooded grasslands	36,000,000	61.77
Non-wooded area	19,440,000	33.36

Forests make significant contribution to the economy and provide ecological services with associated tangible benefits such as serving as water reservoirs, retaining air moisture, regulating river flows and preventing flooding, facilitating ground water recharge, reducing sediment loads in river waters, regulating rainfall patterns, and acting as carbon sinks.

4.2.3. Forest Threats and Challenges

Excisions: Loss of forestland in Kenya has occurred largely through excisions. Between 1932 and 2000, the country lost 223,800ha through excisions. Only a small portion of forest has been added to the forest estate especially since 1960s. A recent study on changes in forest cover in Kenya's five "water towers" between 2000 and 2003 indicate that a total of 4,850ha of indigenous forest were lost through excision in Mau forest alone. Other losses are not documented but there are efforts to survey and document the extent of the excisions.

Box 4.1. The five "water towers" of the country

Kenya's five largest blocks of forests comprise the water towers of the country forming the upper catchments for all main rivers. These are Mt. Kenya, Aberdares Range, Mau complex, Cherangani hills and Mt. Elgon. The Mt. Kenya forest forms the upper catchment of Tana River (Kenya's longest river) and the Ewaso Ngiro North River. This forest alone is estimated to supply more than 40% of the country's water needs. The Aberdares range forests form the upper catchments of Tana, Athi, Ewaso Ngiro North and Malewa rivers. It is also the main catchments for Sasumua and Ndakaini dams, which provide most of the water used in Nairobi City.

The Mau complex is the largest remaining forest block in East Africa. It forms the upper catchments of all but one of the rivers that drain west of the Rift Valley, including the Nyando, Sondu and Mara that drain into Lake Victoria. It is also the main catchment of critical lakes and wetlands in the Rift Valley, including lakes Baringo, Nakuru, Naivasha and Natron. The Mt. Elgon and Cherangani forests form the upper catchment area for two major rivers namely Nzoia and Turkwel. The Cherangani forests also forms the upper catchment for Kerio River, which feeds Lake Turkana.

Illegal Logging: Illegal logging of indigenous forests for poles, posts and timber has led to serious forest degradation in major water catchment areas that include the Aberdares, Cherangani, Mt. Kenya, Mau and Mt. Elgon forests. Currently, there is a ban on timber harvesting from government forests, which has created a timber shortage that in turn has contributed to heightened illegal logging. Due to inadequate capacity to patrol all forests, the government continues to lose revenue through unlicensed logging of forest plantations. Illegal charcoal burning continues to take place in gazetted and non-gazetted forests.

Encroachments and Illegal Cultivation: Illegal cultivation within indigenous forests has reduced the forest cover in the country, especially through the popular *shamba system*. Although the *shamba system* has been practiced in Kenya for decades its overall effect is reduced forest cover, as new seedlings were not allowed to manifest into full forests. Encroachment in Cherangani and Mau forests pose a great threat to these forests. Encroachments also occur in areas where the forest boundaries are not well demarcated. In February/March 2005, the Government started to evict people who had illegally and irregularly settled in Mau, Mau Narok and Mt. Kenya forests.

Livestock Grazing: Livestock grazing has contributed to forest degradation through trampling and grazing of forest seedlings as well as the general destruction of vegetation and consequent suppression of regeneration. During the 2002 aerial survey of the Aberdares, a total of 18,497 livestock were counted in the forest.

Landslides and Quarries: Most landslides in forests are caused by the combination of high rainfall and steep slopes. Illegal human activities on steep slopes especially logging and charcoal burning contribute to most landslides as the forest ability to retain water is reduced leading to flash floods. Quarries also contribute to loss of indigenous forest vegetation and therefore undermining natural regeneration of forest ecosystems and currently a number of such quarries in forests have remained unrehabilitated for years. The ongoing efforts by NEMA to identify and document existing quarries will guide in the issuance of appropriate restoration orders.

Forest Fires: An estimated 3,000ha of government forests are lost to fires annually, most of which emanate from private and non-resident cultivator farms. In some cases, arsonists have set forests on fire for various reasons including pasture improvement and for settlement. Honey harvesters also contribute to unintentional forest fires through their honey harvesting activities.

Pests and Diseases: Pests and diseases are other causes of loss to forest plantations. Currently, an exotic pest, identified as the gall-forming wasp, called blue gum chalcid, is threatening eucalyptus trees in western Kenya. This is an invasive pest native to Australia.

Forest Degradation by Wildlife: Elephants have contributed to wide-scale destruction of both forest plantations and indigenous forests. Forest destruction by elephants is evident in Mwaluganje, Hombe, Gathiuru and Mucheene forests.

Sub-division of Trust Land: The government policy to sub-divide trust land including community-owned ranches, is contributing to large-scale destruction of forests within these areas. A case in point is the recent destruction of forests in Trans Mara District. Pressure is localised on small units leading to degradation of the already fragile ecosystems.

Ownership Status: Lack of clarity on ownership status of some forests threatens their sustainable management as in the case of Maragoli Hills. These hills have been encroached, degraded and left bare of trees.

Bio-piracy: Biopiracy is a major concern in many parts of the country. Valuable biodiversity has been exploited and removed from the country illegally often under cover of research. In Bondo District for instance, bio-piracy on valuable indigenous species by people posing as religious sects performing rites in Got Ramogi Hills has been reported. This is a great threat to some forests. Illegal exploitation of plant material such as *Prunus africana* bark and Aloe species is an issue of concern.

Political Interference: There have been cases of political interference in the management of some forests with some politicians occasionally inciting their constituents to demand forestland for either cultivation or settlement.

4.2.4. Consequences of Deforestation

Deforestation has adversely impacted on social, economic and environmental aspects. Among the main impacts include great loss of forest cover, increased soil erosion, drying of rivers, silting of rivers and dams and increased costs of forest related products, mainly timber.

Loss of Forest Cover: Deforestation has resulted in loss of forestland occupied by both plantations and indigenous forests. Recent surveys indicate that the forest cover in the country is about 1.7% of the total land area, which is very low as compared to the internationally recommended level of 10% minimum for a country. The current reaforestation efforts and reclamation of forest land should increase area under forest cover.

Tree Species and Forest Structure: Heavy exploitation of preferred indigenous species for timber has resulted in their decline. These include *Olea* spp, *Prunus africana, Vitex keniensis* and *Juniperus procera.* Deforestation in East Mau Complex has resulted in widespread growth of *Neuboutonia macrocalyx* and *Macaranga capensis*, which are both colonizers, making some preferred trees such as *Olea* rare in the forest.

Soil Loss: Soil loss through erosion is a major problem in many degraded forests resulting in sedimentation of the water systems downstream. Mt. Kenya is an important source of rivers that support seven hydropower stations. Soil erosion upstream has led to siltation of the hydro-electricity reservoirs thus reducing their capacity to generate electricity. This has necessitated additional expenditure in financing alternative power generation to supplement the national grid. The situation has been compounded by prolonged periodic droughts which have further reduced the volume of water in hydro-electric reservoirs.

Degradation of Water Catchment Areas and Flooding: Massive run off from the Mau forests during rainy seasons is associated with flooding in the Nyando River basin. This has been aggravated by the degradation of forest cover through illegal logging, which has reduced its water retention capacity resulting in flash floods. This has caused loss of human life, damaged property, increased cases of water borne diseases and increased poverty in the region.

Shortage of Forest-Related Products: Deforestation has resulted in insufficient timber and other forest-related products. This is especially so with indigenous hard woods which are now imported from East and Central Africa. Other impacts include closure of many small-scale sawmills and related cottage industries resulting in loss of employment opportunities and aesthetic values of forests.

4.2.5. Responses

The response to the above challenges is the development of the Forestry Master Plan (1994) in 1994, and the subsequent revision of the Forest Policy and legislation. The main indicators of the efforts towards sustainable management of forests are in the provisions of the Forest Bill 2005. The Bill is guided by the principles of sustainable development including public participation in resource management.

***Ex-situ* Conservation:** Many botanical gardens have been established as a form of *ex-situ* conservation, including Isukha Heritage (a community initiative in Kakamega) and botanical gardens established by Maseno University, Egerton University, Jomo Kenyatta University of Agriculture and Technology, Kenya Forestry Research Institute and National Museums of Kenya.

***In-situ* Conservation:** The government has gazetted sections of forests as nature reserves for purposes of *in-situ* conservation. These include Buyangu, Yala, Isecheno and Kisere nature reserves of Kakamega Forest and Gatare Nature Reserve in Maragua District.

Complaints: The Public Complaints Committee (PCC) has received and investigated public complaints on forest destruction from various parts of the country. This indicated that various forests in the country have been destroyed leading to reduced forest cover (Box 4.2).

Box 4.2. Cases relating to forest destruction reported to PCC

Cases relating to forest destruction comprised some 12% of all complaints received. Many of these complaints affect Kakamega Forest, Kaptagat Forest, Aberdares Forest, Ngong Forest, Chyulu Hills Forest, Mau Forest, Arabuko Sokoke Forest and Mt. Kenya Forest. All the above forests are threatened by a number of factors, including:

a) Increased illegal logging both for commercial and domestic purposes;
b) Encroachment for agricultural purposes;
c) Politically motivated forest excisions without any ecological basis;
d) Over harvesting of wood products e.g. debarking; and
e) Deforestation for human settlement.

The committee made the following findings:

i) Forest protection has been largely *ad hoc* from a policy and implementation point of view;
ii) Deforested areas are changing into agricultural land, e.g., in Mau forest;
iii) Conflicting interests in management of forest resources has aggravated forest destruction; and
iv) Both the Kenyan forestry policy and legislation are outdated and fail to address the current challenges.

In view of the foregoing, the PCC recommends formulation of a sound and comprehensive forest policy and the speedy enactment of the Forest Bill. Additionally, NEMA in consultation with the relevant institutions involved in forest management should enhance awareness and public participation campaigns. The Committee calls for continuous monitoring and introduction of forest management planning.

4.3. WILDLIFE BIODIVERSITY

The decline in major wildlife species in the country has reached alarming levels due to increasing human-wildlife conflicts, despite the protection status that most wildlife species are accorded (Table 4.3). Poaching and trade in bush-meat continue to pose a major challenge to management, while corridors for animal migration are increasingly being converted to other uses including human settlements. A framework for management of transboundary wildlife resources for areas such as the Masai Mara National Reserve is required in order to create synergy and ensure sustainable utilization in a holistic manner.

About 35,000 species of plants, animals and microorganisms have been documented in Kenya. This shows that the country has one of the highest gene pools with some species being endemic, rare, threatened or vulnerable. To conserve the biodiversity, the government established national parks, national reserves and forests as protected areas. National parks, national reserves and sanctuaries occupy over 8% of Kenya's land area (Table 4.4 and Figure 4.1). This is an indication that conservation is a priority issue in the country.

4.3.1. Population Distribution and Trends

In Africa, Kenya ranks third in richness of mammal species. Out of the 334 mammal species known to exist in Kenya, 10 of them are endemic. The animal numbers in the country have declined over the years as shown in the census data from selected areas. In Machakos District, the population of Thompson and grant gazelles, kongoni, wildebeest and impalas decreased between 1991 and 2002 as a result of poaching and encroachment of wildlife habitats (Figure 4.2).

Table 4.3. 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
Thomsons Gazelle	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
Total	**1,262,286**	**846,653**	**-415,633**	

Source: DRSRS data

Table 4.4. Status of conservation areas in Kenya

Name	Number	Area Sq Km	% Area Occupied
National Parks	23	30,348	5.2
National Reserves	26	16478	2.8
Marine National Reserves	6	706	0.12
Marine National Parks	4	70	0.01
National Sanctuaries	4	71	0.01
Total	**63**	**47,674**	**8.2**
Community private conservation areas	26	Unkn0wn	Unknown

The conservation of the elephant has been critical in this country bearing in mind that this is one of the animals that has been poached for its highly valued ivory. By 1989, there were 16,000 elephants having dropped from 170, 000 in 1963. This decline in numbers prompted the placement of the elephant in Appendix I of the Convention on International Trade in Endangered Species (CITES). By 1996, Kenya had a population of 26,000 elephants but the down listing of the elephant to Appendix II has resulted in a rise in poaching.

The black rhino population dropped from an estimated 20,000 in 1970 to less than 500 rhinos in the early 1980s due to poaching. To support the conservation efforts of rhinos, rhino sanctuaries were established in the early 1980s. The sanctuaries are in different parks, namely Lake Nakuru rhino sanctuary, Nairobi rhino sanctuary, Tsavo West (Ngulia rhino sanctuary), Aberdares rhino sanctuary, Tsavo East Free range, Chyulu rhino population and proposed Meru rhino sanctuary. The current total population is estimated at 458 animals.

Following the success of the sanctuary approach, the Kenya Rhino Programme has resolved to develop and conserve for the long term, a genetically viable population of 2,000 black rhinos (Eastern sub species) in their natural habitat, and to encourage the continued protection

and breeding of southern white rhinos on private lands and enclosed national parks. The short-term goal of the programme (2001-2005) is to maintain an overall population growth rate of at least 5% per annum with a total population of 500 in 2005 in the full range of habitats.

4.3.2. Challenges and Threats

Land Use Change: Changing land tenure system, subdivision of group ranches and lack of a comprehensive land use policy are major challenges to biodiversity conservation. Conversion of pastoral lands to cultivated land and subsequent subdivision of land is occurring at a very high rate. In settled areas, fences are erected, which stop animal movements and increase their vulnerability. For example, Kitengela area, which borders the Nairobi National Park, is fast being sub-divided for human settlement thereby changing land use resulting in loss of seasonal wildlife migratory corridor and dispersal areas.

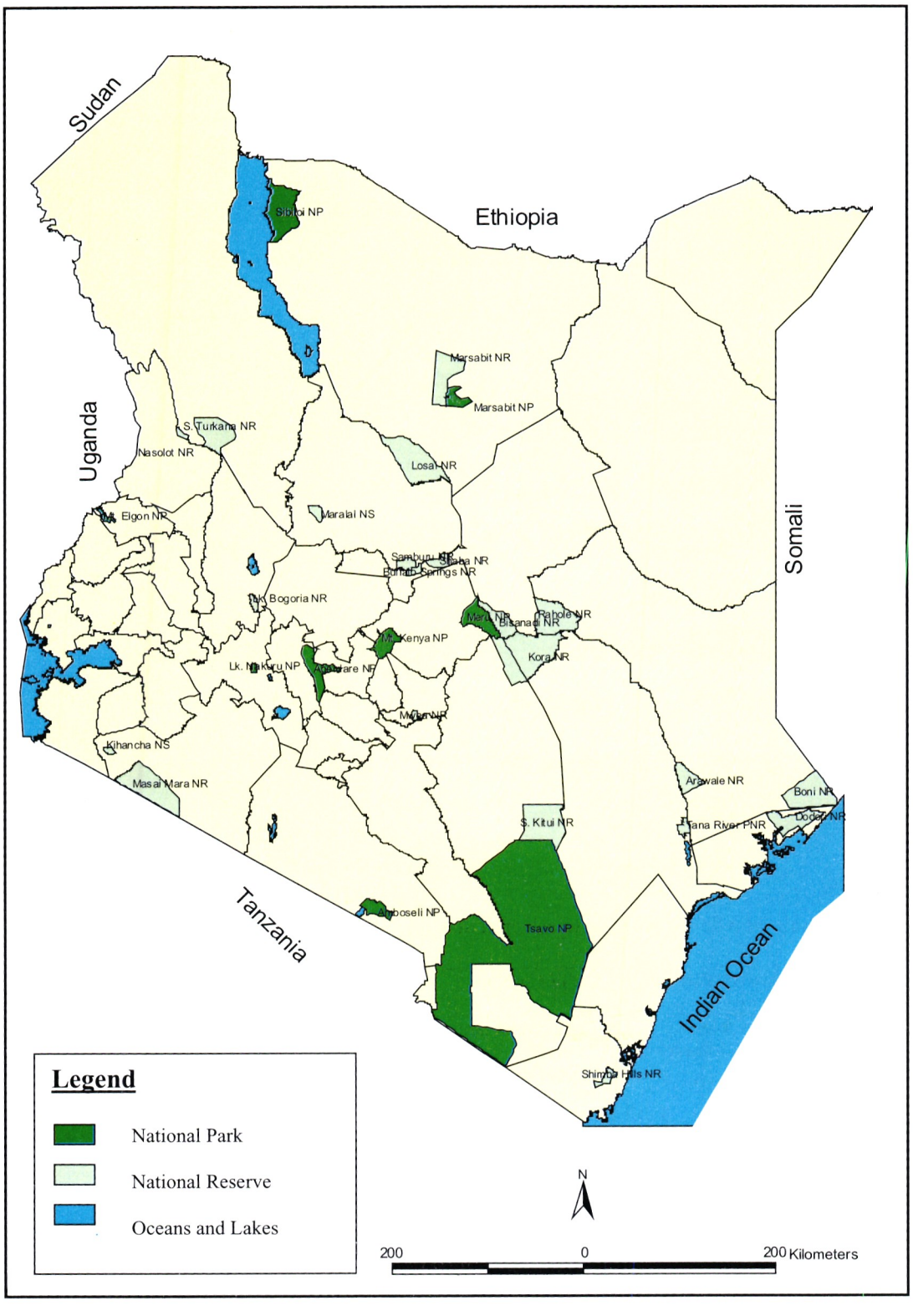
Degradation of the Habitat: Encroachment by livestock into Amboseli National Park and Masai Mara Natural Reserve conservation areas has also increased habitat degradation through loss of tree cover and increased soil erosion.

Poaching and Human/Wildlife Conflicts: Poaching of animals such as rhinos and elephants for their tusks is a threat to conservation. In addition, illegal harvesting of bush meat is a major growing threat to wildlife conservation. This has been exacerbated by changing land use practices from pastoralism to sedentary farming and increasing migration of farming communities to wildlife dispersal areas.

Human encroachment into wildlife corridors and dispersal areas has led to increased conflicts. Table 4.5 presents cases of human/wildlife conflicts in selected districts. For example, human/wildlife conflict is prevalent in Laikipia District due to the influx of livestock in to wildlife areas. The search for grazing pastures has led pastoralists to encroach into protected areas, thus heightening such conflicts as is the case in Amboseli National Park and Masai Mara National Reserve.

***Transmission of Wildlife Diseases*:** Some diseases are common to both livestock and wildlife, including rinderpest and foot and mouth diseases, which can be transmitted to or by wildlife.

Figure 4.1. National Parks and Reserves in Kenya



Source: DRSRS records

Figure 4.2 Trend of five animal species in Machakos District for 1991 - 2002

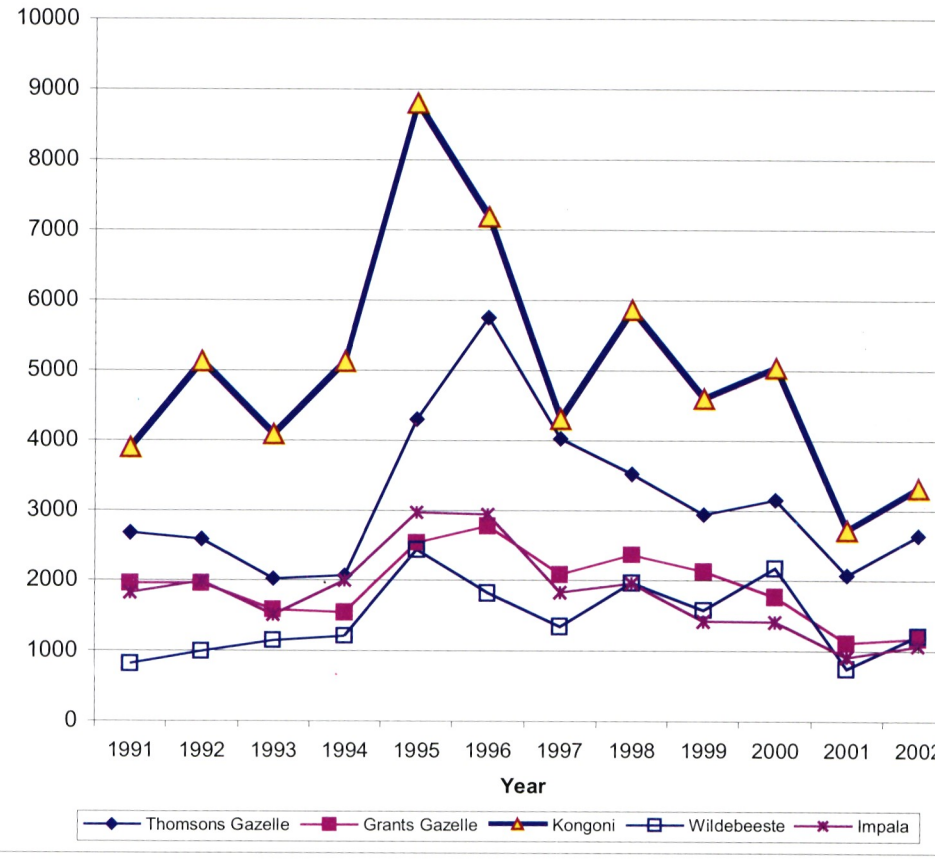


Table 4.5. Cases of human/wildlife conflicts in selected districts

District	Forests/Wildlife Sanctuary	Type of Conflict	Responses
1. Vihiga	▪ Kibiri forest ▪ Kaimosi forest	▪ Invasion of farms by animals ▪ Destruction of crops by wildlife ▪ Damage to forest plantation by locals	▪ Kibiri Forest has been zoned by Forest Department to stem human-wildlife conflict
2. Kakamega	▪ Kakamega forest ▪ Malava forest ▪ Kisere forest ▪ Bunyala forest	▪ Illegal extraction of forest products ▪ Game poaching	▪ Clearance of forest for tea zones to create buffer zone ▪ Gazetted as Kakamega Forest Natural Reserve and Kisere ▪ MoU between Forest Department and KWS
3. West Pokot	▪ Nasolot National Reserve	▪ Hunting wildlife ▪ Grazing livestock in the reserve during dry seasons	▪ Establishment of KWS camp ▪ Community capacity building on dangers of poaching wildlife and benefits of wildlife conservation

4. Ijara	▪ Boni National Reserve	▪ Banditry poaching ▪ Commercial/subsistence poaching ▪ Encroachment into wildlife preferred areas	▪ Translocation of endangered Hirola to Tsavo East National Park ▪ Community involvement in management of natural resources ▪ Community scouting for wildlife security ▪ Fencing of livestock watering points and agricultural farms
5. Tana River	▪ Kipiri Forest	▪ Human activities/domestic needs ▪ Roaming wildlife and livestock	▪ Increase in forest cover. ▪ Community sensitization on sustainable forest management ▪ Enforcement of laws and policies e.g. Forest Act
6. Mt. Elgon	▪ Mt. Elgon Forest	▪ Poaching of wildlife ▪ Human encroachment and excisions	▪ Surveillance by forest guards ▪ Community and NGO initiatives to conserve the forest
7. Nyeri	▪ Forest establishment in 12 blocks within Mt. Kenya Aberdares forest ecosystems	▪ Roaming of wildlife to human settlements ▪ Overgrazing by communities ▪ People entering fenced forests ▪ Closing up wildlife migratory corridors	▪ KWS management/control of conflicts in farms and forest plantations ▪ Ban on logging ▪ Water catchments preservation ▪ Electric fencing of Aberdares
8. Trans Nzoia	▪ Mt. Elgon National Park ▪ Saboti Forest Reserve ▪ Kapolet Forest Reserve	▪ Lack of barrier to prevent human invasion to wildlife areas and vice versa ▪ Crop damage, livestock attack; harm to people and livestock ▪ Illegal extraction of forest products	▪ KWS programme to prevent destruction of property by wildlife ▪ Construction of wildlife preventive barriers at national park e.g. life fence, moats and electric fence
9. Laikipia	▪ Ngare Ndare Forest ▪ Mukogodo Forest ▪ Rumuruti Forest ▪ Laikipia Reserve	▪ Proximity human settlement to wildlife areas, thus raiding of crops by elephants	▪ KWS and MRC 8-part strategy to alleviate human-wildlife conflicts ▪ Fencing of wildlife sanctuaries ▪ Community education on incident reporting, rapid response ▪ Stakeholders workshops to address conflict and way forward
10. Garissa	▪ Ranole National Reserve ▪ Arwale National Reserve ▪ Garrisa Giraffe Sanctuary	▪ Human encroachment into wildlife corridors ▪ Farming along rivers that block animals access to water hence destruction of crops by wildlife ▪ Prolonged drought facing wildlife to gather around boreholes – attacks on livestock	▪ Allocation of water troughs for warthogs to stop threats to livestock and human life
11. Nyandarua	▪ Aberdares National Park ▪ Aberdares Forest	▪ Menace to farms by hippos and elephants (raid on farmlands). ▪ People killed and injured by wildlife. ▪ Human encroachment into park destabilizing wildlife migratory corridors	▪ Fencing project in Aberdares to control conflicts. ▪ Community participation in management programmes of wildlife resources

12. Taita Taveta	▪ Tsavo East and West National Parks	▪ Proximity of human settlement to park resulting in conflicts. ▪ Grazing livestock within park ▪ Crop damage, loss of lives, loss of livestock and human injury ▪ Migration of wildlife during droughts in search of water and pasture	▪ Animal control live-wire fencing and patrol by armed personnel ▪ Improving water availability in parks ▪ Initiation of community projects by KWS ▪ Support of community owned wildlife sanctuaries and lodges
Narok	▪ Transmara Forest ▪ Olpusimoru Forest ▪ South Mau Forest ▪ Masai Mau Forest ▪ Loita Forest ▪ Enoosupukia Forest ▪ Privsate/Group Ranch Forest	▪ Competition over land use; leading to loss of biodiversity and wildlife ▪ Crop damage by wildlife ▪ Human injuries and death as a result of attack by animals	▪ KWS Participatory Wildlife Management ▪ Equitable wildlife utilization and benefit sharing ▪ Awareness creation on co-existence and wise management of wildlife resources

Source: District SoE Reports 2004

Complaints: The Public complaints Committee (PCC) received numerous cases from the public relating to human/wildlife conflicts as indicated in box 4.3. and plate 4.1. Farmers living adjacent to conservation areas have experienced varying degree of adverse effects arising from co-existence with wildlife, including loss of human life, damage to crops and property and predation on livestock by lions, cheetah and hyaenas. This has cost a lot of suffering and loss of economic income to affected families.

Box 4.3. Cases of human/wildlife conflicts reported to the Public Complaints Committee (PCC)

The Committee received a considerable number of complaints directly and indirectly relating to wildlife. The major complaints relate to:

a) Construction of luxury camps and tourist facilities in game reserves, e.g., in the Masai Mara National Reserve;
b) Physical developments along wildlife migration corridors and breeding sites, e.g., in Kitengela, Athi River and Tsavo;
c) Uncontrolled and uncoordinated wildlife cropping activities; and
d) Human encroachment.

The investigations established that:

i) Tourism contributed to increased number of tourist facilities within wildlife habitats putting pressure on wild animals; and
ii) Wildlife habitats are being converted to small-scale farms and group ranches leading to displacement of animals resulting in human-wildlife conflict.

Plate 4.1. Lion at the Masai Mara National Reserve which has occasionally killed livestock



4.3.3. Responses to Challenges and Threats

In order to mitigate against the threats and challenges facing wildlife management in the country, several measures and initiatives have been put in place. In areas where wildlife numbers have exceeded the carrying capacity, measures have been taken to translocate some of the animals to areas where there is less pressure.

The government through the KWS has strengthened research and monitoring of protected areas to ensure availability of adequate and up to-date data and information. This enables the management to take quick and informed decisions on emerging issues. Security has been intensified in all protected areas to minimize poaching. This includes recruitment, training and equipping of KWS security personnel.

In areas where resource conflicts have or are likely to occur, conflict resolution mechanisms have been established, including promotion of wildlife related community income generating activities such as eco-tourism and tour guiding. The government is also considering amendments to the Wildlife Act to respond to the emerging challenges in wildlife management in the country.

Negative attitude by communities towards conservation is a big challenge facing all conservationists hence the need to create awareness on conservation and sustainable utilization of resources among the communities and other stakeholders.

4.4. AGRICULTURAL BIODIVERSITY

Agricultural biodiversity is a term that encompasses all components of biological diversity of relevance to food and agriculture, including plant, animal as well as microbial and fungal species that are an integral part of farming systems (FAO, 1998). Additionally, components

of agricultural biodiversity also provide ecological services such as nutrient cycling, decomposition of organic matter, maintenance of soil fertility, pollination, pest and disease regulation.

Kenya has a wide range of plant, animal, microbial and fungal resources that are important for agricultural production, including indigenous and exotic species that are found in different agricultural landscapes. The importance of diversity within and between species cannot be overemphasized. Diversity within a species results in different varieties of the same species, which in turn enhances the possibility of the same species of crop or animal to be grown or reared in different agro-ecological and climatic zones. For example, the reason why maize is grown widely in the country is because of the availability of different varieties, which perform well in different soil and climatic conditions.

Trends indicate genetic diversity within and between species comprising agricultural biodiversity in the country is being reduced by efforts to improve productivity through cross breeding and general preference for exotic varieties of both crops and animals. Agricultural biodiversity also suffers from neglect and over utilization by a wide segment of the society, fragmentation of agricultural lands and poor land-use practices which have reduced overall agricultural productivity and contributed to erosion of productive capacity of agricultural lands.

4.4.1. Crop Genetic Resources

There is a wide variety of indigenous crop species in the country that provide basic livelihood. Exotic crops have also been introduced and steadily assumed dominance in crop production. Some of the common food crops grown are maize, wheat, rice, beans, sorghum, millet, Irish potatoes, sweet potatoes, cassava, arrow roots, peas, grams and yams. Cash crops include tea, coffee, sugar cane, pyrethrum, sisal, tobacco, rape seed, sunflower, macadamia nuts, cashew nuts, simsim, bixa, castor, soya beans and horticultural crops.

Pollinators: Agricultural biodiversity has been adversely affected by decline in the number and type of pollinators resulting in decreased agricultural production for pollination-dependent crops such as watermelon and passion fruit. The major causes of pollinator decline are destruction of natural ecosystems and indiscriminate use of agrochemicals and other pesticides that kill non-target insects that are potential pollinators. Pollination issues are currently being addressed by the Kenya Pollinators Initiative, a GEF project on conservation of pollinators using an ecosystem approach that is currently being implemented by NMK in collaboration with stakeholders.

Grains: Millets were the traditional cereal crops in East Africa, especially sorghum, finger millet and several varieties of bulrush millet. Millets have been largely replaced by maize as the leading staple food, which is produced in all the arable parts of the country. Maize as a crop is not indigenous to Kenya, but was introduced by Portuguese explorers. It has a remarkable physiological adaptability and is cultivated in a range of areas from the hot coastal lowlands to the wet and cool highlands west and east of the Rift Valley.

Pulses: Pulses include several varieties of beans and peas and their wild relatives. Bean varieties have been increased through breeding by local research institutions for various agro-ecological zones and for length of maturity. There are also farmers' varieties among beans, which they have developed through selection for desirable qualities. Several varieties of pigeon peas, cowpeas, green and black grams are also widely cultivated in the country.

Nuts: Groundnuts are mainly grown in western Kenya (Nyanza and Western provinces), while bambara nuts are mainly grown in the coastal region. Several varieties of groundnuts occur. Choice of grown varieties among farmers depends on taste, appearance and rate of maturity, resistance to pests and diseases and market preference. Genetic diversity in these nuts has not been as interfered with as with the mainstream crops. Nevertheless, intra-species diversity does occur as individual farmers normally do their own selections for successive cropping every season.

Coffee: Coffee has its origins in the Ethiopian highlands and was brought into the country more than a century ago. It has been domesticated and is now a major commercial/export crop. Through natural selection and breeding, several varieties have been developed by the Coffee Research Foundation, such as Ruiru 11.

Tea: Tea is mainly grown in the highlands east and west of the Rift Valley. Kericho area, Nandi Hills and Limuru areas have been associated with tea production for close to a century.

Wheat: Wheat is grown predominantly in the Rift Valley region of Kenya especially Uasin Gishu, Narok, Nakuru, Samburu and Laikipia districts. Diversity of wheat arises mainly from concerted breeding programme by the Kenya Agricultural Research Institute (KARI) and Egerton University at Njoro. Several varieties have been bred for different agro-ecological and market reasons.

Barley: Barley, like wheat is grown in the same regions mainly for the purpose of brewing beer. A breeding programme has resulted in different varieties of barley.

Vegetables: Several vegetable varieties are grown in the country, notably the brassicae family, which are exotic including kales, cabbages, lettuce and broccoli. A number of indigenous vegetable varieties such as the black nightshade, crotalaria and amaranthus are grown in small quantities.

Cut flowers: Almost all cut flower varieties grown in the country are exotic with roses and carnations being the leading species. Considerable diversity within and between species occurs.

4.4.2. Animal Genetic Resources

Sector Contribution: Livestock sector contributes about 40% of the agricultural GDP and about 10% of the country's total GDP. The dairy industry is well developed with an annual production of over two billion litres of milk. Small-scale holders account for 80% of the total milk produced in Kenya. Dairy production is a key source of income to over 60,000 households in the high potential areas. Sale of milk, small stock (sheep, goats, chicken) and eggs 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.

Factors that limit milk production include poor genetic potential of most of the existing herd, inadequate extension services, limited use of modern technologies and inadequate institutional frameworks. For example, liberalization of milk processing and marketing has led to the establishment of a few private processors who are unable to cope with the total amount of milk produced by farmers.

Camel population is not well established. Pastoralism is the main livelihood in the country's ASALs.

Goat: It is estimated that the goat population is 7.7 million, most of which are found in pastoral areas. The East African Goat is indigenous to East Africa and is mainly found in the semi-arid areas of the country. They are quite resilient and survive in very harsh environments. The Galla Goat, which is indigenous to northern Kenya has distinct intra-species diversity. There are two sub-types, a short-eared medium sized goat, locally known as '*Digyir*' and a larger pure white called '*Degeun*'. The galla goats are hardy animals and thrive well in the dry, low altitude bush country of northern Kenya.

Sheep: The sheep population stands at about 5.9 million, most of which are indigenous breeds found mainly in the drier areas and hybrids which do well in the highlands. The Red Maasai Sheep is reddish-brown in colour and is predominantly reared by the Maasai people of Kenya and Tanzania. It is probably the best-established fat-tailed sheep in Kenya and the most numerous. It is now known globally for its genetic trait of resistance to the flat worms, which affect the quality of wool in sheep.

The exotic sheep breeds in Kenya include the white Merino and the Corriedale. The population of these exotic breeds has declined considerably in the country as a result of the collapse of the major wool mills.

Cattle: The East African Shorthorn Zebu cattle breed forms more than 90% of the current cattle population in Kenya and East Africa. Its ability 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. Two main types have been developed through natural and local selection. The large East African Shorthorn Zebu, found mainly in the drier areas of northern Kenya and the Small East African Shorthorn Zebu, in the wetter areas of Kenya (Nyanza, Eastern, Rift Valley and Western Provinces) are valued for their resilience, which enables them to survive harsh environments.

Exotic breeds of cattle found in the country are mainly kept for milk production. The breeds include the Friesian, Guernsey, Ayshier and Jersey. There are also crossbreeds between these breeds found mainly with small-scale dairy farmers. Dual purpose and beef breeds are also kept, including the Black Swiss, Hereford and Charolais. About 90% of beef cattle are in the hands of subsistence farmers and pastoralists.

Other Livestock Species: Emerging livestock comprising of ostrich, guinea fowls, snakes (for venom and skin production) and the crocodiles (for skin and meat) are also gaining importance in consumption. The ostrich population under domestication is approximately 10,000 and production is concentrated in the ASALs in Rift Valley, Eastern and Coast provinces. Guinea fowls and quails are mainly domesticated in western Kenya where they are considered a delicacy.

4.4.3. Threats and Challenges

Pests and diseases: Pests and diseases are common all year round but their threshold to cause economic loss in production occurs seasonally, depending on the weather. The prevalence of pests and diseases depends on crop type and enterprise mix at farm or agro-ecosystem levels.

Livestock production faces a number of pressures/challenges such as drought, poor infrastructure and marketing systems. Pests and disease prevalence, resource use conflicts and inadequate institutional/policy frameworks further constraints the sector's development.

Technologies: Low rates of adoption of new agricultural technologies minimize the contribution of technology to sustainable agriculture and rural development. The situation is further compounded by low rates of technological transfer and inadequate capacities locally.

Pricing: Commodity price fluctuation either discourages farmers from producing if prices are low or encourages them to expand production if prices are good. If expansion occurs, pressure is exerted on agriculture to meet the rising demand with associated consequences.

4.4.4. Responses

To support the development of the livestock sector, priority should be given to:

a) Provision of extension and veterinary services by the government in collaboration with the civil society organizations, private sector and beneficiary communities;
b) Formulation of dairy and beef development policies to further improve the sector, through partnerships with civil society organizations involved in crop and livestock production, commodity marketing, water harvesting for agricultural and livestock production, honey production and other business investments.
c) National Agriculture Extension Policy and the Agriculture and Livestock Extension Programme (NALEP) are some of the policy responses, which the government is implementing to improve agricultural, and livestock production in all areas in an effort to ensure food security at community and household levels.
d) Promotion of joint research initiatives between the government, research institutions, development partners and local communities towards improving genetic characteristics and diversity.
e) Strengthening of credit and marketing institutions such as the Agricultural Finance Corporation and the National Cereals and Produce Board to improve agricultural production and marketing and thereby enhance food security at all levels.
f) Strengthening linkages and creating awareness on information provided by the Regional Famine Early Warning System (FEWS) and the Drought Monitoring Centre to enhance status of preparedness in case of imminent food shortages. This will enable relevant agencies and affected communities to develop appropriate response mechanisms for emergency response.

4.5. DRYLAND BIODIVERSITY

About 88% of Kenya's land surface is ASALs, characterized by severe climatic conditions such as soils prone to severe erosion and inadequate conservation techniques. In much of north and north-eastern Kenya, insecurity has disrupted the lives of pastoralists and their economies. In some cases, they have been unable to return to their areas even where pasture and water are available for fear of cattle rustlers. In some areas, this has resulted in prolonged overuse of land, while in others there are signs of under use of land abandoned for long periods, hence reducing availability of pasture and other resources.

Deforestation: Increased pressure on arable lands is reflected by increased encroachment of cultivation on forests and rangelands, deforestation and increased soil erosion. As a result of these factors, vast tracts of land are being transformed into "dust bowls" losing their productivity and biodiversity as well as impoverishing their inhabitants. Deforestation is a major factor in the continued loss of dryland biodiversity and is closely linked to overgrazing and over-cultivation (Plate 4.2). The presence of invasive alien species has further resulted to loss of biodiversity (Box 4.4).

Plate 4.2. Loss of biodiversity through deforestation



Photo by Frank Msafiri DRSRS, 2004

Box 4.4. Prosopis Tree Species in ASALs

Introduction

Prosopis juliflora is native to arid and semi-arid zones of the northern countries of South and Central America. It is also found in southern parts of USA as well as the dry regions of most African and Asian countries. Several *Prosopis* species have been widely introduced throughout the world over the last 200 years. The first records of *Prosopis* introduction to Africa date back to 1820 and 1900 when they were introduced to Senegal and South Africa respectively. The plant has also been introduced to many other countries including Australia, New Mexico, Ethiopia, Pakistan and Egypt. In Haiti, Revu and India *Prosopis juliflora* provides their most of the wood energy requirements.

The tree is fast growing, drought tolerant and hence able to survive under harsh conditions. As such the weed reduces aridity through its ability to green extremely low rainfall areas. Some known benefits of this species include mitigating wind erosion, providing charcoal, woodfuel, wood carving, furniture including flooring material, fodder for animals and medicinal potential. The plant is also an important agroforestry species being an efficient nitrogen fixing plant.

Despite these apparent benefits, *Prosopis juliflora* has become a highly invasive species colonising large areas of land and currently spread in more than ten ASALS districts in Kenya. The fast spread of this tree is partly contributed by its thorny and hardness characteristic, making it unattractive to potential users. The sharp thorns cause bodily harm to both humans and livestock often resulting to death of livestock. The plant tends to deter potential users, leading to its proliferation and rapid. The rapid spread of this species is causing concern and forms an important national topic of debate and discussion among relevant stakeholders and policy makers.

The introduction of *Prosopis* into Kenya is unknown, but its propagation was in 1980s mainly through ASAL programmes implemented by the government. Large *Prosopis* biomass can now be found in Baringo, Garissa, Mandera, Tana River, Taita Taveta and Turkana districts. *Prosopis* has invaded agricultural and pasture land, watercourses, road sides and wasteland forming dense thorny impenetrable thickets. Its success as an invader is largely attributed to its large number of seeds and their efficient dispersal by livestock who feed on the pods.

Control of the Species

Prosopis is difficult to control and its eradication programmes using manual, mechanical and chemical methods have had limited success. Some of these methods are effective for a short time, but Prosopis generally returns. This is largely because it re-grows from stumps and from massive numbers of seeds stored on the ground. Seeds usually lie dormant in the soil for many years and germination is stimulated by soil disturbance. There is therefore need to develop an appropriate prosopis utilization strategy that carefully balances the adverse effects against the benefits. This will provide a long-term management of the species.

Additional investigation by the Public Complaints Committee (PCC) confirmed the concerns over alien invasive species by local communities who have incurred losses on their livestock through feeding on invasive species such as *prosopis* as indicated in box 4.5. and plate 4.3.

Box 4.5. Investigations on *prosopis* species by the Public Complaints Committee (PCC)

Prosopis species *(Prosopis juliflora)* is one of the invasive species investigated by the Committee. The main concerns relating to this species include its ability to invade and out compete native species thus quickly colonising the new environment. It is clear that it poses a significant threat to other biodiversity resources and socio-economic well-being of local communities. The devastating impact caused by the invasion of *prosopis* in Baringo, Mwingi, Marsabit and Bura is already posing a serious threat to local communities. It is recommended that NEMA in consultation with relevant lead agencies, as a matter of urgency, formulate guidelines to regulate the introduction, control and eradication of alien species. Proper studies should be carried out prior to introduction of any alien species.



Plate. 4.3. A goat feeding on Prosopis species in Baringo district

4.6. AQUATIC BIODIVERSITY

4.6.1. Wetlands

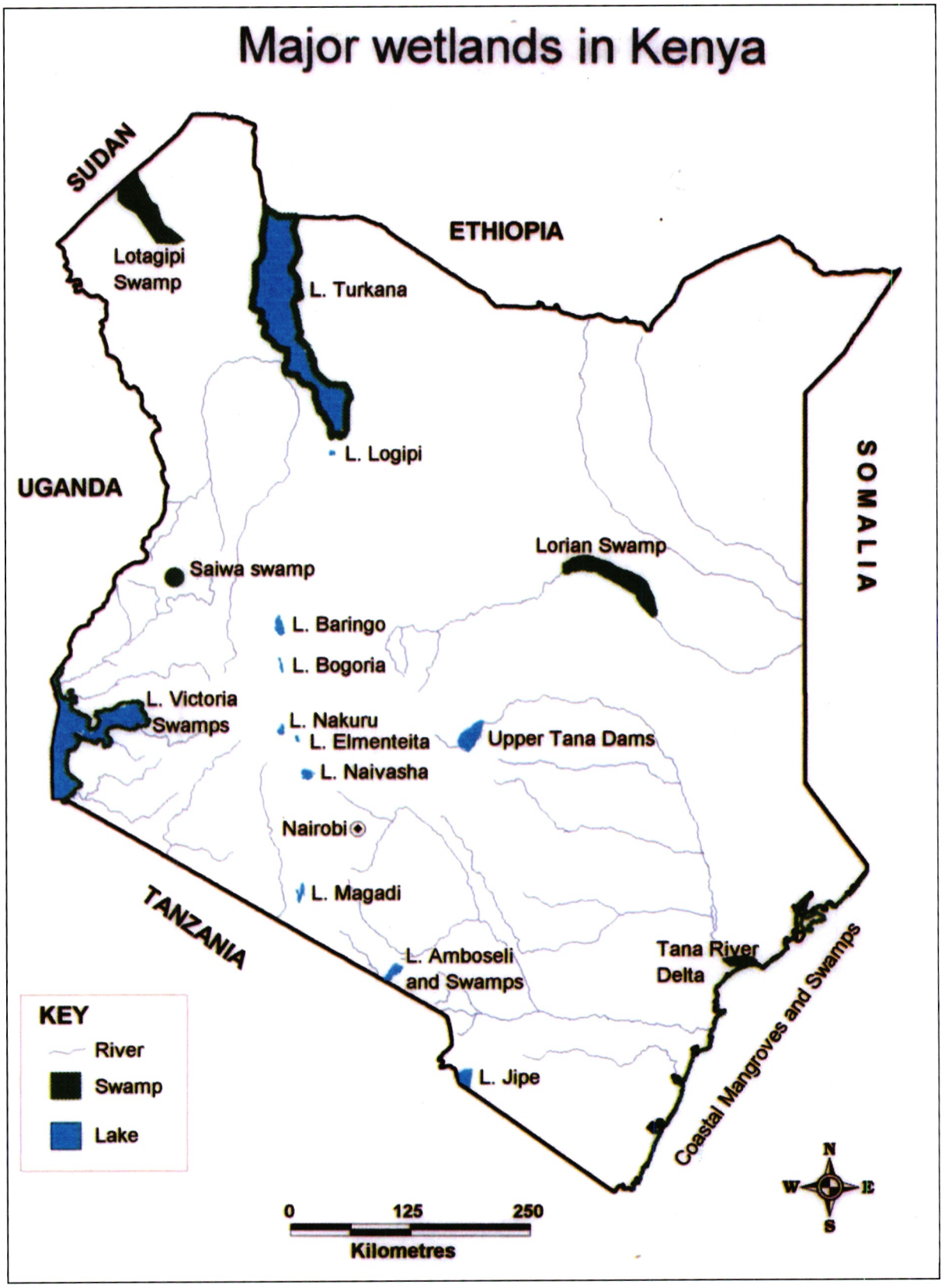
Wetlands can be categorized into two broad types, namely marine and inland ecosystems (Figure 4.3). Inland water ecosystems are more varied and include lakes, rivers, ponds, streams, seasonal streams, cave waters, cow troughs, aquaculture ponds and water in tree holes. Table 4.6 presents the number of known wetlands in selected districts.

Table 4.6. Wetlands in selected districts

District	Number of Known Wetlands
Kakamega	4
Samburu	3
Marsabit	1
Laikipia	2
Butere/Mumias	6
Thika	2
Meru North	4
Teso	5
Nyeri	2
Tana River	1

Source: SoE district reports 2004

Figure 4.3. Major wetlands in Kenya



Source: Ministry of Water and Irrigation

The 1982 United Nations Law of the Sea (UNCLOS) divided the ocean regime into Exclusive Economic Zone (EEZ) conferred as territorial property rights to coastal states, while high seas are categorized as global commons. The EEZ is divided into 12 nautical miles of internal waters and 188 nautical miles that together make 200 nautical miles. There are a total of 467 lakes and wetlands estimated to cover 1,460, 300 ha or 2.5% of total land area (NBU, 1992). This includes 18 large and many small natural lakes, six artificial lakes, in addition to marshes, swamps and the banks of five main watershed river systems.

There are five major drainage basins in Kenya namely Lake Victoria, Rift Valley, Athi-Galana-Sabaki River, Tana River and Northern Ewaso Ngiro (Hughes and Hughes 1992).

Over 10 species of fish have been introduced into Kenyan fishery waters (Table 4.7). The primary aim of introduction is enhancement of fishery production in natural ecosystems for farming or recreational purposes.

Apart from fisheries, aquatic ecosystems and wetlands are important sources of recreation, tourism and mining. Lake Magadi is commercially exploited for soda mining, while lakes Nakuru and Naivasha have a well-developed tourism industry based on the ornithological importance. Lake Victoria and Turkana have a lot of potential as tourism sites although not well developed. Water sports are well developed at the Kenya coast as well as beach tourism, recreational fishing for which Kenya currently holds the All-Africa record for marine fishes.

Table 4.7. Species introduced into water bodies

Species common names	Species scientific names	Lake Victoria	Al. Magadi	Lake Naivasha	Tana River Dams	Lake Baringo	Lake Nakuru	Mountain rivers
Common carp	*Cyprinus carpio*			x	x			
Mirror carp					x			
Trout		x		x				x
Nile Perch	*Lates Niloticu*	x						
Black Bass	*Micropterus salmoides*			x	x			
	O leucostictus	x		x				
	T Zilli	x		x				
	O Niloticu	x						
	T rendali	x						
Lung Fish	*Protopterus aethipicus*				x	x		
Cray fish	*Procambarus clarku*			x	x			
Tilapia grahami	*Orechromis Alcalicus grahami*						x	
Water Hyacinth		x	x	x				

Other uses include domestic water supply, water for irrigation, damming for hydropower generation on the Tana, Turkwell and more recently Sondu Miriu rivers. Damming for provision of domestic water supply is on the increase with the latest as Ndakaini dam, which provides water for the ever-rising urban population in Nairobi. Wetlands products such as papyrus are used to make mats, chairs and thatching houses. Along the coast, communities are dependent on mangroves for timber, firewood and other uses. Most wetlands are of cultural significance to the local communities.

4.6.2. Threats to Aquatic Ecosystems

Threats to all aquatic ecosystems are sewerage, nutrients, synthetic organic compounds, sediments, litter, plastics, metals, oil and diminishing size of aquatic ecosystems.

The scarcity of water is adversely impacting on aquatic life through complete destruction of habitats and alterations. The number of endangered or threatened birds is on the increase. The list of endangered/threatened fish from Lake Victoria kept by the CITES national secretariat at KWS. The formation of the Lake Victoria Fisheries Commission will contribute to holistic management of the lake in the long term.

Aquatic based activities such as unregulated fishing, overcapitalisation, excessive fleet size, vessel re-flagging to escape control, insufficiently selective gear, unreliable databases and lack of sufficient cooperation between states were all issues identified in Chapter 17 of Agenda 21 as adversely affecting marine aquatic ecosystems. The conversion of wetlands to other uses as well as lack of a holistic action plan continues to diminish wetlands ecosystems and cause loss of wetlands biodiversity (Plate 4.4 and Box 4.6).

Inadequate Information: Limitation in time series data is another problem facing scientists when trying to establish the trends in major biodiversity. Usually, data is available for species of commercial significance such as fish and some bird species for which there is a regular monitoring programme. Getting data for other species in time series is not possible hence establishing trends is difficult. Even for species such as fish, data quality is questionable and there are many gaps especially for fish species that are of no commercial value. Where data is available, analysis and use in making management interventions is usually limited.

Alien/Invasive Fish Species: Introduced species such as Nile Perch, Crayfish, Indian Crow and water hyacinth are degrading aquatic environments and altering food chains. Early introduction of trout in mountain rivers was for development of recreational fishing. In Lake Naivasha, Blackbass was introduced to develop the sport-fishery, while other species were for enhancement of commercial fishery.

The latest introduction is the Common Carp, which is now the dominant fish and is altering the characteristic of fishery through destruction of Tilapia breeding grounds and increased turbidity in the lake. In Lake Victoria, Nile Perch was introduced to feed on the large pelagic stocks and in the process enhanced the fishery production, which at the time was largely Tilapine and was declining. Invasive species have included water hyacinth and *Salvinia molesta.* Salvia has successfully been eliminated from Lake Naivasha, while in Lake Victoria water hyacinth has been reduced by 80%.

Crayfish is believed to ubiquitous to all water systems having been introduced into many dams for fish farming purposes; its burrowing character is destructive to most aquatic systems. In Lake Naivasha, it is interfering with natural dynamics of submerged macrophytes due to heavy predation.

The latest accidental introduction into Lake Naivasha is the Common Carp, while Blackbass, Common Carp, Mirror Carp and Tilapine species have been accidentally introduced into Tana River dams. Other introductions include an Eel recorded in Lake Victoria and Bill Sunfish into Nairobi Dam.

Legal and institutional mechanisms for managing alien species are fragmented. In most cases the approach is reactive. There is therefore lack of clear principles and procedures as well as criteria for analysing risk and for dealing with eradication and control across all taxonomic groups.

Pollution and Waste: Pollution is a major threat to most aquatic ecosystems through mainly raw sewerage from municipalities. The municipalities have inadequate treatment works, especially for Kisumu and most towns around Lake Victoria. Although the Naivasha town sewerage system was recently upgraded, it is still unable to cope, having been developed while the town had few residents. Lakes Baringo and Elementaita, as well as Kaimosi and Mudete dams in Vihiga are silted. Nairobi River is one of the most heavily polluted water bodies.

Along the coast, the impact of increased siltation load is evident in areas such as Ungwana Bay and at the mouth of Tana and Sabaki rivers. Chemical pollution of rivers has been reported as a result of increased use of herbicides and pesticides in agricultural activities.



Plate 4.4. Agricultural encroachment into riverine forests

Box 4.6. Threats to Riverine Forests

The law on keeping a fringe of not less than 30ft along the riverbank is flouted by most farmers, many of whom grow vegetables and other crops.

In almost all areas along the rivers, eucalyptus trees are grown to provide fuel wood. The tree is very destructive due to its high water intake.

Survey undertaken in eight districts found that most river fisheries are adversely affected by water abstraction, sand harvesting and destruction of catchment area, planting of eucalyptus trees and farming right up to the riverbank.

There is increasing occurrences of dry river beds in almost all districts, especially rivers which were considered permanent in the last decade.

Habitat alteration are due to conversions, sand harvesting, over abstraction of water, introduction of alien species, over-fishing, sediment loading, nutrient loading and chemical

at sea then migrate upstream for some stage of their lifecycle. It is this activity that is interfered with by the dams which lack a fish bypass. Riverine fisheries are most at risk from excessive abstraction of water, destruction of catchment areas, habitat alterations, sand harvesting and siltation load whose effects are clearly visible to the naked eye at Malindi.

Over-fishing is responsible for declining fish production in all fresh water lakes and replacement of high value fish by those of low value. Other threats are from coral bleaching, climate change related activities, impacts from land-based activities, increased sea traffic and uncoordinated development of coastal areas.

Declining Species Composition: The National Capital Index for freshwater commercial species shows a decline of 40% of all species. In Lake Naivasha, only one species is endemic, while all others are introduced; the most recent of which is the Common Carp that has been accidentally introduced from fish farms up in the catchment area. Inland water species composition declined by 40% between 1993 and 2003. In Lake Victoria, what used to be a multi-species fishery has been reduced to a three-species fishery. This loss of fish biodiversity is blamed on Nile Perch which feed on other fish species. In addition, poor land use practices could also have a significant contribution. The three commercial species are *Rastrineobola argentea, Lates niloticus* (Nile perch) and *Oreochromis niloticus*.

Invasive Plant Species: Water hyacinth whose marts once wrecked havoc to fisheries and navigation have declined by approximately 80% in Lake Victoria due to the success of control programme under the Lake Victoria Environmental Management Project (LVEMP). A monitoring programme is required to take care of resurgence. However, water hyacinth still poses a problem in Lake Naivasha and the Nairobi Dam, which is completely covered.

Non-consumptive Use: It is important to constantly assess the status of individual species and habitats in order to determine whether the objectives of the marine protected areas are attained as well as manage impacts resulting from non-consumption use. It is also important to institutionalise a structure that allows feedback to local communities in order to minimize conflicts.

4.6.3. Response Measures

Article 207 (4) of UNCLOS calls on parties to establish rules and standards to deal with marine pollution. In this regard, the UNEP Regional Seas Programme has concluded several protocols relevant to the Eastern Africa region. These include the Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region; the Protocol for Protected Areas and Wild Fauna and Flora in the Eastern Africa Region and the Protocol for Combating Marine Pollution in cases of Emergency in the Eastern Africa Region.

Conservation Areas: There are 2,905,002ha within Kenya's territorial waters, constituting marine conservation areas. However, there is need for an institutional framework to link the lead institutions with various mandates in coastal and marine management.

UNCLOS established property rights for coastal states within which they have sovereign rights. Kenya is currently licensing foreign fishing vessels to fish in this area at a cost of US$ 20,000 per fishing season.

Regional Fisheries Agreements and Institutional Arrangements: Discussions on the establishment of the South West Indiana Ocean Commission are ongoing to ensure rational utilization of fisheries resources within the high seas. Whale Sanctuaries have been established since 1938, a temporary one was established in 1979 in the Indian Ocean for 10 years and extended for a further 10 years in 1992. This was through provisions provided by the International Whaling Commission and internalised in the Fisheries Act (Cap 378).

Other international measures include the voluntary instruments like the FAO Code of Conduct for Responsible Fishing and International Plans of Actions addressing issues of concern on fishing capacity and illegal, unreported and unregulated (IUU) fishing. Other regional measures taken include establishment of the Lake Victoria Fisheries Commission by the East African Community. It is designed to holistically address environmental problems within the lake and its catchment.

Ramsar Sites: Lake Naivasha was declared a wetland of international importance (Ramsar Site) in 1990. Other Ramsar sites are lakes Nakuru, Baringo and Bogoria. The riparian community received the Ramsar Award for community initiated management plan. Closed fishing season and areas have been established for lakes Victoria Naivasha and Baringo. Lakes Naivasha and Baringo have within the recent past been totally closed to fishing.

4.7. TECHNOLOGICAL DEVELOPMENT AND TECHNOLOGY TRANSFER

Major aquatic resources such as fisheries have since 2001 started declining against appreciating prices, which is creating incentives for over-exploitation. In addition, species composition is changing and in most water-bodies, introduced species are replacing endemic species. Many aquatic environments are becoming eutrophic resulting in increasing incidences of algal blooms, while major wetlands are under pressure from conversion. Legal provisions in the Law of the Sea should be exploited with a view to enhancing benefits associated with sustainable exploitation of the coastal and marine resources.

Biotechnology is a promising field for enhancing benefits accruing from biodiversity and its products. Biotechnology has traditionally drawn heavily from indigenous knowledge on local biodiversity. However, current biotechnology efforts use genetic engineering. Several research initiatives are in progress under field trials (sweet potatoes and *Bt* cotton) using tissue culture and genetic engineering. Already some products developed are in the market such as the Irish potato, bananas and sweet potatoes. Kenya is addressing issues related to introduction of genetically modified organisms (GMOs) through the Biosafety Bill. The challenge is in building adequate capacity for risk assessment, management and containment.

Biotechnology has been developing desired qualities from both fauna and flora to meet the demands including those for food and medicine. Biotechnology has improved from simple selection to tissue culture and to current recombinant DNA procedures. Recombinant DNA is currently being used in the production of genetically modified organism (GMOs) including the living modified organism (LMOs). GMOs or LMOs are organisms or products modified through artificial (*in vitro*) modification of nucleic acids such as recombinant DNA – technology and through cell diffusion.

It has been noted that whereas biotechnology may be good for human survival, there are associated risks, which need to be monitored. Some of the dangers include the bio-engineered vaccine virus against rinderpest which is related to human smallpox virus.

Environmental risks associated with LMOs include passing on transgenes to wild species, whose impacts may be difficult to monitor, especially if released in centers of crop origins and megadiversities. LMOs have the potential to negatively affect genetic diversity, including future food security. The developing countries needing food aid are often supplied with GMO/LMO food in contravention to the Prior Informed Consent under the Biosafety Protocol. Allowing patentability of LMOs under Trade Related Intellectual Properties (TRIPs) means developed nations will dictate trade and their use. Due to lack of finances and capacities, developing nations may lack ability to enforce and effectively monitor GMOs/LMOs. Areas under genetically modified crops continue to expand worldwide. The following are some of the biotechnological activities being undertaken in Kenya.

Tissue Culture: This technology is being applied in development of:

- Pyrethrum by the Pyrethrum Board of Kenya;
- Potatoes by the National Potato Research Centre;
- Research on other indigenous species are ongoing including sugar cane, banana *Melia volkensi, Grevilles robusta* and *Ocotea usambarensis* by the Jomo Kenyatta University of Agriculture and Technology (JKUAT);
- Grafting of clonal eucalypts brought from South Africa by Tree Biotechnology and Kenya Forestry Research Institute (KEFRI).

Box 4.7. Tree biotechnology project

The project is being implemented by the Forest Department and KEFRI. Other areas where the technologies are applied include Mondi Forest of South Africa aiming to improve tree production through integration of biotechnology techniques in traditional propagation systems.

This project concentrates on various Eucalyptus species, especially E. *glandis, E. saligna, E.camaldulensis, E. tereticornisE. Uropholla, E. nitens and E. dunii using the* seedlings and clones. The research aims at developing Eucalyptus species that is tolerant to the blue gum chalcid pest *(Leptocybe invasa)* that attacks the Eucalyptus trees. The pest causes the formation of gals on twigs and foliage resulting in twisted and deformed leaves and shoots. As a result, the infected trees assume stunted growth. In Kenya, the spread of the pest is prevalent in Nyanza and Western provinces, particularly in districts neighbouring Uganda from where the pest spread although its country of origin is Australia. So far the extent of the attacks has affected 4% of trees under five years old and 20% of seedlings.

The pest was recently observed at Mtwapa in Coast Province, where it is believed to have been transmitted through the transfer of infested plant materials. Research to identify the natural pest is underway in Australia with a view to developing biological control agents for its long-term management. Further collaboration will be sought from other countries where the pest has occurred such as Israel, Morroco, Iran, Italy and Uganda.

The project advises farmers on which species to plant in regard to altitude and rainfall of the intended planting site. The clonal tree nursery is at Karura near the Forest Department headquarters. The project has established trial plots in many parts of Kenya (Coast – Sokoke, Gede, Msambweni), Eastern Province (Embu and Kitui), Central Province (Hombe, Kabete, Muguga and Karura), Nyanza (Yala), Kakamega, Turbo and Kibwezi.

The demand for the seedlings produced by the project is currently very high and many farmers are now planting them especially because they are very fast growing with rotation ages being two years for firewood, three years for poles, four years for Telecom poles and fence posts, and six years and above for electricity poles and timber.

Growing of these fast-growing trees offers a sustainable supply of wood to meet the growing demand for paper and other wood products. They generate substantial employment, reduce global warming, protect watersheds and take pressure off natural forests.

Source: Forest Department and KEFRI records

Production of biofertilizers: Rhizobium inoculants are produced both at the University of Nairobi and at KEFRI.

Artificial insemination: Drawn from four cattle breeds making livestock genetic base narrow.

Recombinant DNA techniques are being applied in the production of:

- Monoclonal antibodies at KEMRI
- Production of Transgenic virus resistant potatoes (rosita) from Mexico at the Kenya Agricultural Research Institute (KARI) in collaboration with Monsanto.
- Production of livestock vaccines

About 15 vaccines have been developed in Kenya using modern monoclonal antibodies props against various diseases. Scientists at the National Veterinary Laboratory have successfully sequenced capripox virus genome and cloned the gene conferring resistance to Nairobi sheep disease and Rift Valley disease to produce a bivalent vaccine which has been tested in Kajiado and Narok districts.

Mechanisms to monitor genetically modified organisms: The Cartagena Protocol on Biosafety, which was signed in 2002, focuses on transboundary movement of GMOs. Parties to the protocol are encouraged to develop national biosafety frameworks to monitor GMOs at all stages - access, production, release and use. This calls for strengthening of scientific research on risk assessment and management of GMOs. Kenya has developed guidelines on biosafety.

4.8. ACCESS AND BENEFIT SHARING

Best ways of conservation, sustainable utilization and equitable benefit sharing of biodiversity-derived products are being explored by various parties globally. Issues of access and benefit sharing from genetic resources and associated knowledge are major concerns in biodiversity business worldwide. Companies and individuals are actively researching on biodiversity to discover, patent and commercialize the findings, which is currently a lucrative business. There exist disparities between the patent owners who have the skills and technology and owners of biodiversity resources and associated intellectual knowledge.

Current legal systems recognize patents as a means of ownership enforceable under law. Patent systems do not put into account resource ownership and access (both to genetic material and associated intellectual knowledge). Patent holders for a long period have had free access to both indigenous knowledge and genetic resources, while the owners of genetic resources do not have free access to developed patents. While patent owners continue to be wealthier, the resource owners, who protect biodiversity have continued to be poorer. This scenario has caused an outcry globally where proper mechanism, involving use of intellectual property rights derived from genetic resources are being proposed. Proper exploitation of intellectual property can reduce poverty and enhance biodiversity conservation through benefit sharing.

Whereas most countries are aware of intellectual property issues associated with biodiversity they are weak in contractual negotiating skills in terms of derived benefits. Lack of enforceable regulations has enabled foreign companies to exploit Africa's resources cheaply.

Due to richness of unique biochemical products from microbial diversity, companies are exploring biodiversity products all over the world in search of new discoveries. Some of these companies such as Genencor, has collected about 15,000 strains of microbes stored in deep freeze at Palo Alto in the Netherlands. Genencor has 11 industrial products on the market and is also developing cleaner and cheaper ways of making industrial chemicals from these products. Companies are searching for extremophiles in unique habitats to train the genes for mass production of industrial strength enzymes used for better detergents, cleaner chemicals and effective DNA finger prints.

The extremophile-*Deinoccus radiodurans* can withstand 10,000 times amount of radiation that would kill human beings and has unique ability to repair broken DNA. Defence Advanced Research Projects Agency is sponsoring experiments on genetically engineered extremophiles to extend shelf life of blood clotting platelets in extreme conditions to treat battlefield wounds.

Two cases in Kenya, The Seed for Life Project under the Millennium Seedbank and Lake Bogoria/KWS vs Proctor and Gamble royalties, over extremophiles extracted from Kenya's soda lakes, used in making the popular tie and dye alternative bleach detergent and its stone-washing products, are good examples. KWS is seeking compensation on behalf of Kenya government and the communities around Lake Bogoria from Proctor and Gamble through public interest intellectual property advisors (PIIPA) of USA. If proper bioprospecting mechanisms are put in place, the country stands to benefit from proceeds of products developed from the country's genetic diversity.

Seeds for Life Project: The millennium seed bank project aims to conserve 10% of the world's flowering plant species through long-term *ex-situ* conservation and provide for collaboration between Royal Botanic Gardens (RBG) at Kew of UK and partner countries to pursue this conservation objective. The Kenya government through the Forest Department, KARI, KEFRI, KWS and NMK signed a Material Transfer Agreement (MTA) with RBG in September 2000. This is among the first efforts by Kenya to put in place a system on access to her genetic resources. It is a 10-year project undertaken in phases upon approval.

The main focus is on species in arid and semi-arid lands of Kenya. Collecting areas are:

Eastern Province	- Mwingi, Machakos, Makueni, Tharaka Nithi, Marsabit, Meru and Moyale.
Rift Valley Province	- Kajiado, Narok, Baringo, Koibatek, Turkana, Pokot, Transmara.
Central Province	- Nyeri, Nanyuki
North Eastern Province	- Garissa, Wajir, Mandera.
Western Province	- Busia.
Nyanza Province	- Siaya
Coast Province	- Taita Taveta, Tana River, Kilifi, Kwale

Access and benefit sharing measures in CBD have been incorporated in MTA Agreement (Articles 5.1 and 5.2). Access will be based on permit and/or prior informed consent and licence in connection with subsequent use of plant materials by partners. The article further states that NMK, FD and KWS shall grant access to those collecting in areas under their jurisdiction.

Article 6.0 of MTA on benefit sharing state that benefits shall be shared equitably. Among the projects which have benefited are;

- Technical and academic training;
- RBG Kew international diploma in plant conservation techniques;
- Technical and research attachments at RBG Kew;
- Participation in MSBP;
- Post graduate studies;
- Focused in country workshop;
- Local training of junior staff;
- Provision of equipment; and
- Community benefits.

Articles 9.0, 10.0 and 11.0 address issues of research and commercialization where RBG Kew shall not commercialize or obtain a patent on transferred material. The same RBG Kew shall not supply the plant material or its progeny to a third party without obtaining prior written permission from the government but copyrights to publications are jointly owned.

This MTA has put in safeguards to any abuse that may arise from misuse of Kenyan material. The only thing that is not evident is the contractual forms on access of both genetic resources and associated indigenous knowledge.

Achievements

- *Ex-situ* conservation of 1,102 accessions covering 700 species.
- Duplicated storage of seed material and herbarium specimen at RBG Kew.

Bio-prospecting Activities in Various Districts in Kenya: There are no formal mechanisms for tracing persons or corporations accessing and using the country's genetic resources to search for commercial products (bioprospecting). This makes it difficult to determine the actual impact of such activities on the status of the country's biological diversity as well as the level of benefit sharing among the relevant stakeholders.

Reports from the districts indicate that there are bio-prospecting activities going on in different parts of the country. The reports do not indicate whether there are any arrangements to share benefits that may arise from such activities among the stakeholders and in particular the local communities. Table 4.8 provides a summary of bio-prospecting activities recorded in the districts.

Responses: Until the enactment of the EMCA, the country lacked legislation to regulate access to genetic resources and benefit sharing. As a result, persons or organizations engaged in bio-prospecting activities in the country did it either illegally or disguised as academic research.

Table 4.8. Bio-prospecting activities in various districts in Kenya

District	Bioprospecting activity	Target	Actors
Mt. Elgon	Aloe medicinal materials	Aloe	-
Kakamega	Harvesting of plants	Medicinal plants	Tourists
Vihiga	Prunus africana – bark poaching + colobus meat	Prunus	-
Taita Taveta	Aloe, bee keeping	Aloes honey	-
Bondo	Got Ramogi plant harvesting	N/A	-
Migori	Aloe tree	Aloes	-
Homa Bay	Nile perch bladder and skin	Nile fish	-
Suba	Neem tree	Neem tree	ICIPE
Trans Nzoia	Illegal Aloe harvesting	Aloe spp	Somalis
Nandi South	Tree barks for medicine, insects and animals	*Prunus, Fagara*, Butterflies, Agana lizards	-
Nakuru	Tree barks, roots and lianas	*Warbugia, Octea*	-
Samburu	Gums, resins, tannis, tree barks	Aloe, *Acacia senegal, Boswelia neglecta, Xanthoxylon chalybeum*, Rhino cerous chameleon, Pancake tortoise, *Acacia geradii, A.* nilotica, A. tortilis	KWS, LWF, ITDG, Merchants
West Pokot	Aloe gum	*Aloe secundiflora*	Somalis
Mwingi	Survey of flora and fauna of Mumoni and Nuu	All plants	NMK for research only
Meru South	Wood carving	Dalbergia spp, jacaranda spp, Combretum spp, Terminalia spp, Azanza spp	Wood carvers
Tharaka	Aloe and wood carving	Aloe spp, Dalbergia spp	-
Machakos	Wood carving and dyeing industry	-	Wood carvers and ciondo makers

Source: District SoE Reports

In the late 1990s, an attempt was made to establish an institutional framework to coordinate access and benefit sharing activities in the country through the establishment of an inter agency committee made up of representatives of key biodiversity related institutions. The committee was coordinated by the National Council for Science and Technology. It managed to examine and provide comments on the Material Transfer Agreement between Kenya and Kew Gardens of Britain (Seed for Life Project). In the absence of such a mechanism it has been left to institutions and individuals to make decisions, if and when, contacted by persons interested in accessing the country's genetic resources.

In other areas, existing measures for the regulation and access to genetic resources and benefit sharing indicate that there are several legal, policy and institutional measures which regulate the access to genetic resources. However, the issue of benefit sharing is not well articulated especially with regard to bio-prospecting.

The situation is set to change for the better once regulations on conservation of biological diversity in the country are gazetted as subsidiary legislation under EMCA (1999). These regulations include provisions on access to genetic resources and benefit sharing.

4.9. INDIGENOUS KNOWLEDGE AND BIODIVERSITY MANAGEMENT

In the past two decades, Kenya has witnessed increased interest and research based on indigenous knowledge, particularly in traditional medicine. There has been a rise in the number of institutions, incorporating IK in their programmes and/or engaging in IK activities.

The importance of IK in Kenya is clearly defined in the National Environment Action Plan of 1994, the National Biodiversity Strategy and Action Plan of 1999, and EMCA.

Indigenous knowledge (IK) is the local knowledge that is unique to a given culture or society. It is the information base for a society, which facilitates communication and decision-making. Indigenous information systems are dynamic, and are continually influenced by internal creativity, experimentation and contact with external systems (Opole, Chweya and Imungi 1995).

Lately, there has been a growing recognition within government and development agencies of the crucial role indigenous knowledge plays in socio-economic development. This follows realization that many development interventions have failed to induce people to participate because of the absence of instruments and mechanisms to enable them to use their own knowledge. Indigenous people have over the years met the socio-economic needs and enhanced co-existence between human beings and nature, creating natural ecological balance and equitable distribution and use of resources. Jean-Philippe Soule gave the following definition which brings out clearly as to who indigenous peoples are:

"The Indigenous Peoples of the world are the exclusive guardians of the large wilderness habitats upon which modern societies depend (plants, animals, climate, and water). Their lifestyles are the only proven working models for the sustainable consumption of biological resources. Maintaining and understanding the earth's most biologically diverse areas is dependent on maintaining the cultural diversity and integrity of the indigenous peoples who live there".

Indigenous peoples are entitled to the recognition of the full ownership, control and protection of their cultural and intellectual property. They have the right to special measures to control, develop and protect their sciences, technologies and cultural manifestations, including human and other genetic resources, seeds, medicines, knowledge of the properties of fauna and flora, oral tradition, literature, designs, visual and performing arts.

They need special attention as the forces of economic development disrupt their traditional lifestyles that can offer modern societies many lessons in the management of resources in complex forest, mountain, and dry land ecosystems. Some are threatened with virtual extinction by insensitive development over which they have no control. Their traditional rights should be recognized and they should be given a decisive voice in formulating policies about resource development in their areas.

The Convention on Biological Biodiversity (CBD), to which Kenya is a party, recognizes the rights of indigenous and local peoples in traditional knowledge and innovations. Article 8(j) of the CBD is perhaps the most authoritative provision dealing with traditional knowledge. It provides that each contracting party shall, as far as possible and as appropriate, "subject to its national legislation, respect, preserve, and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant to the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices."

Application of IK: Local and indigenous communities rely on biological diversity to meet their basic needs. As a result of this reliance, the communities have accumulated knowledge on the uses of various animal and plant species. This knowledge covers areas such as animal and human health, weather and climate change predictions and best practices for conservation of biological diversity.

Threats/Challenges: In the recent past, the world has witnessed growing demand for herbal medicine. It has also witnessed heightened bio-prospecting activities in search for commercial products among multinational corporations. Indigenous knowledge is a major source of information on plants and animals with medicinal, cosmetic and pesticide values. This growing interest and the potential of indigenous knowledge to provide useful leads has led to increased occurrence of illegal access and application of indigenous knowledge to develop commercial products. The following are some factors that contribute to illegal access and application of indigenous knowledge:

- Lack of a policy on Indigenous Knowledge;
- Lack of databases, inventories and documentation;
- Inadequate awareness on the potential economic value of IK among local communities;
- Inadequate frameworks for equitable benefit sharing and access.

4.10. BELOW GROUND BIODIVERSITY

Below ground biodiversity (BGBD) comprises all organisms that live in the soil environment. They are diverse as the above ground organisms ranging from macro and micro-organisms. The organisms include invertebrates, bacteria, fungi and viruses. They are classified as microbes, mesofauna and microfauna. Below and aboveground biodiversity have been traditionally considered separately, with BGBD being overlooked. It is now recognized that the two components interact to influence community and ecosystem-level processes and properties (Wardle et al. 2004). Anthropogenic and natural changes of either above or belowground components therefore greatly influence ecosystem processes and properties and subsequently changes the aboveground and belowground community (Wardle et al. 2004).

Considering the magnitude of human activities (agricultural intensification, deforestation, continuous cropping, overgrazing, pesticides) and degradation of habitats, concern on threats to belowground biodiversity is increasing and projects are emerging to address the impact of land use on belowground biodiversity. Until recently, studies on BGBD were mainly on pests and pathogens. In addition, institutions of higher learning (universities) and national agricultural research institutes (NARIS), have been working on some organisms like nitrogen fixing bacteria, mycorrhizas, pathogens, pests (nematodes and termites) and earthworms. This approach was not holistic, and there was a need for detailed studies to establish the impact of land-use on belowground biodiversity.

Global concern on loss of BGBD resulted in a global project on BGBD, which assessed the impacts of land-use gradients on BGBD. Kenya is among seven countries undertaking this study. Others are Brazil, Mexico, Indonesia, India, Uganda and Ivory Coast. The project is being implemented globally by TSBF-CIAT. National institutions involved are University of Nairobi (coordinator), KEFRI, KARI, Regional Centre for Mapping of Resources for Development (RCMRD), NMK and the United States International University (USIU). Study sites are in Embu and Taita Taveta hot spot regions of aboveground biodiversity.

Functional groups are invertebrates (earthworm and termites), nematodes, collembolla, fungi (mycorrhizae, pythium and trichoderma) and nitrogen fixing bacteria (now legume modulating bacteria). Other projects on BGBD include a preliminary survey in 2004 in Mt. Elgon, undertaken by the National Museums of Kenya and Makerere University and funded by International Union for the Conservation of Nature (IUCN). This survey was part of the preparation for the main five year cross border project that should commence in 2005.

Mycorrhizal fungi are among the belowground organisms being studied by BGBD project. They form mutually beneficial associations with plants and are keystone to soil processes (Harley and Smith 1983). They form an interface between soil and plants, hence are affected by both plant and soil conditions. Mycorrhizal fungi are associated with a wide range of hosts in diverse soil types and climatic regions of the world (Harley and Smith 1983). They have the ability to absorb nutrients, transfer nutrients from one host plant to another, form soil aggregates greater than 240 µm diameter (Hamel *et al.*1997). Mycorrhizal fungi also influence plant biodiversity (van der Heijden *et al.* 1998), help to control pests (e.g. nematodes) and fungal pathogens (Azcon-Aguilar and Barea 1996) and affect fitness of plants in polluted environments (Hildebrandt *et al.* 1999). Plants with mycorrhizal fungi are therefore able to occupy habitats they otherwise could not (Smith and Daft, 1978).

The sustainability of mycorrhizae in soil is important to maintain and promote productivity of croplands, rangelands and forests, and may be critical to maintenance of biodiversity (Allen *et al.*, 1995). Disturbance of vegetation, soils and associated microflora is increasing with expanding human populations. Mycorrhizal fungi are depleted in soils that have been damaged (Allen, 1988). This information is necessary to control degradation and emergence of diseases that may be difficult to control due to loss of natural enemies. Any efforts to restore degraded habitats, re-establish trees or introduce new species into the ecosystem will require knowledge on belowground biodiversity. The mycorrhizal symbiosis is a good indicator of change and can initially be used to evaluate change.

4.11. OUTLOOK

Forests

The Forest Bill 2005 has addressed principles of sustainable forest management using participatory approaches with recognition of benefit sharing arrangements. Privatization of forestry as business enterprise will provide an opportunity for employment, enhance incomes and increase the much needed forest cover. It is therefore paramount that this Bill is enacted as a matter of urgency in order to enhance forest conservation, while protecting the interests of local communities.

Wildlife

Several measures and initiatives have been put in place to mitigate against the threats and challenges facing wildlife management in the country. These include:

- Translocation of specific animal species to suitable conservation areas with lesser pressures and within the carrying capacity of the range. The translocations should be based on upto date data and information on the receiving habitats to ensure species specificity and survival.
- Intensified security measures through surveillance and monitoring, should be enhanced across all conservation areas to eliminate poaching for wildlife trophies and game meat.

- This will require increased technical and security personnel as well as a mechanism for community policing.
- There is need to strengthen conflict resolution mechanisms in areas where resource use conflicts have or are likely to occur. The measures will include promotion of wildlife related community income generating activities such as ecotourism and tour guiding through the amendment of the Wildlife Act.
- There is need to create awareness on the importance and associated benefits of conservation as this contributes to sustainable use of resources. This will contribute to change of attitude by communities towards appreciating conservation as an asset and a source of their livelihoods.

Indigenous Knowledge

In regard to benefits associated with IK, it is necessary to:

- Collate and document IK information;
- Develop a national policy on IK;
- Develop an institutional framework for IK; and
- Build capacities to enable communities to negotiate benefit sharing arrangements with those who need to use their knowledge.

Below Ground Biodiversity

- Below ground biodiversity presents a new area of research that has potential to offer information on status, varieties and potential applications of such species. This presents development avenues in the areas of industrial and health advancement. There is therefore need to expand this research in various areas of the country in order develop an inventory of the various species as well as the factors likely to affect them.

- There is also a need to create awareness at all levels on the benefits associated with below ground biodiversity, especially on their potential contribution to soil fertility and productivity for improved crop production and food security.

CHAPTER FIVE

LAND USE AND WATER RESOURCES

5.1. INTRODUCTION

The provision of water is a critical component in sustainable development. Degradation of watershed areas is on the increase resulting in diminished water resource availability. The major issues of concern relating to water resources are availability, quality, utilization, shared resources, strategies for harvesting, droughts and floods. Consideration is also given to opportunities and potential responses that need to be addressed in the sector, including potential actors in the implementation of proposed solutions.

5.2. WATER RESOURCES

Water is a life support resource without a substitute; its availability is unevenly distributed in the country. For example, Nyanza, Western and Central provinces have adequate water resources, while all other regions have inadequate quantities.

The total annual surface and ground water potential is 19,590 and 619Mm^3 respectively. However, total annual demand has grown from 2,073 Mm^3 in 1969 to 3,874 Mm^3 in 2000 and is expected to reach 5,817Mm^3 in 2010. Access to good water for livestock, agriculture, domestic and industrial use is limited in space and time. Only about 12% of the country has reliable rainfall, while 88% experiences erratic rainfall and have evapotranspiration rates higher than the amount of rainfall received. Construction of dams and pans to tap runoff and rainwater harvesting from roofs are ongoing activities to supplement the existing water sources. Rain water harvesting practices have been on the rise in order to meet water demands for domestic, livestock and agricultural uses.

Degradation of watershed areas in the country is on the increase, resulting in diminished water resources. The main causes of watershed degradation stems from the abuse and poor management of forests and soils, overgrazing, extension of settlements into watershed areas, unsuitable felling of trees for fuel wood (about 70% of rural population depend entirely on fuel wood for energy requirements) and other wood products. This loss has generally impacted negatively on important watersheds.

The removal of vegetation cover on catchment areas has reduced water retention capacity, enhanced soil erosion resulting into poor water quality and reduced soil fertility. Excessive soil erosion has caused flooding, sedimentation of downstream reservoirs, lakes and irrigation schemes. In the ASALs, the situation is even more critical. To reduce soil erosion, several mitigation measures such as terracing, agro-forestry, cut off drains and check dams are widely promoted and have shown some positive results. Reforestation campaigns by the Ministry of Environment and Natural Resources are ongoing.

5.2.1. Water Catchments and Drainage Basins

Kenya's drainage system is subdivided into five drainage basins consisting of 192 subdivisions (Cege, 1968). There are five drainage basins in Kenya namely Lake Victoria,

Rift Valley, Athi River, Tana River and Ewaso Ngiro, managed by various institutions including government agencies and regional bodies (Fig. 5.1). Only two of the basins have surplus water resources - Lake Victoria and Tana River. The other three basins often rely on inter-basin water transfers to meet their basic water demands. At the end of 2005, management of water basins is expected to have been taken over by the Water Resources Management Authority in accordance with the ongoing water sector reforms, as stipulated in the Water Act of 2002.

Lake Victoria Basin: The Lake Victoria catchment is gradually being degraded due to increased human activities. This has led to deforestation, increased soil erosion, siltation of the lake and reduced agricultural productivity. Replacement of indigenous vegetation by exotic plantations has reduced interception of storm water, increased stream flows and loss through evapo-transpiration by about 18% (JICA, 1980). Evaporative forces account for over 80% water loss from the lake (Okanga, 2001; COWI, 2002). The mean evaporation rate over the lake ranges between 1108 mm and 2045 mm per year (COWI, 2002).

Upper Ewaso Ngiro North Basin: The Upper Ewaso Ngiro North basin, mostly the Laikipia Plateau is a zone of transition from the wetter to drier part of the eastern Kenya highlands. A large proportion of the central region is under large-scale ranches, while wheat and barley are grown on the higher (wetter) altitudes. Small-scale subsistence settlements are also spreading with pastoralists inhabiting the northern region, mainly a harsh and fragile environment, where widespread overgrazing, soil erosion and general land degradation are quite rampant.

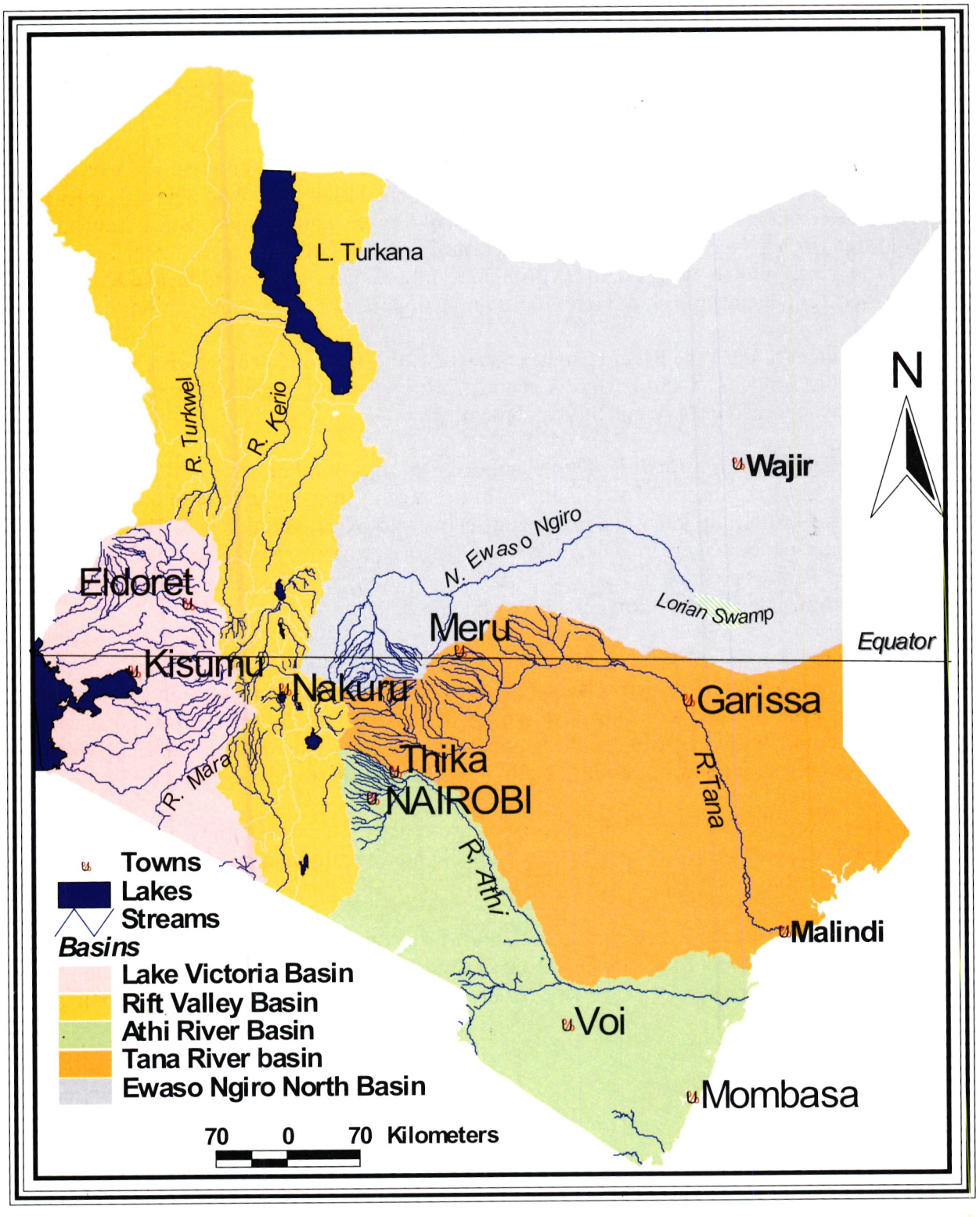
The basin lies in the lee slopes of Mt. Kenya and the Aberdares range, hence the area is generally dry. Rainfall ranges from 365 mm per year at Archer's Post to over 2000 mm on the Aberdares. The average annual precipitation for most of the Basin is about 700 mm. The western and north-western parts of the basin receive rain in a single season, between April and August, while the eastern side has a clear bimodal distribution with rainfall maxima in April and October.

Athi River Drainage Basin: The Sabaki River (commonly referred to as Athi/Galana/Sabaki river system) originates from the central highlands around Mt. Kenya and the Aberdares range. Middle Athi catchment is drained by the seasonal Kiboko River which is made up of the Olkejuado and the Selenkei tributaries. The Selenkei is an important water course that provides water for both humans and livestock throughout the year. The Sabaki River flow rate ranges from 0.5 m^3/sec ($40x10^3$ m^3/day) in the driest periods to 760 m^3/second ($70x10^6$ m^3/day) during times of flood.

The lower course (Galana/Sabaki) traverses ASALs characterized by scarce, unpredictable and erratic rainfall. Tsavo catchment has its headwaters at the foot of Mt. Kilimanjaro and Chyulu Hills. The Tsavo River, a major tributary of the Sabaki drains a permanent spring and other perennial springs.

The south, central and eastern parts of Lake Amboseli basin are marked by a number of permanent swamps, while the western half is dominated by the seasonal Lake Amboseli. The swamps get their recharge from a number of seasonal streams on the Kilimanjaro foot hills, while Lake Amboseli gets its recharge from the seasonal Namanga and Esokota water courses.

Figure 5.1. Major drainage basins of Kenya



Source: Ministry of Water and Irrigation

Rivers traversing urban centres such as Thika and Nairobi City have poor water quality due to untreated or poorly treated municipal and industrial discharges, posing a major threat to this ecosystem (population approximately three million). Nairobi River is highly polluted posing a threat to biodiversity, as a result of industrial discharges and effluents from mushrooming informal/unplanned settlements. Other sources of pollutants are agrochemicals (fertilizers and pesticides) from farms that grow coffee, tea, horticultural crops (including cut flowers) and maize, as well as dairy and beef farming.

Tana River Drainage Basin: Tana River originates from the southern and eastern slopes of Mt. Kenya, the eastern slopes of the Aberdares and Nyambene Hills. It is the longest, largest and most complex river in Kenya. It passes through most of Kenya's agro-climatic zones from humid and cold areas on Mt. Kenya and the Aberdares, to arid and very hot zones in the lower Tana. The upper Tana is impounded by five dams (Masinga, Kamburu, Gitaru, Kindaruma and Kiambere) for hydro-power generation, which have been gaining importance for fish production.

The management of the Tana River basin is entrusted to the Tana and Athi Rivers Development Authority (TARDA). The Authority is mandated to promote integrated and sustainable utilization of water resources within this catchment.

The Rift Valley Drainage Basin: This basin consists of a number of closed basins, which include those discharging into Lake Turkana in the north through Turkwel and Kerio rivers mainly; and those draining into Lake Natron through Ewaso Ngiro South River. There are other rivers discharging their waters in to lakes Baringo, Bogoria, Nakuru, Elementaita, Naivasha and Magadi. The basin is characterized by sparse population, low level of urbanization and industrialization; and low-medium productivity potential.

Lake Naivasha is important for fishing, tourism and biodiversity conservation as well as horticultural production, which provide employment opportunities and income generation. The lake provides water for both domestic and industrial use. The Olkaria Geothermal power plant contributes about 20% of electricity to the national grid. The integrity of Lake Naivasha is highly threatened by eutrophication, agricultural pollution, siltation and waste disposal.

Lake Baringo, just like other Rift Valley lakes, is threatened by unsustainable land use practices in the catchment, including siltation, loss of valuable biodiversity and unsustainable livestock and crop production.

Table 5.1 shows the area and distribution of both surface and ground water resources in the five drainage basins in Kenya. Table 5.2 shows the surface areas and average depths of inland water lakes, as well as the quality of their waters. Characteristic of the main rivers are shown in table 5.3.

Table 5.1. Major catchments and river basins in Kenya

Drainage Basin	Area (km^2)	Rivers	Surface water yields in m^3/day	Remarks
Lake Victoria North	19,615	Nzoia, Yala, Sio and the North Awach	11,993,184	Nile only outlet, at 23.4km^3/year lake levels ranges between 0.4 – 1.5 m (Balirwa, 1998)
Lake Victoria South	27459	Nyando, Sondu/Miriu, Gucha/Migori and the South Awach		
Rift Valley	124,722	Kerio is the main river with a total length of 320 km, and approximate flow rate of 4.47 m^3/s.	211,680	Most major lakes in Kenya lie within the Rift Valley basin, namely; Lakes Naivasha, Baringo (fresh), Lakes Turkana (Brackish) and Lakes Nakuru and Magadi (saline).
Athi River	66,420	Athi/Galana/Sabaki river system mostly from the Mount Kenya region. The major water courses include Embakasi, Kitengela and Stony Athi	582,336	Sabaki is the second largest river, 500 km Upper Athi catchment has headwaters in Ngong hills and supplies Athi River Township and irrigation activities along its banks.
Tana River	126,927	Mostly from the Mt. Kenya area	71,841,600	The basin supports over 5.8 Million people. Tana River has a length of some 1,000km
Ewaso Ngi'ro	209,320, (upper 15,634)	Mostly from the Nyandarua range & tributaries from Mt. Kenya	674,784	It is the largest drainage basin in Kenya, disappears into Lorian swamp

Source: Ministry of Water and Irrigation records

Table 5.2. Characteristics of major lakes in Kenya

Lake	Area (km^2	Depth (m)
Fresh water		
Naivasha	115	6.5
Victoria	3785	43
Baringo	130	10
Brackish		
Turkana	6405	120
Saline		
Elementaita	18	1.1
Nakuru	5-30	Seasonal
Magadi	100	-
Bogoria	34	10

Table 5.3. Characteristic of the major rivers in Kenya

River	Total length (Km)	Station measurements taken	Width (m)	Depth (m)	Flow (m^3/Sec)
Tana	725	Kiganjo	12.00	0.36	0.35
		Tharaka	43.28	3.68	63.59
		Garsen	63.00	3.45	61.99
Athi	591	Thika	26.00	0.10	1.50
		New Kibwezi	5.70	0.48	0.38
		Lugard Falls	102.58	0.30	4.88
Kerio	320	Turgard Falls	2.30	0.34	13.00
			0.70	0.10	0.10
			14.10	0.18	0.30
Turkwell	305	Turkwell Gorge	20.50	0.29	1.84
Nzoia	240	Webuye	28.69	1.77	10.14
		Moiben	4.70	0.31	0.44
		Nambale	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: Ministry of Water and Irrigation records

The Mara River traverses both Kenya and Tanzania with its source in the Mau catchment area. The river basin in Kenya is 8941 km^2, while the whole catchment is approximately 10,300 km^2. The basin has important swamps including Musiara and Olpunyata in Kenya and Masarua in Tanzania. Olpunyata swamp supports migratory wetland birds in addition to flora and fauna.

Lake Bogoria is an alkaline water body located on the floor of the eastern Rift Valley. It is 42 km^2 in area, 17 km long with a maximum width of 4.5 m. It is fed by hot springs, geysers and fumaroles along its shore.

5.2.2. 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 yields in the different basins is given in table 5.4. 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 drier areas, aquifers are low yielding and have poor quality (Table 5.5.). Over 14,000 boreholes have been drilled countrywide with the average abstraction yield of 7 m^3/hr. However, it is threatened by intrusion of salt water in coastal areas, leacheates from garbage dumps in urban areas and infiltration of industrial pollutants, mining wastes, petroleum sector, fertilizer and pesticide residues in the agricultural areas.

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 to address over abstraction. Ground water abstraction is now only permitted under licence. Afforestation programmes should greatly mitigate against depletion of groundwater resources.

Box 5.1. Ramsar Sites in Nakuru District

Lake Naivasha is the first Ramsar Site in Kenya. The lake faces enormous challenges including catchment destruction, pollution from flower farms and settlements around the lake and excessive water abstraction. In order to address these challenges, the Lake Naivasha Management Plan has been gazetted.

Lake Nakuru is another important Ramsar Site famous for its unique large population of lesser flamingo. The lake ecosystem is rich in biodiversity and it is managed by the Kenya Wildlife Service (KWS). Major threats to this ecosystem include pollution from industrial, municipal and agricultural sources, wate level fluctuations due to weather changes. Various initiatives supported by the Worldwide Fund for Nature (WWF) and KWS in collaboration with Egerton University, local communities, NGOs and government agencies have been put in place to address these problems. The initiatives include awareness creation, tree planting programmes, Environmental Impact Assessment (EIA) licensing and Environmental Audits (EA) for relevant projects.

Source: Nakuru District SoE report 2004

Table 5.4. Ground Water Resources

Drainage Basin	Ground water, Safe yields in m^3/day
Lake Victoria basin	118,622
Rift Valley	318,192
Athi River	222,319
Tana River	431,499
Ewaso Ngiro	602,281
	1,692,913

Source: Ministry of Water and Irrigation records

Table 5.5. Ground water characteristics within the five key basins

Basin	Ground water characteristic
Lake Victoria	Over 90% of bore holes 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 in excess of the WHO recommended levels of 1.5 ppm.
Tana	Ground water is generally fresh and free from colour and turbidity. Hardness varies from soft to moderate soft. There are some amounts of fluoride (around Kiambu).
Athi	Over 50% of boreholes contain hard and saline water. Shallow wells and boreholes around the coast are prone to contamination.
Ewaso Ngiro North	Boreholes tend to have 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 water is often hard and varies in salinity levels.

Source: Ministry of Water and Irrigation Records

Ground waters along the coast are threatened by seawater 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.

Box 5.2. Impacts of Flooding in Nyando District

Flash floods in many part of the Nyando River (especially Kano plains) and parts of Sondu Miriu arising from catchment deforestation, result in the destruction of river banks, food crops and infrastructure. Other impacts include displacement of people, destruction of farms, homes and increased disease incidences.

5.3. SHARED WATER RESOURCES

5.3.1. Shared Aquatic Ecosystems

A shared ecosystem spans across the common border(s) of two or more parties. The parties could be two or more communities sharing a small lake, two or more districts or two or more sovereign states, sharing a large swamp. Due to the large number of shared aquatic ecosystems in Kenya, this section only covers ecosystems shared between Kenya and her neighbours. These are lakes Victoria and Jipe; rivers Omo, Mara and Ewaso Ngiro South; and the coastal/marine strip (Wakhungu and Sikoyo, 2003).

Lake Victoria: Historically, the Lake Victoria shores were fringed by extensive papyrus (*Cyperus papyrus*) dominated wetlands and dense forest patches. Much of the forest cover and the wetlands, especially on mainland catchments have been severely degraded through excessive resource use by a rapidly rising human population.

These changes together with the decline in water quality are causing concern on the sustainability of fish production, which is the most important resource from Lake Victoria. One of the major causes of degradation of water resources in the Lake Victoria ecosystem is poor farming practices. These activities contribute to soil erosion and siltation leading to enrichment of the lake ecosystem with nutrients and pollutants from the catchments.

The contribution of nutrients from atmospheric deposition of nitrogen and phosphorous, industrial and municipal sources is negligible for the lake as a whole, but important for local inshore areas (Table 5.6). General run-off and effluents from urban centres and lakeside settlements are the main sources of excess nutrients, which cause serious eutrophication in near-shore environments associated with major towns. Eutrophication due to nutrient enrichment, cause excessive growth of phytoplankton or macrophytes, which when they decompose impair water quality (cause low dissolved oxygen, high turbidity and production of toxic gases such as hydrogen sulphide).

The Lake Victoria ecosystem has been under threat from eutrophication since the early 1990s when changes in oxygen regimes and phytoplankton composition were noted. The lake wetlands are undergoing serious degradation as a result of excessive resource harvesting, over grazing and conversion to agriculture and industrial development. The over-loading of the wetlands with municipal sewage and industrial effluents is likely to outstrip its treatment capacity. The near-shore wetlands are under threat too, from destructive fishing practices.

Table 5.6. Nutrient pollution loads in Lake Victoria

Source	BOD (tons/year)	Total Nitrogen (tons/year)	Total Phosphorus (tons/year)
Catchment	0	49,510	5,690
Atmosphere	0	102,150	24,400
Industry	5,610	410	340
Municipal	17,940	3,510	1,620
Total	**23,550**	**155,580**	**32,050**

Source: (Wakhungu and Sikoyo 2003)

Nile perch and water hyacinth are two alien introductions that have had considerable impacts on the ecology and socio-economic importance of the lake. Water hyacinth infestation and proliferation is a manifestation of existing high levels of nutrients in the lake.

The Yala Swamp located on the north-eastern shoreline of Lake Victoria, is one of the most important riparian and floodplain wetlands around the lake, and indeed one of the largest in Kenya. It provides a very important habitat for refugee populations of certain fish species, which have otherwise disappeared from the lake, besides being home to some unique waterfowl species such as the Papyrus Gonolek. The swamp supports livestock grazing, fishing, biomass fuel, building materials, crafts, water, hunting, medicinal herbs, research and tourism. Yala Swamp is also an important habitat for various species of birds and animals. Other functions are flood control, silt and nutrient trapping, and as a carbon sink.

The conversion of Yala Swamp to agricultural uses is seen as panacea to food security and employment in the area. Parts of the swamp have in the past been used to grow rice, maize and sorghum. At present, a rice project of several thousand hectares is under implementation. While these developments have important socio-economic objectives, they have had significant hydrological and ecological impacts on the swamp and associated lakes. Conflicts and threats to the swamp include drainage for agriculture, uncertain land tenure, uncontrolled grazing, lack of holistic management and inappropriate land use in the catchment.

Lake Kanyaboli is a favourable nursery ground and refuge area for many fish species, and it has been nicknamed a 'living museum' for Lake Victoria fisheries because many fish species, which have disappeared from the main lake, are still found in appreciable numbers in this lake.

Lake Jipe: Lake Jipe lies astride the Kenya-Tanzania border. Tsavo West National Park borders the southern portion of the lake, while Mt. Kilimanjaro dominates the horizon, some distance to the northwest. Lake Jipe receives its main inflow from Mt Kilimanjaro. However, there has been a considerable fall in the lake level.

In the 1960s, Lake Jipe had a booming fishery dominated by *Oreocromis jipe* and *Clarias gariepinus,* with *Barbus* sp and *Labeo* sp as minor components. The lake, situated in a largely arid environment, is the remaining vital resource to the riparian communities and their livestock. It provides crucial watering and feeding resources to the wild game of Tsavo West National Park. The lake has a variety of avifauna including many Palaearctic migrant waders and inter-African migrant water birds, whose status in the area is not clear.

The causes and magnitude of subsequent impacts of the changes in the environment and resources of Lake Jipe, which still need to be established and documented, include:

- Collapse of the fishery probably due to changes in water quality;
- Increase in siltation due to increased human activities in the catchments;
- Expansion of the emergent fringe of macrophytes dominated by *T. domingensis* escalated by declining lake level and heavy siltation;
- Reduced inflow into the lake due to increased water abstraction in the catchments and interference with initial water flow patterns into the lake by heavy siltation in the wetlands at the mouth of River Lumi;
- Increased salinity of lake water, due to reduced surface inflow and/or infusion into the lake by ground water percolating through the rock; and
- Disappearance of the original hydrophytes such as nymphaea and water lettuce, possibly due to changing water quality.

The apparent decline in the diversity and numbers of avifauna is possibly due to the collapse of the fishery and the deteriorating water quality, which have had considerable effect on the food and general environment of birds. Regarding the management of Lake Jipe ecosystem, there is need to:

- Conduct a comprehensive and coordinated basin-wide scientific study to determine the causes and impacts of the degradation;
- Forge partnership with key stakeholders to identify relevant issues, develop solutions and formulate management strategies; and
- Integrate management of Lake Jipe with Lake Nyumba ya Mungu and River Pangani basin ecosystems.

Coastal Aquatic Ecosystems of Kenya and Tanzania: The coastal marine belt within the East African Community covers a stretch of about 1400 km of the western Indian Ocean, shared by Kenya (about 600 km) and Tanzania (about 800km). The coastal marine belt habitats include estuarine areas, coral reefs, mangrove forests, tidal flats and sea grass beds. These ecosystems provide essential nursery beds, feeding areas and shelter for a large variety of marine biota. The rivers extend for various distances inland, tapping water from the hinterland and far beyond. The floodplains and deltas of most of these rivers support important agricultural and other socio-economic activities in the region.

The array of resources in the marine and coastal environment supports social and economic opportunities such as fishing, agriculture, aquaculture, tourism and industry. Degradation is often exacerbated by the shared nature of the aquatic resources, which often reduce the degree of commitment to rational exploitation and management due to lack of a sense of ownership.

In recognition of the importance of their marine and coastal areas and the environmental threats they face, governments of East Africa through UNEP's Regional Seas Programme formulated a regional framework and mechanisms to address environmental and resource degradation. The initiative by the East African Community (EAC) to "develop common guidelines for Environmental Impact Assessment of Shared Ecosystems" is in tandem with UNEP's Regional Seas Programme.

One of the most significant ecosystems at the coast is the Tana River delta. It is Kenya's largest delta and among the five most important deltas in the eastern Africa region. The delta has been recognized as an area of global importance due to its biophysical and socio-

economic services. Efforts to declare the area a Ramsar Site are ongoing. The dynamics of the river have resulted to numerous ox-bow lakes, several floodplains and marshes, which give rise to patches of riverine forests and other habitats with unique fauna and flora.

The delta is characterized by fresh and brackish water, dune system and coastal forest habitats hosting a wide variety of species, including two of the five endangered turtles (the green and hawksbill turtles), the elusive and threatened dugong, and provides important nesting grounds for the Arctic tern, and feeding areas for whale sharks.

The Tana River delta area is also of significant socio-economic importance to local communities and continues to play a vital role in their livelihoods through fishing, cultivation, grazing and increasingly, tourism. In particular, the delta serves as a dry season grazing area for the pastoral communities in and around the delta, and others coming from as far as Garissa and beyond. Due to diverse and conflicting economic activities taking place in the delta, there have been frequent resource use conflicts. Concerns have been raised regarding past and ongoing utilization of the delta's resources, which may drastically alter its socioeconomic and ecological integrity.

Lake Turkana and Omo Basin: Lake Turkana is the largest of the Kenyan Rift Valley lakes and is situated at the northern tip of the country's border with Ethiopia. The Lake covers an area of 7,560 km^2 and receives most of its waters from the Omo River whose catchment is primarily in the Ethiopian highlands, and rivers Turkwell and Kerio originating from the Cherangani Hills in Kenya. The lake provides for the needs of the local communities through fishing and navigation.

The lake contains a diverse array of both plants and phytoplankton. The lake's fishery is not well developed for commercial exploitation. In terms of management, there are parts of the lake that are protected under the Wildlife Act and include Sibiloi National Park on the northeastern shores, Mt. Kulal Biosphere Reserve and North, Central and Southern Islands National Park. Disappearance of both birds and crocodiles due to reduced water levels has been reported.

Land use changes upstream of the Omo River are adversely affecting water quality in the lake, mainly due to siltation.

Mara River and Mara-Serengeti Ecosystem: The Mara River is 395 km long originating from the Mau Complex in Kenya and discharges into Mara Bay of Lake Victoria in Tanzania. Its sub catchments include Loita Hills and Loita plains. The Mara River is considered the lifeline of the Masai Mara National Reserve situated in the south-west of the country. The Masai Mara, which is contiguous to Serengeti National Park in Tanzania, is an important ecosystem because it supports one of the richest and most biologically diverse composition of fauna in the region and is one of the most vibrant tourist attractions in the region. Virtually all the wildlife and human life in the Mara-Serengeti ecosystem depend on Mara River for their livelihood. However, the future of this function is threatened by the destruction of Mau Forest Complex.

Ewaso Ngiro South River and Lake Natron: The source of Ewaso Ngiro South River is a marsh area in a gently undulating plateau between Olokurto and Shabaltaragwa. Nosagami

catchment is 76 km^2 and was completely forested in the 1960s, but now is almost completely bare of trees. The river drains into the highly alkaline/saline Lake Natron in Tanzania, which is a major breeding habitat for the lesser flamingo in the region.

Lake Bogoria: Lake Bogoria is protected as a National Reserve by Baringo and Koibatek County Councils. It is a well-known feeding ground for the lesser flamingo and together with Lake Natron form an intricate system of breeding and feeding grounds for the lesser flamingo. The watershed of the lake is continually being degraded due to land use changes, leading to soil erosion and siltation of the lake.

Lotikipi Plains: The Lotikipi plain is located 90 km west of Lake Turkana and occupies an area of 500,000ha in Kenya and slopes northwards into Sudan. The plain is located in a semi-desert zone with annual precipitation of 250-500 mm. It receives its waters from several seasonal rivers, some of which retain water in their beds during the dry season.

The floodplain is basically grassy with reeds and papyrus in the wettest sites and scattered acacia and Balanites trees. The floodplain, which lacks formal conservation status, is hardly utilized except for some small-scale hunting. It is apparent that the plain has the potential to revolutionize the economic status of the region, if optimally used.

5.4. WATER AVAILABILITY AND UTILIZATION

5.4.1. Water Availability

The objective of the 1998 National Water Policy is to facilitate the provision of water in sufficient quantity, quality and within a reasonable distance to meet the needs of human beings, agriculture, livestock and industry, while ensuring safe disposal of wastewater and environmental protection. About 90% of the urban population has access to safe water, compared to 35% of the rural population (Welfare Monitoring Survey III, 1997). Shortfalls to water access have been responsible for most conflicts especially between various demands.

5.4.2. Water Demand and Supply Status

Table 5.7 presents estimates of 1995 water demand and projections to 2010. Water demand estimates was 1.8 million m^3/day in 1993 and is projected to increase to 3.7 million m^3/day by 2010, as a result of expected population growth. Overall unit consumption rate per capita was also projected to increase from 88.8 l/c/d in 1995 to 101.6 l/c/d in 2010.

Water Supply: There are many types of water supply schemes developed in the country such as:

1) Urban water supply schemes that cover mainly urban centres and their periphery areas;
2) Community based water supply schemes that serve rural communities; and
3) Regional water supply schemes that supply several urban and rural areas simultaneously.

Apart from the domestic water supplies, many water pans and dams are constructed particularly in the ASAL areas for watering livestock.

Table 5.7. Water demand estimates (Unit: 1,000m^3/day)

Category		1995		2010	
		Current study	Previous NWMP	Current study	Previous NWMP
Residential	Urban	616.2	747.8	1,573.4	1,642.9
	Rural large scale	213.9		436.1	
	Small scale	103.4	468.2	395.4	932.6
	Sub-total	933.5	1,216.0	2,404.9	2,575.4
Non-residential	Health facilities	16.0		25.4	
	Schools	135.3		176.3	
	Industry & Commerce	200.9		499.0	
	Sub-total	352.1	593.9	700.7	986.3
Total		1,285.7	1,809.9	3,105.7	3,561.7
(l/c/d)		88.8		101.6	
Livestock Water		517.5	376.6	583.2	621.4
Grand Total		1,804.3	2,196.6	3,688.9	4,183.2

Source: Ministry of Water and Irrigation records

5.4.3. Types of Water Uses

There are various water uses which can be categorized into domestic, industrial, agricultural, livestock and wildlife.

Domestic Water Supply: Comprises water used in households, commercial establishments and institutions, and in certain cases, also incorporates a percentage of livestock water use, particularly in the high potential areas.

The general objective of the National Water Development Policy continues to be the development of water supply systems to incorporate the provision of sewerage facilities for disposal of waste water. Development of sewerage systems has, however, been encountering a problem of land availability for sewage treatment plants. This is a major challenge in advancing sewerage development in the urban centres.

Industrial water supply is normally incorporated in the domestic water supply and serves industrial needs. Water quality requirements for domestic and industrial water are not separated. As a result, clean water, which is treated for domestic use, is wasted on industrial activities, construction and other uses. The wastewater characteristics of the domestic and industrial water systems are also fundamentally different. There is therefore need for industries to pre-treat their wastewater before discharging into the public sewers.

Water supply for energy generation plays a key role in electricity production as hydropower provides 57% of locally generated electricity. The dependency was noticeable during the prolonged 1999–2000 drought when the supply was rationed as a result of the reduced production of the hydroelectric energy to the national grid by 40%.

Hydropower generation often entails building reservoirs that transform terrestrial ecosystems, requires resettlement of displaced communities, alters seasonality and quality of river flows, and impacts downstream water users. Other sources of electric power generation (thermal and geothermal) also depend on water for cooling and recharge to maintain groundwater levels and equilibrium. In this regard, environmental impact of new projects and audits for

existing ones need to be well conducted to mitigate adverse effects and monitor compliance respectively.

Water for agricultural production is largely dependent on rain water. However, of late, there have been numerous crop failures as a result of climate change. This has made rainfed agriculture unreliable in many areas. Irrigated agriculture is becoming important even in areas where irrigation would not have been considered earlier. In addition, migration of people with farming backgrounds into the marginal areas has introduced irrigation into the ASALs making irrigation the largest user of water.

Livestock and wildlife water supply is drawn from surface, groundwater and rainwater harvesting. In ASALs, livestock water-use commands the highest category of water demand, particularly in areas where irrigation is not feasible. In this regard, ASAL development revolves around adequate provision of watering points for livestock.

Wildlife water supply is difficult to assess since wildlife numbers and movements are difficult to monitor regularly and determine demand. There are 31 national parks and national reserves for which data are available, and 13 of them have some constructed facilities primarily for wildlife, such as waterholes, boreholes or dams. Almost all these parks and national reserves require additional physical facilities. It is important to maintain sustainable supplies of water for wildlife in protected areas in order to avoid human-wildlife conflicts as a result of wildlife movement into adjacent human settlement areas in search of water.

5.4.4. Water Abstraction

Water abstraction has been controlled by the Apportionment Board under the Ministry of Water and Irrigation. This function is being moved to the Water Boards formed under the reform process in the water sector in accordance with the Water Act of 2002.

In the past, illegal abstraction of water has been rampant and enforcement mechanisms poor. With the enactment of EMCA (1999), water abstraction projects listed in Schedule II of the Act should comply with EIA and EA regulations. It is expected that stakeholder collaboration will improve management.

Box 5.3. Nakuru Flower Farms

The mushrooming of flower farms in Nakuru District, especially in Naivasha and Rongai divisions will worsen the current water scarcity in the district. In Naivasha, most farms depend on water from the lake for irrigation. The growing demand is unsustainable given that recharge for lake water is Malewa River whose discharge has been declining due to water abstraction upstream.

The waste from the flower farms is released back into the lake, leading to increased pollution. Many flower farms have also encroached into the lake's riparian land thereby depriving bird and wildlife of their food and habitat.

Source: Nakuru District SoE Report 2004

5.4.5. Catchment Degradation

Human settlement activities and land use practices including agriculture have resulted in removal of vegetation cover, making water catchment areas vulnerable to degradation especially soil erosion in both high potential lands and ASALs resulting in:

a) Landslides which have occurred in Murang'a and Meru districts;
b) Floods which have occurred in Busia, Nyando and Kisumu districts;
c) Siltation of lakes (Jipe, Baringo and Ol Bollosat) and hydropower reservoirs, thereby reducing their storage capacities;
d) Droughts and desertification processes; and
e) Climate change effects as evidenced by erratic rainfall patterns.

5.4.6. Efforts Towards Sustainable Utilization of Water

The 1998 National Water Policy addresses water resource management. The emphasis is to preserve, conserve and protect available water resources and allocate it in a sustainable, rational and commercial manner. The Water Act of 2002 has revolutionized the water sector by introducing public participation. The Act also establishes the Water Resource Management Authority to coordinate the water sector activities in the country. The current reforms in the sector include the formation of seven boards to manage and coordinate water issues in the seven drainage basins.

Water availability and utilization is guided by the following statutes:

a) The Water Act of 2002
b) The Environmental Management and Coordination Act (EMCA) of 1999
c) The Local Government Act (Cap 265)
d) The Public Health Act
e) The Mining Act
f) The Forest Act

5.5. WATER QUALITY

Water quality is closely linked to the type and nature of activities and land use practices. Industrial, agricultural, recreational and domestic activities often pollute water, thereby reducing its quality resulting in outbreaks of waterborne diseases. Ongoing industrialization and intensive agriculture contributes to water contamination. Some of the urban population are exposed to hazardous chemicals as well as infectious agents. Surface and ground waters are getting more polluted from poor land use practices and poor disposal of liquid and solid wastes.

5.5.1. Sources of Water Pollution

The main water quality threats to human health and environmental safety include sewage, nutrients, toxic metals and chemicals. The most widely spread pollutant is undoubtedly faecal matter present in domestic sewage, causing high levels of pathogens in water supplies that are not treated. High coliform counts are found in most surface waters used in the rural areas. Run-off from agricultural areas with high fertilizer and chemical contents pollute most surface and ground water sources. Metal contamination usually occurs on a local scale as a result of industrial waste in selected areas. Heavy metals originate mostly from municipal and industrial wastewater treatment plants.

Deforestation, river damming and destruction of wetlands are all taking their toll on water quality. Destruction of wetlands eliminates a vast natural filter.

Cases relating to water pollution were also investigated by the PCC which indicated wide range of sources of pollution into our water systems as indicated by Box 5.4. Plate 5.1 illustrates problems of water pollution prevalent in most urban areas in the country.

Box 5.4. Cases relating to water pollution investigated by the PCC

About 13% of complaints investigated related to pollution of the following water masses: Lake Victoria, Indian Ocean, Rivers Athi, Nairobi, Nyando, Yala, Nzoia, Burguret and, Yondoni. The nature of cases included:

a) Disposal of untreated sewage into water masses;
b) Discharge of industrial and domestic effluent into water masses;
c) Disposal of solid waste into water resources;
d) Oil spillage into water masses, e.g., oil spill in Mombasa and Lake Victoria;
e) Washing of motor vehicles next to lake shores, rivers banks and beaches;
f) Siltation caused by poor agricultural practices; and
g) Physical development on riparian areas and coastal shores.

Investigations revealed that: sewage remains the largest source of contamination of water masses (Plate 9.1). Regrettably legislation and regulations protecting water masses and catchments areas are not fully enforced by local authorities which appear to have abdicated their responsibilities by allowing the discharge of untreated waste directly and deliberately into water masses. Equally, the provisions in the Environmental Management and Coordination Act and other relevant statutes that protect the aquatic ecosystems are not being fully enforced. It is therefore recommended that NEMA in consultation with relevant lead agencies should take urgent measures to mitigate water pollution by strengthening integrated management of water resources and enforcing the relevant legal provisions.

Plate 5.1. Water pollution in urban areas



Incidence of Water Borne Diseases: Diarrhoeal diseases accounted for 4.7% of all out-patient cases reported in 1999. The diarrhoeal diseases were more prevalent in Nairobi, Rift Valley, Nyanza and Western provinces (HMIS, 1999). This could be associated with crowded slum settlements in Nairobi, inadequate safe means of disposal of feacal matter,

poor hygienic practices and lack of safe water (Table 5.8). Trends of waterborne disease outbreaks between 1998 and 2004 are outlined in Table 5.9 and Table 5.10 respectively.

Table 5.8. Reported incidences of diarrheal diseases

1996		1997		1998		1999	
Total	%	Total	%	Total	%	Total	%
701,207	4.5	719,439	5.3	631,488	4.7	643,151	4.7

Source: Ministry of Health, 1999

Table 5.9. Cholera trends, 1998-2004

Year	Cases	Deaths
1998	15364	923
1999	10964	368
2000	1509	93
2001	1001	55
2002	319	10
2003	0	0
2004	211	4

Source: Ministry of Health, 2004

Table 5.10. Water borne diseases outbreaks in 2004

Disease	Cases	Deaths	Affect Districts
Cholera	211	4	Kwale, Kilifi & Mombasa
Diarrhoea with blood	170	0	Kitui and Malindi
Typhoid	27	0	Kitui and Malindi

Source: Ministry of Health, 2004

Most communities believe that children's faecal matter is safe and not much effort is made to ensure safe disposal. According to a Kenya Demographic Health Study (KDHS) conducted in 2003, only 42% of women in Kenya were found throwing children feacal matter into a toilet or latrine; other methods included rinsing away (15%) and throwing them either outside the yard or outside their dwelling/houses. In North Eastern Province, only 13% of the women were found disposing children faecal matter into a latrine.

5.6. WATER HARVESTING

Ecosystem approaches have been promoted as a means of establishing links between environmental issues related to land management and development (UNEP Governing Council, Decision 21/1). Water has been identified as a focal area in land use management and environmental assessment. Environmental degradation of drylands aggravates poverty and forces inhabitants to emigrate in search of water and pasture.

The national supply of piped safe drinking water is very low, with 40% coverage. This makes rain water an important alternative. The country has the potential to harvest 350 billion cubic metres of rain water. However, problems of technological adaptation coupled with high levels of poverty have impeded the efforts.

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. The physico-chemical properties of rainwater are generally good. However, rainwater quality depends on the locality and surface over which it is collected and handled. Further, the quality of rainwater is determined by the type of land use activities and practices. Soil and water conservation is important in the integrated management of water resources.

About 68% of the population live in rural areas and subsist on rainfed agriculture. Most of this population group often harvest rainwater using various methods, some of them detrimental to water quality. It is therefore important to promote best practices in rainwater harvesting to ensure human and environmental health and safety.

Water availability in ASALs shows major disparities where its spatial and temporal distribution is skewed, with most areas receiving flash rains that end up unused. High population growth in high and medium potential lands has resulted in migration to marginal areas with fragile ecosystems, which are either water stressed (having less than 1700 m^3/pc/year) or suffer from water scarcity (less than 1000 m^3 p.c./year).

***Existing Water Harvesting Facilities/Technologies*:** Rainwater collection on natural land surfaces is a key land use. Such surfaces include rock surfaces, agricultural and range lands. Other surfaces include artificial surfaces, roads, residential, institutional and business premises, and other open areas specially prepared for water harvesting.

Storage is largely to meet emergency demand, mitigating water stress and as part of requirements for surface water abstraction permits. Inadequate storage has been responsible for some of the observed climate change impacts. Inadequate storage has hampered efforts to produce sufficient food, fodder, fibre and to support climate change enabling activities.

Climate variability has increased the need to increase storage capacity in order to meet dry seasons demands. Currently, there are 3,000 small pans and dams in Kenya with a total storage capacity of approximately 124 million cubic meters. Additional storage volume is via sand and sub-surface dams, ponds and others. By 2010, about 30 times the current capacity will be required, based on catchment conditions existing in 1980. As massive degradation has occurred since 1980, a lot more storage and massive development of storage infrastructure, design, construction and maintenance technology will be required. Water resources assessment records and proper planning will be paramount.

Kenya has not invested adequately in water harvesting. Maximum per capita storage of surface water has declined from 11.4 m^3 in 1969 to 4.3 m^3 in 1999. Investment of about Kshs.38 billion annually is required for the next 30 years to mitigate against decreased flows, storage and resultant impacts of climate change.

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There is low level adoption of water harvesting technologies by rural households and agricultural activities, due to inadequate awareness and low incomes. Other limitations to rainwater storage are technological, social, economic, cultural and climatic. Surface and underground storage reservoirs fed by surface runoff are some of the existing strategies in rainwater harvesting for agricultural and household use.

Table 5.11. Provincial Water Resource Issues

Water Resource Issue		Province							
		Rift Valley	**Western**	**Central**	**Nyanza**	**North Eastern**	**Eastern**	**Coast**	**Nairobi**
1.	Conflicts	Samburu, Narok Boreholes, Uasin Gishu	Vihiga, Mt. Elgon (over tariffs)	Maragua	Nyando	Ijara	Mwingi, *Kitui, Isiolo, Meru South, Machakos (human/wildlife)	Taita-Taveta (Human-Wildlife, Water use)	Dagoretti (rationing)
2.	RWH Collection & Storage	Transmara – (Pans, shallow wells), Nandi North (Pans), Butere, Silting in Nakuru	Increasing dams in Gucha, silting in Butere	Thika – RWH for irrigation, Nyeri (ferro – for storage increasing Nyandarua (200 Pans/dams) Kirinyaga (pans/dams) Kiambu (176,866 households with roof – RWH	Gucha – Kentainers for storage 20 – 24,000l Kuria – more dams & roof RWH, Migori (RWH for industry, Africulture from dams/pans), Siaya-Nyando – annual floods	Ijara – increased pans	Earth, sand & Sub-surface dams, rock catchments in Kitui, Mwingi, 40% coverage in Mbeere, 300 roof RWH in Moyale	Urban RWH, Ruai, Kasarani	8 dams in Kasarani
3.	Water Borne Diseases	In Trans Nzoia, Nandi North	Lugari & Trans Nzoia	Lower Maragwa			rise in Machakos	Taita-Taveta	

** Reducing human-wildlife conflicts*

Agriculture and Livestock: Agriculture and livestock water-harvesting facilities include sand and subsurface dams, earth dams, pans, rock catchment and appropriate storage. Various types of micro and macro catchment systems are applied in agricultural and livestock water harvesting. In this regard, provisions for low season irrigation purposes in water permits should be reviewed in the event of scarcity especially water for domestic use. Water harvesting for livestock is a major priority in ASALs where harvesting facilities are located. The potential negative impacts on the environment include overgrazing at watering points.

Conflicts between agricultural and livestock water will persist unless sufficient plans are made to meet both demands adequately and mitigate any negative impacts (Table 5.11).

5.6.1. Efforts Towards Sustainable Harvesting and Utilization of Water

Target 10 of the Millenium Development Goals (MDGs) aims to halve the number of people (about 1.2 billion) without sustainable access to safe drinking water and basic sanitation by 2015. In Kenya, this converts to 650,000 people per year over 10 years to make per capita supply about 1300 m^3/year.

Promotion of rainwater harvesting could be achieved by upgrading existing RWH activities, promoting crop varieties that are efficient in water use, enhancing waste water management, practicing safe pesticides use and promoting agroforestry. Reviving traditional RWH practices has played a major role in conflict resolution and has been a key strategy in stimulating local economies. Respect for social value of rainwater has been known to contribute to prevention of conflicts.

5.7. DROUGHT AND FLOODS

5.7.1. Drought

Drought and dry spells occur when the amount of overall rainfall at any one time is below the minimum required to generate fundamental ecosystem services to support crops and livestock production and human health. The rainfall depth in drought events is generally below 300 mm (Rockstrom, 2000). Agricultural drought occurs when there is inadequate soil moisture to support crop production.

The Kenya government has put in place programmes designed to minimize risks associated with drought. This has helped to put in place instruments for early warning, contingency plans and mitigation. The drought recovery programme initiatives include Drought Management Project (DMP), Drought Preparedness, Intervention and Recovery Project (DPIRP), Emergency Drought Recovery Project (EDRB), and the Arid Lands Resource Management Project.

The areas affected by drought and dry-spells have experienced reduced water levels leading to human, livestock and wildlife populations concentration near available watering points. This causes degradation, loss of livestock and high incidences of disease outbreaks due to poor hygiene and sanitation practices as well as poor water quality and inadequate amounts.

Droughts have been recorded to occur between three to 10-year periods. Drought experienced in 2004 was due to erratic long rains (March-May 2004), which resulted in a drought emergency affecting 26 out of 71 districts in the country. This caused a severe water shortage that affected the agricultural and industrial sectors resulting in acute human and animal suffering as well as degradation of environmental resources. Some of the drought prone areas in Kenya include Turkana, Marsabit, Mandera, Wajir, Garissa, Tana River, Isiolo, Samburu, Baringo, Koibatek, Trans Mara, Narok, Kajiado, Kitui, Machakos, Makueni, Mbeere, Maragua, Nyambene and Tharaka districts.

The *La Nina* drought of 1999/2000 affected 4.7 million people. In the period 1999-2004, drought was reported in Samburu, Bomet, Narok, Keiyo, Vihiga, Maragua Kirinyaga, Suba, Bondo, Mwingi, Isiolo, Mbeere and Moyale districts. The vulnerability to droughts and dry spells in the prone areas exerts very high pressure on livelihoods and erodes the coping mechanisms of the affected communities. Impacts were aggravated by inadequate rehabilitation of water supply infrastructure damaged by *El Nino*.

Some of the major consequences of drought include acute and chronic malnutrition rates of about 35% and 45% (UNICEF, 2004). In drought prone areas, diseases are common as a result of malnutrition which increases mortality rates. Further, droughts result in loss of livelihoods, leading to over-reliance and unsustainable utilization of natural resources.

***Mitigation Measures for Droughts*:** The Government received support from UNICEF, which conducted nutrition surveys in February 2004. The results were used to support decisions by the Kenya Food Security Group and Office of the President in food aid and non-food interventions. In June 2004, UNICEF also participated in a multi-sectoral assessments undertaken by the Kenya Food Security Group. UNICEF has continued assistance programmes in nutrition, health, water/sanitation, education and HIV/AIDS in the North-Eastern Province, Turkana and Marsabit (Table 5.12).

Table 5.12. Costs implications related to drought

Sectors	Amount required (Us$)
Health and Nutrition	3,393,600
Water and Sanitation	3,528,000
Education & Child Protection	1,713,600
Total	**8,635,200**

UNICEF has been providing supplementary food for 5,000 young children in Turkana. In addition, emergency health kits and critical immunization equipment have been sent to the drought-affected areas.

Other mitigation measures included improving reliable access to safe water, hygiene and sanitation facilities for the drought-affected communities, especially schools. In addition, partnership mapping to assist in optimal use of resources has been undertaken since the last drought of 1999-2002. Early Warning Systems have been strengthened through the Arid Lands Resource Management Project to enhance an effective drought monitoring system. The project publishes early warning system bulletins, which provide information on drought situation.

Participatory community initiatives have also been adopted in drought management. The Arid and Semi Arid Land Management Project has helped develop a number of drought mitigation interventions through a participatory approach in 11 districts. The strategic drought management and contingency plans have been elaborated by the District Steering Groups including all stakeholders. Communities have, through a Participatory Rural Appraisal, set their drought mitigation and developmental priorities.

Access to water in the drought affected areas has been addressed through contigency funds, established in 2001/02 financial year. The initiatives aimed at facilitating conflict resolution, creating shelter facilities for internally displaced persons, supporting water tankering to remote communities and providing fast-moving spares as well as emergency repairs of boreholes.

About 24 selected pasture areas were equipped with temporary water supplies replenished by tankering as grazing reserves. Other investments financed boreholes, water pans and shallow wells which improved access by an estimated 40% or 800,000 of the arid lands population and an equivalent or higher percentage of livestock population. These initiatives have improved both livestock and human well-being and health.

5.7.2. Floods

Kenya is highly vulnerable to major natural hazards such as floods, which have caused considerable loss of human, livestock and wildlife, as well as damage to infrastructure and social services. Past occurrence of floods has had both positive and negative impacts to life, environment and economy.

The negative impacts included destruction of property and infrastructure, increased soil erosion in areas with poor land use and management practices, and increased frequency of mud and landslides, especially in the hilly areas of Muranga, Embu and Meru. Other negative impacts were surface and ground water pollution, destruction of small storage earth dams, and increased siltation of aquatic bodies. However, floods have had positive effects, such as dilution of pollutants, enhanced soil moisture for crop farming and improved hydro-power generation.

Agriculture and Livestock Sectors: Heavy rainfall resulted in high incidences of disease outbreaks for livestock and crops in most parts of the country. The flooding also affected farms through water logging leading to further reduction in yields, and destruction of livestock watering facilities. Several cases of deaths of animals through drowning were also reported, especially in low lying districts of Kisumu, Budalangi, Nzoia and Nyando basins. The combined loss was estimated at Kshs 17.9 billion. In ASALs, the rains depicted a different scenario with a remarkable improvement in crop and livestock production.

Infrastructure: Transport and communication sectors suffered the consequences of the 1997-98 *El Niño* and 2002 rains. Several roads and bridges were destroyed, comprising about 100,000 km of both rural and urban roads. This seriously affected transport network in most parts of the country. The damage was estimated at Kshs.50.9 billion.

Overhead and underground power cables were destroyed by falling trees/posts and collapsing buildings, causing a disruption in services including electric energy supply. However, recharging of the hydroelectric dams by the rains enhanced hydro-electric power generation.

Mitigation: The 1997-98 *El Niño* rains showed that the country was not adequately prepared and had no facilities in place to deal with adverse impacts of floods. The government lacked a flood disaster management policy and an institutional framework to monitor and manage flood disasters. 'Public awareness creation programmes were initiated and the floods were declared a national disaster. The government mobilized resources for relief food, water treatment chemicals, alternate power generation and medical supplies to the worst-affected communities. Donor support was also mobilized to assist in rehabilitation and emergency operations. NEMA is working closely with all relevant institutions to mitigate environmental disasters.

5.8. OUTLOOK

There is need for a policy on national disasters and floods with strong and well coordinated early warning and management mechanisms between the lead agencies such as the Kenya Meteorological Department (KMD), Central Bureau of Statistics (CBS), Department of Resource Surveys and Remote Sensing (DRSRS), and the Arid Lands Resource Management Project in the Office of the President.

There is also need to develop a cost-effective drought and flood management system to manage risks and improve the livelihoods of persons living in drought-prone areas. The key features are a decentralized planning, decision-making, financing and implementation system at the district level, supported by a responsive and well-coordinated national body.

Capacity building is critical to drought and flood management. This should be done while considering the participation of local communities to cultivate a sense of ownership and accountability. The grassroots level multi-sector institutions should also be strengthened in order to improve the effectiveness of project interventions. This would significantly help in the implementation of devolved procedures and prepare the ground for more accountability and the empowerment of benefiting communities, allowing the larger issues like conflict resolution to be addressed. In addition, the government should promote public education through pro-active awareness campaigns on causes and consequences of drought and flood events. Women and the youth should be particularly targeted, as they are the most vulnerable groups in the society.

The forecast should, if possible, be for periods longer than three months, so that effective control measures can be put in place. It is also necessary to design and sustain strategic food security reserves for emergency use during such disasters.

There is need for appropriate policies, plans and strategies to support flood prevention through integrated watershed development programmes in all prone areas. In urban areas, water drainage systems should be maintained and serviced regularly to avoid blockage and subsequent flooding. Similarly, there is need to install and strengthen flood control measures such as dykes and dams to provide a permanent solution to flooding occurrences.

Additionally, the following measures are recommended for action.

- Implement reforms as per the Water Act of 2002;
- Enhance environmental sanitation and hygiene standards;
- Promote rainwater harvesting strategies and best practices at the household level;
- Develop rainwater harvesting promotion centers for awareness and demonstration training;
- Enforce relevant land resource laws/regulations including Environmental Impact Assessment and Environmental Audits;
- Promote research to generate relevant information to support decision-making;
- Invoke conservation orders where necessary as stipulated in EMCA, 1999;
- Conserve wetlands from overuse and conversion to other uses through participatory approaches and appropriate management plans in accordance with precautionary principles; and
- Increase investments in physical and other appropriate infrastructure, especially in ASALs.

CHAPTER SIX

LAND-USE AND ENERGY RESOURCES

6.1. INTRODUCTION

The overall national development objectives include accelerated economic growth, improved productivity in all sectors, equitable distribution of income, reduction of poverty, enhanced agricultural and industrial production, increased employment opportunities and improved rural-urban balance. The extent to which these objectives can be realized on a sustainable basis and in an environmentally sound manner is dependent on the degree and economic efficiency with which critical factors of production are made available. The realization of these objectives is only feasible if quality energy services are available in a sustainable, cost effective and affordable manner to all sectors.

Energy is a driver to economic development of any country. Its five major categories of energy sources have been identified in Kenya, namely biomass, fossil fuels, electricity, solar and wind, all of which are at different levels of exploitation.

The status of these energy sources, their utilization impacts on natural environment. The impacts of changing land uses on energy are analyzed together with consumption patterns, demand, supply the unexploited energy potential. Threats and issues of energy-based pollution are analysed taking cognizance of impacts of energy and land use. The requirements of environmental impact assessment and audit in energy related activities and programmes have been highlighted.

An outlook at the end of the chapter presents recommendations, appropriate policy responses and regulatory measures necessary to enhance opportunities in the energy sector. This will form the basis for collaboration between the NEMA and the relevant stakeholders in the further development of the energy sector especially in regard to monitoring compliance to provisions of EMCA as the country continues to develop.

6.2. TYPES AND SOURCES OF ENERGY

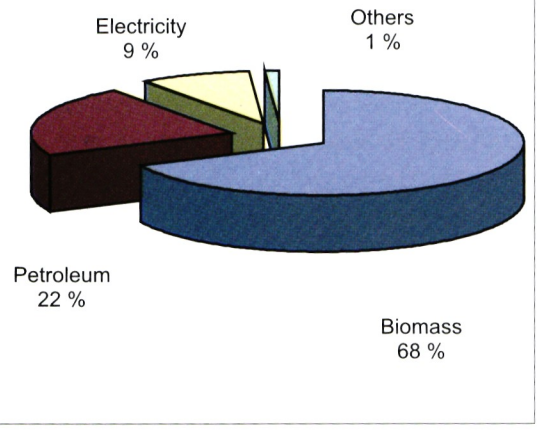
There are five broad energy sources, namely biomass, fossil fuels, electricity, solar and wind (Table 6.1). Biomass contributes 68% of all energy needs, petroleum (22%) and electricity (9%) (Figure 6.1).

Apart from fossil fuels, which are imported, the rest are produced locally, each with varying impact intensity on land-use. Most energy resources, though locally available, require external technologies in terms of hardware for their production and conversion. Acquisition of such technologies impose heavy demands on the meagre foreign exchange.

Biomass energy is the principal source of energy for most Kenyans, particularly those living in the rural areas. Petroleum fuels, on the other hand, dominate the modern economic energy supply.

Electricity has the advantage of being extremely versatile, but its distribution nationally is quite low at 15%.

Figure 6.1: National energy supply by source



Source: Ministry of Energy 2004

Biomass Energy: Biomass energy is the largest form of primary energy accounting for 68% of the total national energy consumption. It represents various wood-based fuels, which include fuel wood, charcoal, biogas and biomass wastes. Fuel wood and charcoal are collectively referred to as wood fuel; they are the largest and most common form of biomass energy consumed in Kenya. A comprehensive biomass study undertaken in 2000 revealed that the principal sources of fuel wood were agro-forestry (84%), biomass in trust lands (8%) and gazetted forests (8%).

Fossil Fuels: All fossil fuels are imported either as crude oil or refined petroleum products. The refining of crude oil is done at the Kipevu Oil Refineries in Mombasa, where a range of products is obtained. The petroleum products are subsequently transported to various retail outlets countrywide via road tankers or oil pipeline.

Electricity: The major sources of electricity in the country are hydropower; thermal power and geothermal. The minor sources are biomass-based co-generation, solar photovoltaic, wind and mini/micro hydropower.

Non-conventional Energy Sources: Non-conventional energy sources include animal draught power, dry cell batteries and candles. Animal draught power is extensively used in agriculture in carrying luggage and drawing water in both rural and urban areas. Dry cell batteries are commonly used for flash lighting and for powering domestic entertainment appliances such as radio and TV as well as to run other appliances like clocks.

6.3. STATUS OF THE ENERGY RESOURCES

Sessional Paper No. 4 of 2004 on Energy sets out the national policies and strategies for the energy sector. The broad objective of the energy policy is 'to ensure adequate, quality, cost effective and affordable supply of energy to meet development needs, while protecting and conserving the environment'.

6.3.1. Biomass Energy

Biomass energy resources are derived from forests formations such as closed forests, woodlands, bush lands, grasslands, farmlands and plantations as well as from agricultural and industrial residues.

Currently, there exists a growing imbalance between supply and demand of biomass energy (Table 6.1). In 2000, the biomass demand stood at 34.3 million tonnes as compared to an estimated sustainable supply of 15 million, thereby indicating a deficit of over 56%, while the current deficit is estimated at 60%. The principal drivers of biomass energy demand are population growth, lack of access to energy substitutes and the growing incidence of poverty among Kenyans. Biomass energy supply and demand imbalance is exerting considerable pressure on the remaining forest and vegetation stocks, thereby accelerating the processes of land degradation and desertification. In addition, the production of biomass energy poses a threat to competing land use systems such as agriculture, forestry and human settlements.

Among the components of the biomass energy, charcoal is an important fuel, particularly for urban dwellers. Since charcoal production depends on woody biomass, its rising demand is associated with the increasing levels of deforestation. In areas adjacent to major urban centres, charcoal trade is active (Plate 6.1). Effective regulation of the charcoal industry remains one of the key challenges facing the government.



Plate 6.1a. Retailing of charcoal in urban centres



Plate 6.1b. Wholesale of charcoal is common along major highways

Table 6 1 Energy Supply and Demand Status

		Status					Indicators					
		Supply					Demand					Land-use
	Energy Type	2000	2001	2002	2003	2004	2000	2001	2002	2003	2004	Intensity
1	**Biomass**	15024510	15117662	15211392	15305702	15400598	34280490	35212919	36170711	37154554	38165158	
	Fuelwood (Tonnes)						14890858	15095502	15350988	15595254	15833909	
	Charcoal (Tonnes wood for char)						16506498	16940347	17422584	17917274	18418090	
	Biogas (No of Plants)	1100	1173	1246	1319	1392						
	Biomass wastes (Tonnes)						2883134	2694833	3397139	3642026	3913159	
2	**Fossil fuels**											
	Crude oil (000 Tonnes)	2452	1966	1493	1383							
	Petrol (000 Tonnes)	875	1208	1024	1820		366	374	366	327		
	Diesel (000 Tonnes)						741	691	655	666		
	Kerosene (000 Tonnes)						384	306	274	195		
	Jet fuel (000 Tonnes)						432	420	472	489		
	LPG (000 Tonnes)						33	36	41	41		
	Fuel oil (000 Tonnes)						490	558	499	412		
	Coal (000 Toe)	66	66	98	92	95	66	66	98	92	95	
3	**Electricity**											
	Hydro (GWh)	1793	2031	3071	3233							75km2/GWh
	Mini /micro hydro											
	Thermal (GWh)	2017	1965	1167	931							
	Geothermal (GWh)	367	456	447	498							
	Co-generation (GWh)		531									
4	**Solar**											
	Solar PV (No of Units)	150000	170000	190000	210000	220000						
	Solar thermal (No of Units)	50000	55000	60000	65000	70000						
5	**Wind**											
	Wind electrical (GWh)	0 2	0 2	0 4	0 4	0 4						12km2/GWh
	Wind mechanical											
6	**Others**											
	Animal power											
	Dry -cell batteries											
	Candles											

6.3.2. Petroleum

The petroleum industry is constrained by limited supply facilities for fuels including Liquefied Petroleum Gas (LPG), inadequate distribution infrastructure in the remote parts of the country, price and inadequate enforcement of legal and regulatory provisions. This exposes the public to health, environmental and safety hazards. In addition, the sub-sector has experienced proliferation of substandard fuel dispensing facilities and services, including the mixing of motor fuels with kerosene and dumping of export fuels for illicit financial gains at the expense of both the consumer and government revenue.

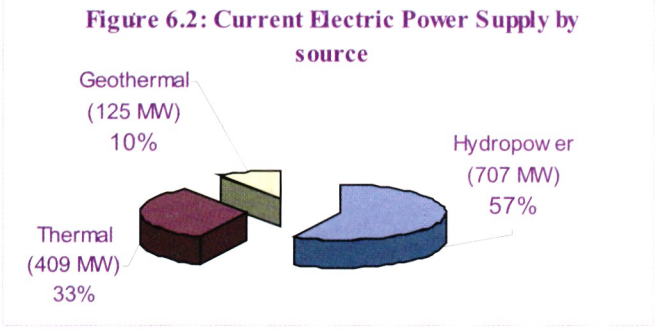
6.3.3. Electricity

Electricity is crucial to Kenya's economy given its versatility in application. However, its consumption is extremely low at 121 kWh/capita, while national access rate at about 15% is below the average 32 % for developing economies. Table 6.1 shows the energy supply and demand between 2000 and 2004.

The generation system has an installed capacity of 1,239 MW, comprising 677 MW of domestic hydropower (55%), with 30 MW (2%) being imported from Uganda, 125 MW Geothermal (10%), and 407 MW oil-fired thermal (33%) (Figure 6.2). The corresponding effective capacity is 1111.2 MW under normal hydrology against a peak demand of 821 MW. However, under severe drought such as was experienced in 2000, the effective capacity of the hydropower plants would be reduced from 639 MW to 501 MW.

The construction and operation of electric power projects has direct impacts on the quality of the environment either by the emission of pollutants or by changing the ecological systems. Such impacts are dependent upon the nature of the technology in use as well as the size and the general location of the plant. Environmental health and safety regulations require that mitigating measures be put in place to minimize adverse impacts of such projects. As such, comprehensive EIA studies are required for all projects prior to their licensing to ascertain the level of potential environmental damage, the required mitigation measures as well as the associated costs.

Figure 6.2: Current Electric Power Supply by source



6.3.4. Renewable Energy Sources

Kenya is endowed with significant amounts of other renewable energy sources, which include solar, wind and small hydropower plants, power alcohol, biogas and municipal waste energy. However, only solar, wind and small hydropower plants are currently being harnessed.

Solar Energy: Solar energy is used for heating and drying, while solar photovoltaic (PV) for lighting, water pumping, refrigeration and telecommunications. Solar PV is widely used for provision of electricity in off-grid rural and urban slum areas. It is estimated that upto 220,000 solar PV units are currently in use in Kenya. About 7,000 solar thermal units are in use for drying and water heating.

Wind Energy: Wind energy has been used in Kenya primarily for water lifting since the beginning of the 19th Century, but its use declined with the advent of oil fired internal combustion engines, which are flexible and more convenient to use. However, with the rising cost of oil, the exploitation of wind energy is becoming increasingly more attractive particularly in areas remote from the grid and oil supply outlets.

To promote investment in wind energy generation, the Ministry of Energy has completed preparation of a National Wind Resource Atlas. As revealed by the atlas study, wind energy potential for power generation shows varying temporal and spatial distribution. Generally, most areas in the country are endowed with less than 300 Watts m^2 (Figure 6.3). To ensure security of supply, the government is promoting the development of wind-diesel hybrid systems for electricity generation in areas remote from the national grid. A total of 550 kilowatts have been installed, generating about 0.4 gigawatt-hours of electrical power.

Biogas: Biogas technology has been actively promoted in the country since early 1980s. About 1,392 biogas plants have been installed, each producing about 1.2 m^3 of biogas per day. Faster adoption of the technology is hampered by the high capital costs of construction and low level of awareness.

Co-generation Using Bagasse: Co-generation using bagasse as a primary fuel is common practice in the domestic sugar industry. The industry comprising seven sugar companies produces a combined average of 1.8 million tonnes of bagasse with fibre contents of about 18% by weight annually. Out of this quantity, about 56% is used in co-generation using an installed capacity of 25 MW and the balance disposed at cost. Mumias is the only sugar company among the seven factories that is self-sufficient in electricity production from its bagasse and has the capacity to sell the surplus 2 MW to the national grid.

Animal Power: Animal draught power is a major source of energy in the agricultural sector for tillage as well as for transportation. This entails use of oxen, donkeys and camels, among others for ploughing and/or hauling of luggage. This energy source has neither been quantified nor well planned.

6.4. IMPACTS OF ENERGY RESOURCES ON LAND USE

Kenya relies on three major types of energy, namely wood energy, petroleum and electricity. Apart from petroleum, the rest are sourced locally. Some of the energy problems currently experienced include high and rising import bills, adverse environmental impacts of current patterns of energy use and inadequate energy resources available to the majority of the poor especially in rural areas. Kenya has been spending over 60% of total foreign exchange earnings on petroleum imports and the erratic price increases has reduced access to energy resources.

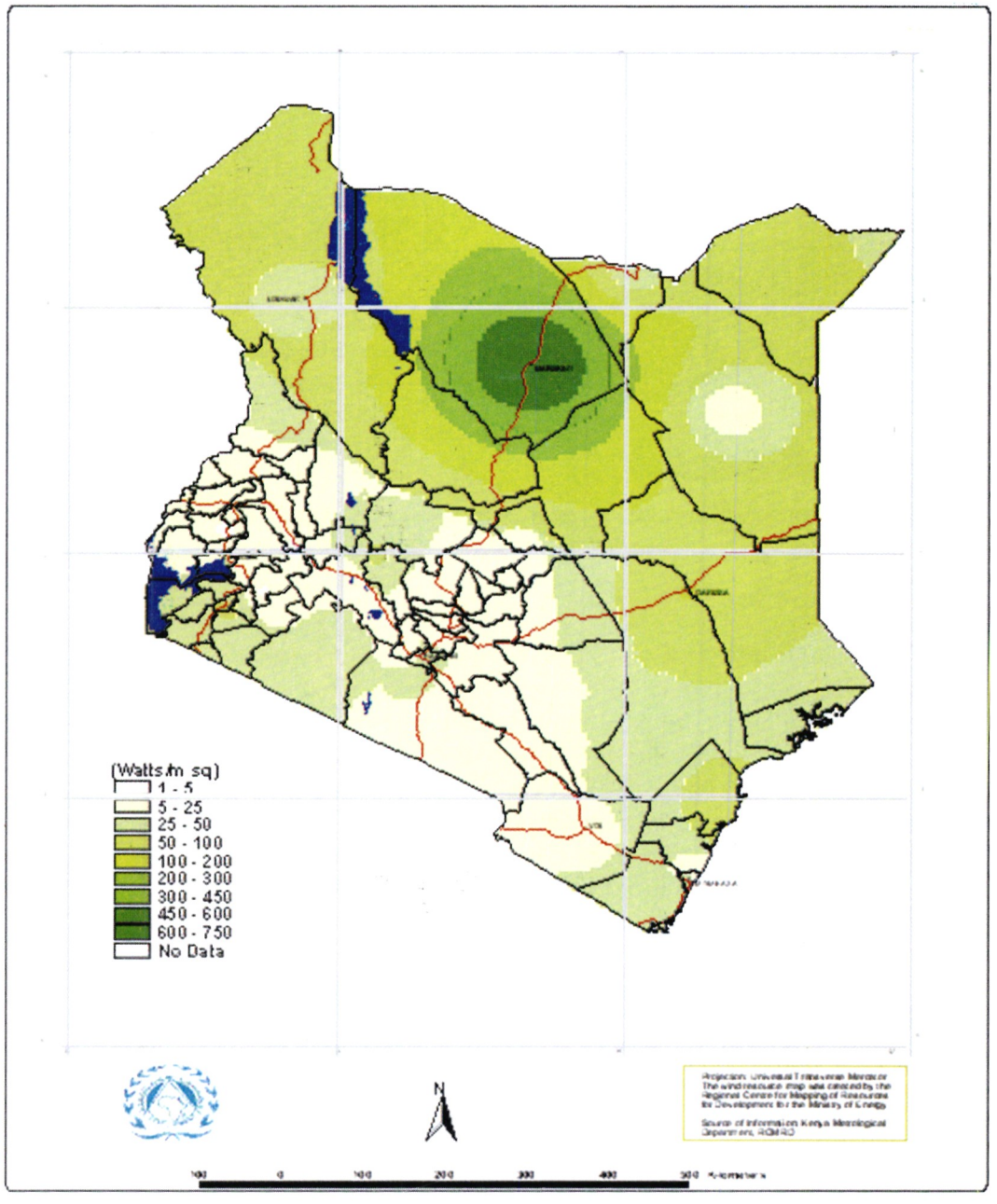


Figure 6.3. Potential extractable wind power

Table 6.2. Comparison of energy consumption by type in selected districts

	Type of Energy						
District and Consumption Estimates Provided	**Wood-fuel and Charcoal (%)**	**Hydro-electricity Geothermal (%)**	**Solar (%)**	**Biogas (%)**	**Kerosene (%)**	**Wind (%)**	**Others (%)**
Narok	99	10	2	1	70	2	
Nyandarua	99	10,000 houses	1.5				
Mbeere	80						
Kisumu	75	2	1	1	5		
Thika	80	57	5		19.5		
Kuria	95						5
Kakamega	96	49.6			92		21
Ijara					99.5		
Samburu	85.9	2	2	2	2.3		
Bureti	91.2	1.5	0.7		97.4		
Taita Taveta	90	10					
Keiyo	30117 houses	1182 houses					
Transmara	90	2					
Kericho	71	3					
Wajir	85						
Meru North	100	0.4		1			
Maragua	80	0.4		16			
Garissa	93			1.4	3		
Trans Nzoia	90						

Source: District SoE Reports 2004

Wood energy supplies about 68% of the total national primary energy demand and 95% in the rural areas (firewood and charcoal). Energy requirements impact profoundly on other competing land uses such as agriculture, forestry, human settlements and infrastructure. Hydropower as the major source of electric power exerts considerable pressure on water resources for other uses, displaces human population as well as taking up land from other uses. Geothermal energy is an important source of energy nationally. Its source is predominantly within pastoral lands. It is therefore important to undertake comprehensive impact analysis in order to ensure balanced resource development and thereby address any potential conflicts.

Kenya has no known commercial reserves of petroleum, coal and natural gas although exploration is in progress. In the oil exploration, the zoning of land into designated blocks for detailed exploration creates an immediate land use change at the local level. In the event of future exploitation of identified fossil resources, such activities would inescapably create a sudden appreciation of land value and the investor must be ready to adequately compensate the owners to facilitate their relocation.

The renewable energy sub-sector, including such energy resources as solar and wind, among others has remained largely under-exploited. However, there is growing national interest to step up efforts to mainstream the development of these sources into national energy development programmes.

6.4.1. Impacts of Energy Resources on Land Use

Energy exploitation contributes to deforestation and land degradation. Kenya is facing two major challenges in the context of energy-land use nexus. These have to do with how to balance the land use requirements for urbanization, human settlement and agriculture on one hand, and energy production and supply on the other. The environmental consequences of

deforestation and land degradation are severe as they lead to ecological instability, loss of agricultural production, desertification, climate change and loss of biodiversity. For this reason, there is evidence that should the current energy consumption patterns continue, the quest for sustainable energy development will remain an illusion.

The government has instituted measures, which are meant to forestall or minimize the environmental effects of energy production and use. For instance, the National Development Plans have consistently highlighted the need to ensure a balance between energy development and environmental protection. The current energy policy (Sessional Paper No. 4 of 2004) emphasizes the need for integrated energy planning to ensure that all other significant sectoral concerns are addressed.

6.4.2. Impacts of Biomass Energy on Land Use

The current demand for biomass energy far outstrips the sustainable supply by almost 60% (Table 6.1). Inevitably, the continued high dependence on biomass resource to provide energy to majority of Kenyans means its demand will undoubtedly continue to rise leading to the felling of more trees for fuelwood and for charcoal production. This in turn exerts pressure on biomass resources as well as on arable land in an already deteriorating environment, thus jeopardizing economic growth prospects especially for the most vulnerable groups of the population, namely women and children.

At the same time, the rapid urbanization phenomenon compounds the biomass supply problem, particularly charcoal to meet the soaring demand against a background of declining biomass cover. The issue of charcoal is a pertinent concern in the energy-land use nexus context. Incidentally, most charcoal is produced from shrub-lands, rangelands and wooded savannah areas. While the impact of charcoal production on forests and woodlands is certainly negative, there is a fundamental difficulty to quantify it owing to its apparent low national priority rating.

Most charcoal production involves clear-cutting, while other production involves selective harvesting. In other cases, some tree removals are purely for commercial charcoal production, while in others the trees are cleared to create additional agricultural or pastoral land, with charcoal simply being a by-product of the land clearance. Commercial charcoal production in some areas has led to deforestation of large tracts of wooded savannah (Ecoforum, 2002). An alternative source of charcoal increasingly gaining recognition is from agricultural wastes such as coffee husks. These sources should be promoted as means of saving further destruction of woodlands and forests.

6.4.3. Impacts of Petroleum Consumption on Land Use

Petroleum products are transported to distribution outlets via road tankers and oil pipeline. These transportation infrastructure inadvertedly require land to be set aside as wayleaves and road reserves. In addition, the pipeline pumping stations and depots, as well as petroleum retail outlets, all take up considerable land space. On aggregate basis, this leads to significant land use competition. Additionally, land under these facilities is often polluted and degraded.

As long as petroleum-based fuels, such as kerosene and LPG remain inaccessible by the largest segment of Kenyan population, the demand for biomass energy will continue to grow.

6.4.4. Implications of Electricity Demand and Supply on Land Use

Although hydropower is regarded as being environmentally benign, the hydroelectric generation infrastructure requires a dam and a reservoir. The construction of these structures destroys the natural ecosystem and displaces human populations taking up sizeable chunks of productive land. For example, the construction of Masinga Dam reservoir displaced over 1,000 families (ELC, 1985), while the construction of Kamburu, Kindaruma and Masinga hydro dams flooded an area of 15, 10 and 120 km^2, respectively (ELC, 1985). In addition, about 5 km strip of land on both sides of the river is set-aside for immediate catchment protection and access to the facilities.

Elsewhere, Kiambere dam inundates an area of 25 km^2 and a further 100 km^2 is set aside as a buffer zone for its protection (Kenya/Canada Energy Advisory Project, 1992). During the construction of Kiambere Dam, more than 5,000 families were displaced. Nonetheless, after construction of hydropower water reservoirs, new opportunities for fisheries were created. However, socio-cultural impacts have been experienced in the affected areas. For instance, the emergence of 'Kisumu Ndogo' fishermen's villages in the vicinity of the Masinga hydropower facilities, apart from increased fish availability, created socio-cultural change.

***Impacts of Geothermal Resource Development on Land Use*:** Kenya's geothermal resource is located within the Rift Valley. Some of the fields with geothermal prospects are in densely populated areas, while others are within national parks. Olkaria Geothermal field is located at the Hell's Gate National Park adjacent to Lake Naivasha and the large flower farms. The geothermal power plants have not altered significantly the ecology of the surrounding National Park. (Plate 6.2 and 6.3).

Plate 6.2. The Olkaria I Geothermal Power Plant



Source: Ministry of Energy, 2004

Generally, an average geothermal power plant is estimated to use between one to eight (1-8) acres of land per megawatt, compared to 5-10, and 19 acres per megawatt for nuclear and coal power plants respectively (Amber Hallet, 2003). On the other hand, large hydropower requires over 275 acres of land per megawatt for an adequate size reservoir (Pimentel et al, 1989). However, the effect of geothermal resource development on land depends on a number of interacting factors, namely characteristics of reservoir, type of extracted fluid, type of application, size of the plant and terrain.

In addition, ancillary supportive infrastructure for geothermal resource exploitation such as access roads and power transmission lines imposes additional impact on the terrestrial environment.

The overall power transmission system is currently made up of 1,181 kilometres of 220kV lines, 2,035 kilometres of 132kV lines, 580 kilometres of 66kV lines, 5,430 kilometres of 33kV lines and 13,879 kilometres of 11kV lines, all used for both power transmission and distribution. The corresponding distribution transformer capacity in service is 6,267 MVA broken down into 3,721 substations and 2,546 transformers. The foregoing transmission and distribution infrastructure takes up significant land area taking into consideration the power line way leaves and the area occupied by the substations.

Plate 6.3. The Panoramic view of Olkaria II Power Plant, Africa's largest Geothermal Power Plant 70 MW



Source: Ministry of Energy 2004

6.4.5. Impacts of Other Renewable Energy Sources on Land Use

Other renewable sources of energy such as solar and wind are largely under-exploited, hence their impacts on land may be negligible. However, as these resources continue to be exploited their impacts on land use will become increasingly significant.

6.5. ENERGY CONSUMPTION PATTERNS, DEMAND AND SUPPLY

The energy supply and demand patterns are clearly indicated in Table 6.1. As the population increases, the demand for both traditional and modern energy is expected to rise exponentially, taking into account the changing lifestyles. Table 6.2 details how various energy types were used in the year 2004. Depending on the relative abundance of supply and ease of access to various energy types, three levels of consumption are observed, particularly for biomass energy. These are abundance situation and consumption bordering on extravagance, consumption level which approximates true demand and acute scarcity where consumption is below the level for maintaining a reasonable standard of living.

Table 6.3. Sources and end-uses of household energy in Kenya in 2000

Overall use	Lighting	Cooking	Space Heating	Water Heating	Entertain-ment (TV, Radio)	Ironing	Home Business	Other
Electricity (15%)	99%	24%	8.5%	26%	90%	69%	16%	REF - 35%
Firewood (67%)	4 4%	99%	33%	66%	-	-	2 8%	-
Wood Wastes (2.5%)	8%	96%		60%			6%	
Charcoal (47%)		95%	43%	62%		57%	5.1%	
Kerosene (93%)	82%	88%		39%			2.2%	
LPG (7.8%)	1.7%	99%		18%			1%	
Farm Residue (21%)	3.3%	97%	20%	46%		5.5%	1.2%	
Solar (1.2%)	100%				18%			
Vehicle Batteries (8.5%)	6.5%				TV -- 48% Radio – 88%			
Candles (11%)	95%-							RL*-- 8.4%
Dry Cells (73%)	80% (FL)*				67%			Cl*-20%

Key: REF Refrigeration, FL Flash light, Rl Religion, Cl Clock

Source: Kamfor Report, (2002)

The following sub-sections provide details of consumption and supply with specific reference the to the 2000 comprehensive study and analysis of demand and supply.

Firewood: In 2000, the average annual firewood consumption in both rural and urban areas was 3,394 and 2,701 kg per household respectively. The corresponding per capita consumption was 741 and 691 kg respectively. At the agro-ecological zone level, consumption of firewood was observed to be higher in the medium potential zones compared to the high and low potential zones. The respective consumption of firewood in 2000 was 3,099, 3,721 and 3,394 kg per household per year for high, medium and low potential zones respectively.

Charcoal: On average, the urban charcoal consumption in 2000 was 156 and 152 kg per capita for rural and urban dwellers respectively (Kamfor, 2002: 12). The study revealed that contrary to the popular view that charcoal is a fuel for the low income urban dwellers, 83% of high income groups regularly used charcoal, meaning that charcoal is consumed by all categories of urban dwellers. It is important to note that the Kenya ceramic stove which was introduced in the 1980s had an acceptance level of 47% by 2000.

There is a biomass supply deficit in all the provinces as evidenced by the widespread depletion of existing biomass stocks. As such there is need to put in place an appropriate strategy for sustainable conservation and utilization of wood biomass.

Farm Residue: Nationally, 21 % of households were observed to use farm residue in 2000 (Kamfor, 2002). Common farm residues used for energy are maize cobs (15 %), maize stalks (9 %), tea prunings (3 %), and sorghum stalks (1%). The respective urban and rural per capita consumption of farm residues was 351 and 435 kg (Table 6.3)

Wood Waste: This energy source includes timber off-cuts and rejects, wood shavings and saw dust from wood used in construction and other industrial purposes. The per capita consumption of wood waste in 2000 was 304kg and 310 kg for rural and urban households respectively (Table 6.3).

Kerosene: Kerosene is a widely used fuel with a national average of 93% of the population. About 82% of kerosene is used for lighting. It is also used for domestic cooking, particularly by the low income urban dwellers. The rural consumption of kerosene for lighting is evenly distributed at 94%, 94% and 95% for the high, medium and low agro ecological zones respectively. However, the urban consumption varies with income at 97% and 90% for low and medium income groups and 34% for the highest income groups. The lower use of kerosene by the higher income groups is a reflection of access to electricity (Table 6.2).

Liquid Petroleum Gas (LPG): About 7.8% of the households nationally use LPG mainly for cooking (Kamfor, 2002). The consumption by the urban households was 23%, while it was 1.8% for the rural households. The percentage of rural households using LPG was 2.6%, 1.4% and 0.9% for high, medium and low agro ecological zones respectively, while in the urban areas it is 86%, 41% and 7.8% for the high, medium and low-income groups respectively. Overall, the per capita consumption of LPG in rural areas is 3.7 kg while in the urban it is 9.9 kg (Table 6.3).

Electricity: Currently, only 15% of all Kenyan households have access to electricity. Of the people living in urban areas only about 50% currently access electricity, while in the rural areas it is about 4%. At the household level, electricity is used for lighting (99%), entertainment (90%), ironing (69%), refrigeration (35%), water heating (26%), domestic cooking (24%), home businesses (16%) and house heating (9%). Most of the urban households with access to electricity are in the high and middle-income groups. Only 26% of the lowest income group has access to electricity. The national average consumption is 694 kWh and the corresponding per capita consumption of 216 kWh and 115 kWh for urban and rural households respectively (Table 6.3).

Solar: Kenya has great potential for use of solar energy throughout the year because of its strategic location near the equator. Despite this potential, the contribution of solar to national energy supply is minimal with only 1.2% of households using it for lighting, water heating and to a smaller extent, cooking. Development of solar energy has the potential for rapid growth if considered for economic incentives as the technology is reliable and provides environmentally friendly option (Table 6.3).

Batteries: Dry cells and vehicle batteries are used at the household level as a source of energy. They are used for flashlights (80%), radio/cassette players (67%) and clocks (20%). The motor vehicle batteries are used by 8.5 % of the population for radio/cassette players (88

%) and for television sets (48%). As more households in the lower income bracket acquire electronic equipment, the use of car batteries is correspondingly growing. Its use is slightly higher in the urban households where they are used by medium to low income groups.

Table 6.4. Biomass balances situations by provinces-tonnes/year (Year 2000)

Province	Demand (Consumption)	Woody biomass supply	Crop residue Supply	Wood Wastes Supply	Total biomass Supply	Biomass Deficit	% Deficit
Nairobi	2,315,352	5,234	5,172	43	10,449	-2,304,903	-99.55
Coast	3,007,811	1,424,563	41,931	950	1,467,444	-1,540,367	-51.21
North Eastern	1,193,379	938,673	1,312	-	939,985	-253,394	-21.23
Eastern	5,758,959	3,223,793	286,459	1,520	3,511,772	-2,247,187	-39.02
Central	4,628,861	1,036,500	289,362	2,845	1,328,707	-3,300,154	-71.30
Rift Valley	8,649,465	4,440,500	767,612	9,961	5,218,074	-3,431,392	-39.67
Nyanza	5,394,571	1,098,395	408,394	120	1,506,910	-3,887,661	-72.07
Western	4,171,217	696,791	344,218	162	1,041,171	-3,130,047	-75.04
Total	35,119,616	12,864,450	2,144,460	15,600	15,024,510	-20,095,106	-57.22

Source: Kamfor report, 2002

6.6. UNEXPLOITED AND POTENTIAL ENERGY SOURCES

The current known and unexploited potential for various domestic energy resources is summarized in table 6.4. While the large hydro potential of over 30 MW is diminishing, there is great potential in geothermal resource, where about 1,875 MW of the current known potential is yet to be exploited. Incidentally, the exploitable potential for geothermal resource could be higher than currently estimated if more efficient geothermal harnessing technologies are used.

Elsewhere, combined heat and power (co-generation) technology has a significant potential for power generation within the Kenyan sugar belt. Currently, all the factories are producing some amount of power through co-generation.

Both solar and wind resource potential are under-exploited. There is a renewed commitment by government to accelerate the exploitation of these resources. The wind power potential is found in a few isolated places countrywide. Hybrid power supply systems combining wind, solar and diesel appear to be a potentially more reliable option in places where considerable wind potential exists (Table 6.4).

On the basis of least-cost criteria, the current hydropower potential in various basins is considered not competitive compared to the thermal and geothermal alternatives, unless concessional funding is secured for their development.

Table 6.5. Unexploited potential of various energy resources

Energy Source	Known Potential	Exploited Potential	Current policy
Co-generation using bagasse	120 MW	25 MW	Cogeneration is flagged in the Sessional Paper No. 4 of 2004 on Energy as one energy sources to be exploited.(see sections 4.7.1, 6.14.2, and 6.14.2.1)
Hydropower	1500 MW	677 MW	Construction of Sondu Miriu (60 MW) progressing; Construction of Mutonga/Grand Falls hydro scheme planned.
Mini/Micro hydro	3000 MW	Below 1 MW	Feasibility pilot projects to be implemented
Oil	None	None	Exploration continuing
Geothermal	2000 MW	125 MW	Geothermal resource assessment to be fast tracked, successive development of assessed geothermal fields
Wind	346 W/m^2 in isolated places	550 KW (Ngong & Marsabit	Promotion of wind energy exploitation in the
Solar Solar PV Solar Thermal	4-6 kWh/m^2/day	4.3 MW	Solar-based rural electrification for selected schools in North Eastern Province on-going as part of diversification of power supply
Coal	Not quantified	None	Exploration continuing in Mui and Taru basins

Source: Ministry of Energy 2004

6.7. THREATS TO ENERGY RESOURCES

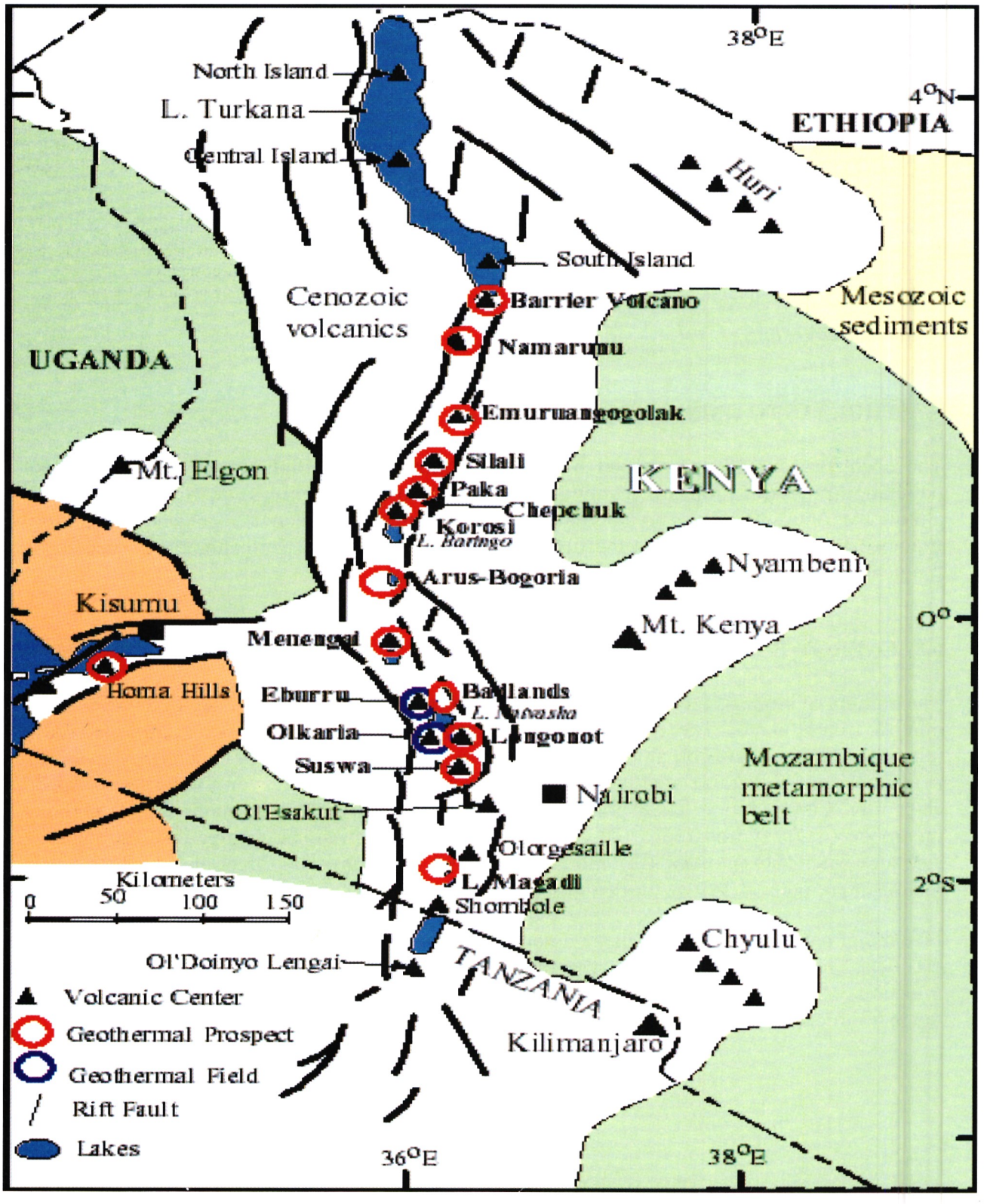
The energy resource is threatened by the interaction of a multiplicity of factors such as population pressure, rural urban migration, unstable fossil fuel prices, unaffordable cost of alternatives, lack of access to alternative energy sources, ineffective legal and regulatory framework, competing land uses, inefficient transformation and end-use technologies, increased frequency of extreme weather episodes and unemployment.

6.8. ENERGY-BASED POLLUTION AND WASTE

The burning of biomass fuels, especially in poorly ventilated kitchens yield high emissions of a number of pollutants. The emissions occur during combustion of carbonaceous materials releasing a wide range of organic materials that are of an entirely different character from those in the fuel itself. Several related studies in Kenya have so far revealed seven combustion-related categories of air pollution. These pollutants include suspended particulate matter (SPM), carbon monoxide (CO), hydrocarbons (HCs) and other organic emissions, nitrogen oxides (NOx), sulphur oxides (SOx), ozone (0_3), mercury (Hg) and lead (Pb). The foregoing constitutes the indoor air pollutants affecting particularly women and children.

Five major categories of ill health are associated with high exposure to biomass combustion products. These are chronic obstructive lung disease (COLD); heart disease, acute respiratory infections (ARI); low birth weight (LBW) due to maternal exposure together with associated range of prenatal and infant disorders, eye disorders and cancer.

Figure 6.4. Simplified geological map of western and central Kenya showing locations of oil fields and prospects.



Source: KenGen, 2002

Geothermal: While production of geothermal energy is largely considered environmentally benign, it is nevertheless associated with emissions of pollutant gases among them hydrogen sulphide (H_2S), carbon dioxide ($C0_2$) and geothermal wastewater. All these pollutants adversely affect the flora and fauna as well as posing potential pollution to groundwater resources. For instance, Olkaria geothermal field is particularly environmentally sensitive in that it is situated in the Hell's Gate National Park, and is surrounded by large flower-growing farms near Lake Naivasha. This is a fresh water body and also a Ramsar Site located about 5km from the field.

Fossil Fuels: The combustion of fossil fuels is the largest source of atmospheric pollution. This process gives rise to large quantities of sulphur and nitrogen oxides, heavy metals, hydrocarbons, particulates and carbon monoxide, which pose potential danger to health. Also, fossil fuel combustion processes are the chief sources of human-generated greenhouse gases in the form of carbon dioxide and methane. Such pollution has arisen, not only as a result of fossil fuel combustion in power plants and industry, but also from motor vehicles and households.

Transportation is a major cause of air pollution in urban areas. The major air pollution concerns are carbon monoxide (CO) emissions, photochemical smog, toxic emissions, and particulate matter.

Vehicles have a large effect on human exposure to pollutants, because their emissions are released close to the ground. For example, vehicles are the dominant source of CO emissions, contributing to high CO concentrations at street level. At moderate concentrations, CO impairs motor skills, and at higher concentrations it significantly impairs the blood's oxygen-carrying capacity with potential fatal results.

Additionally, vehicles are significant contributors to the formation of secondary (photochemical) pollutants, such as ozone, which are becoming a widespread urban problem. Photochemical smog involves the production of oxidizing agents (e.g. ozone), which, at sufficiently high concentrations, impairs breathing, causes eye irritation, and damages materials, vegetation and crops.

6.9. ENVIRONMENTAL IMPACT ASSESSMENT AND AUDIT

Part VI and the Second Schedule of EMCA state that energy development projects with potentially significant environmental impacts should be subjected to environment impact assessment (EIA) study. Similarly, Part VII of EMCA stipulates that existing energy activities should undertake annual environmental audits. Figures 6.5 and 6.6 show the percentage of projects by sectors for which Project Reports (PRs) and EIA study reports were received by NEMA for review in the year 2004.

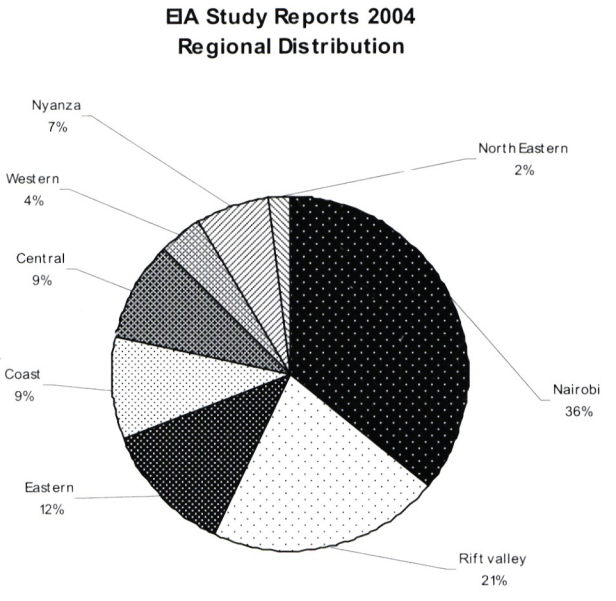


Figure 6.5. EIA Study Reports by region 2004

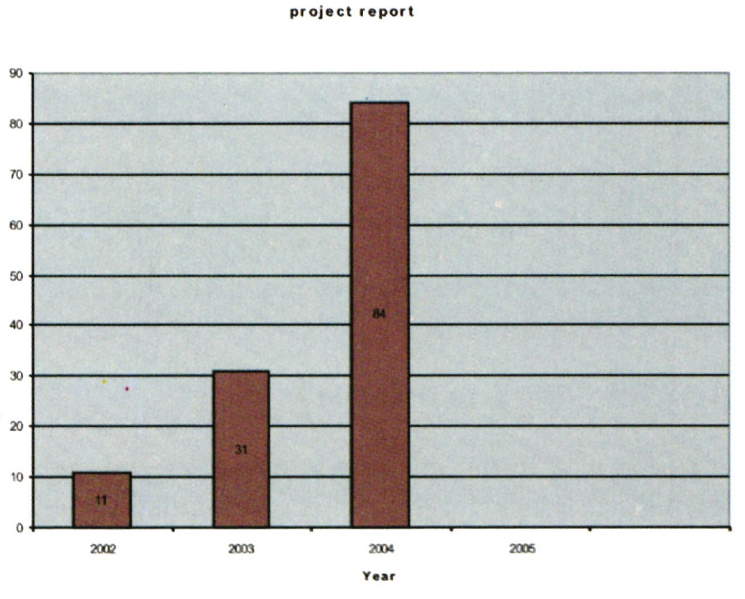


Figure 6.6. Project reports received by NEMA, between 2002 and 2004

In 2004, 54 energy projects undertook both environmental impacts assessment and environmental audit of which 16 carried out environmental impact assessment studies.

6.10. INTERNATIONAL AGREEMENTS

Energy activities impact on land and are targeted by MEAs, to which Kenya is party and strives to fulfil the relevant obligations as well as draw the benefits inherent in the same. The relevant MEAs related to energy resources are discussed below.

inherent in the same. The relevant MEAs related to energy resources are discussed below.

***United Nations Framework Convention on Climate Change*:** The combustion of energy is greatly associated with anthropogenic green-house gases emission such as nitrous oxides and nitrogen oxides. The burning of fossil and biomass fuels releases to the atmosphere the gases such as carbon dioxide, methane, nitrous oxide and nitrogen oxides. For this reason, the energy sector is one of those targeted for climate change mitigation under the United Nations Framework Convention on Climate Change (UNFCCC), which Kenya ratified in August 1994. The emerging carbon trade mechanisms pursuant to the Kyoto Protocol is expected to positively impact on the levels of greenhouse gas emissions, while contributing to sustainable development objectives.

***United Nations Convention to Combat Desertification (UNCCD)*:** Most energy related activities impact on the various ecological systems and accelerate the processes that trigger off the desertification phenomenon. UNCCD provisions should be used to address relevant mitigation actions. For example, the issue of biomass harvesting for fuel production and potential land degradation is central to UNCCD agenda.

***Millennium Development Goals*:** Whilst there is no mention of energy in each of the eight MDGs, energy services are inevitably an essential input to achieving all the goals. For example, the 9th meeting of the Commission for Sustainable Development held in April 2001, concluded that in order to implement the goal accepted by the international community to halve the proportion of people living below the poverty line by 2015, access to affordable energy services is a prerequisite.

6.11. OUTLOOK

The future thrust of the energy sector may be summarized as follows:

- Increase contribution of renewable energy in the overall national energy supply mix;
- Enact legislative and regulatory framework to guide various energy sub-sector elements such as charcoal, wood energy supply, institutional reforms;
- Enhance partnership and promote privatization of energy utilities to enhance competition and ultimately achieve efficient service delivery;
- Build a critical institutional and human capacity to effectively address current and future challenges to achieve greater efficiency in the energy sector;
- Provide incentives for individuals, businesses and industry to increase wood fuel by encouraging on-farm forestry, solar energy, adopt use of energy efficient stoves and fireplaces;
- Promote integrated energy planning to incorporate energy and land use concerns;
- Inculcate energy efficiency, conservation and environmental audits consistent with the energy policy and EMCA, 1999; and
- In order to reduce the biomass supply and demand imbalance, an ambitious two-pronged strategy is recommended the establishment of 25,000ha of fuelwood in gazetted forests areas using improved tree clones; and commercialization of fuelwood production to the tune of 500,000 ha through woodlot development in private farms at a rate of 28,000ha annually, over the next 16 years (Kamfor, 2002). The former is anticipated to result to an extra supply of over 800,000 tonnes of wood annually.

CHAPTER SEVEN

INDUSTRY, MINING, TRADE AND SERVICES

7.1. INTRODUCTION

Trade, industry, mining and services sectors have undergone steady growth over the past decade. The industrial establishments in Kenya are spread in various parts of the country and are concentrated in Nairobi, Mombasa, Kisumu, Nakuru, Eldoret, Nyeri, Thika and Athi-River. Agro-based industries are generally scattered in high potential areas.

The range of industrial activities undertaken include food processing, leather tanning, cement and building materials, textile, paints, furnishes and lacquers, wood and wood products, soaps and detergents, floriculture, tobacco and beverages, coffee processing, tea processing, pulp and paper, petroleum refining and related products, plastics and rubber, printing and packaging, metallurgical (iron, and steel, metal fabrication), pharmaceutical, mining and quarrying, and chemical industries

The recent regional and international agreements such as African Growth and Opportunity Act (AGOA), Common Market for Eastern and Southern Africa (COMESA) and the East African Community (EAC) have increased industrial and trade activities. However, liberalization has resulted in the influx of sub-standard imported products with short shelf life, leading to increased waste generation.

Despite its contribution to the economy, some activities of the sector have negative impacts on the environment such as pollution, land degradation, loss of biodiversity as well as socio-cultural erosion.

7.2. INDUSTRY AND ENVIRONMENT

Manufacturing accounts for 13% of the Gross Domestic Product (GDP). By the end of 2000, the sector had nearly 700 medium sized and large-scale enterprises and 1.3 million micro and small enterprises; and employed about 300,000 people in the formal and 3.7 million in the informal sectors respectively. This growth accounted for over 27% of the national total export earnings by 2001.

The sector registered a positive growth of 1.2% in 2002 due to several factors including reduction of import duty on most raw materials, availability of energy and water, expanded market through AGOA, COMESA and EAC trade arrangements. Despite these gains, the sector still performs at less than its optimal capacity due to high costs of energy, poor infrastructure and inability to meet increased customer needs and demands.

The cumulative and collective impact of over 1.3 million micro and small-scale enterprises (MSEAs) on the environment may even surpass that of large industrial establishments to a noticeable extent. Large industrial establishments are subjected by law to environmental impact assessments (EIAs) and annual environmental audits (EAs).

7.2.1. Agricultural Production/Agro-Based Industries

There are about seven types of agricultural industries namely coffee, sugar, slaughter houses/abattoirs, leather, pulp and paper, pyrethrum and grain milling.

The coffee industry. Coffee processing is a major industry in Kenya with about 100,000 ha under coffee of which 30,888 ha are large-scale commercial farms while the rest are under cooperatives and small holder farmers. In total, there are about 1,200 coffee factories, located near streams and rivers. Wastewater from coffee factories is normally discharged into water courses after pre-treatment, or directly through seepage pits; and in some cases, wastewater is used for irrigation. Various by-laws stipulate that all coffee factories should recycle the waste water, optimize their processes and adopt cleaner technologies and strive to ensure treatment of effluent discharge at acceptable pollution levels.

The sugar industry: Sugar industries are mostly located in the Lake Victoria Basin. The main sugar factories are Mumias, Sony, Nzoia, Chemelil, Muhoroni, Western Kenya, Miwani, Busia (proposed) and the Agrochemical Food Corporation. They are located near permanent rivers and use the water which is eventually discharged after treatment. Most of these factories have stabilization/sedimentation ponds that discharge a biological oxygen demand (BOD) of 120 ml per litre depicting high rates of river/underground water pollution. 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.

The slaughter houses: Slaughter-houses are widely distributed and have significant potential impact on the environment, including pollution of rivers and streams, attraction of scavengers, unsightly landscape and odours.

Leather industries: Most leather industries process raw hides to the wet blue stage. They have serious environmental problems with respect to the management of foul odours, leather trimmings, chrome effluents and lime effluents from their operations. Treatment of wastewater from leather industries involves screening, grit removal, aeration lagoons and filtering beds.

Pulp and paper: The only large-scale pulp and paper factory is in Webuye town. There are also a few smaller industries involved in paper recycling. Webuye's Pan Paper Mills has been associated with air pollution and obnoxious smells. Key air pollutants from this sector are oxides of nitrogen, sulphur, hydrogen sulphide gas and dust. Oxide emissions from the plant contribute to acid rain whose effects include corrosion of iron sheet roofs, leaching of plant leaves and reduction in fish species in Nzoia River. However, observed health impacts of such emissions are yet to be comprehensively studied and documented.

7.2.2. Manufacturing sector

Kenya's manufacturing sector developed under the import substitution policy. Over the years there has been considerable shift to export oriented manufacturing. The sector plays an important role in adding value to agricultural output and providing sector linkages, hence accelerating overall growth (Table 7.1).

Table 7.1. Manufacturing Sector Output and Value Addition

YEAR	1996	1997	1998	1999	2000
Value of Output (Kshs.million)	576,400	675,200	703,000	745,500	661,200
Value Added (Kshs.million)	51,000	58,300	71,600	85,700	96,100

Source: Ministry of Trade and Industry

The manufacturing sector is composed of small, medium and large-scale enterprises with major foreign multinational companies from the European Union, United States of America, and Asia. Kenya has a relatively large manufacturing sector whose share of GDP has increased slightly over the past decade. The manufacturing sector comprises of more than 700 established enterprises. By 2001, the sector had employed directly over 216,600 persons. However, limited technological progress reflects past import substitution policy orientation.

In 2002, the volume of manufacturing production recorded a modest expansion of 1.2% up from 0.8% registered in 2001. The growth in output in 2002 was attributed to many factors among them, stable macro economic environment, reduction in import duty to zero rate for the majority of industrial intermediate inputs, government interventions in promoting export opportunities for manufactured goods, enactment of anti-dumping and counterfeit duty legislation to curb practices that disadvantage local manufacturers and the lifting of the fish export ban by the European market. Other factors contributing to growth include reduction of import duty on most raw materials, availability of energy and water, expanded market due to AGOA, COMESA and EAC trade arrangements. Despite these positive signs the sector still performs dismally largely due to high cost of energy and poor infrastructure.

Within the sector, performance was mainly due to increased real output in the food processing industries. Real output in the plastic products, printing and publishing sub-sectors increased by big margins. The sugar industry registered significant increase in output of 31% partly due to high drop in imports of sugar in 2002 and increased amounts of cane harvested, from 47,800ha in 2001 to 53,900ha in 2002. All other industries in the agro-processing sub-sector except processing of miscellaneous foods recorded positive growths.

The beverage and tobacco sub-sector posted a significant growth of 4.9%, while textile and clothing manufacturing grew by 3.4% on the account of the AGOA market. Other activities which recorded growth were leather and footwear, petroleum and other chemicals, non-metallic mineral products, non-electrical machinery and transport equipment

In the Export Processing Zones (EPZ), there was increased activity in 2002 compared to 2001 with direct employment doubling as the number of operating companies in the zones increased markedly. Declines in output were noted in the production of furniture and fixtures, paper and paper products, basic industrial chemicals, rubber products, clay and glass products, metallic products, electrical equipment and manufacturing of miscellaneous products.

Effects of globalization on Kenyan industry: Globalisation has opened up the local market to international competitors who often enjoy certain advantages including subsidies, more efficient technologies and better infrastructure. This presents an unfair competition to local enterprises, which lead to collapse of industries and loss of jobs. Since most industries in Kenya are agro based the impact is reduced agricultural production, loss of livelihoods and increased poverty.

Efforts to promote industrial development: The promotion and development of the industrial sector is critical to development. A sustainable industrial policy is at the heart of development strategies and encompasses a variety of inter-related economic, social and environmental objectives such as the encouragement of an open and competitive economy, the creation of productive employment and protection of the natural environment through efficient use of renewable and non-renewable resources.

A self-sustaining industrial sector must have strong linkages to the domestic economy. Efforts have to be made to promote linkages among industries, and relevant institutions to enhance the spread effects of industrial growth and to facilitate the transfer of appropriate technologies, skills as well as the growth of sub-contracting between the small, medium and large scale industries.

A well-developed skill and knowledge base is necessary for successful domestic technology strategy and absorption of imported technologies. Domestic technological capabilities will continue to be strengthened through greater cooperation between industry and domestic Research and Development (R & D) activities.

7.2.3. Industrial Potential

The government has put in place a policy framework to foster a conducive environment for private sector participation in economic development through incentive packages and export promotion programmes such as Manufacturing Under Bond (MUB) and Export Promotion Zones (EPZs). Both packages offer privileges such as tax holidays, exemption from duty in machinery, raw materials and intermediate inputs as well as removal of restrictions on foreign capital repatriation.

In addition, the African Growth and Opportunity Act/AGOA) allows Kenya's manufactured products duty free access into the US market. The government has put in place measures to take full advantage of this arrangement.

7.2.4. Industrial Production Technologies

After independence, Kenya's industrial technology acquisition was based on the import substitution policy. Accordingly, industrial investments were geared towards local manufacture of the products which were then imported. The policy also advocated the protection of local manufacturing industries under the then Foreign Exchange Act. This however impacted negatively on transfer of environmentally sound technologies, since investors took advantage of the scenario and off-loaded a lot of their old and sometimes obsolete technologies into Kenya. Some of these technologies are still in use.

In the 1970s, the industrial policy was changed to promote export-oriented industrial development. Through this policy only projects with technologies capable of producing high quality products and competing effectively in the global market could be supported.

Some Kenyan industries lost their market share in the East African region in the 1980s to higher quality and cheaper imported goods. Further, the European and American markets imposed restrictions on imports based on tariff, non-tariff and technical barriers based on attaining certain environmental requirements and standards.

Responses to industrial development: To achieve and maintain competitiveness in the international market, while addressing the pressing need to create employment, Kenya should be selective in acquiring its technologies. There are four broad means to acquire technology: indigenous research and development; direct foreign investment; purchasing or leasing "off-the-shelf"; and, overseas training. Technology can also be acquired by accessing patent documents in the public domain kept in Patent Offices such as Kenya Industrial Property Institute (KIPI).

The private sector should be encouraged to invest more heavily in technology development, either independently or through collaboration with research and development institutions such as KIRDI. Particular attention should be given to the adaptation of known and available industrial technologies to suit local needs and conditions. KIPI should be supported to effectively perform its functions to protect inventions and innovations through patenting, to promote inventiveness and to register technology transfer.

Although direct foreign investment has been the most prominent source of technology acquisition, the government should give greater attention to the nature and conditionality surrounding the importation of technologies and to promote diffusion of the same.

Cleaner production technology (CPT): The Kenyan government signed the International Declaration on Cleaner Production in August 2000. Cleaner Production is the continuous improvement of industrial processes, products, and services to reduce the use of natural resources, prevent pollution at source and reduce waste generation at source in order to minimize risks to people and the environment.

Cleaner production can be applied to the processes used in any industry and to industrial products themselves. For production processes, cleaner production results from one or a combination of the following measures: conserving raw material, water and energy, eliminating toxic raw materials and reducing the quantity and toxicity of all emissions and wastes at source during the production process. In addition, cleaner production aims at reducing environmental impacts of products over their entire life cycles, from raw material extraction, through manufacturing and use, to the ultimate disposal of the product. This will lead to a reduced need for end-of-pipe- technologies and may in some cases even eliminate the need for them altogether.

Individuals and industries may be richly rewarded for taking preventive environmental action in the form of cleaner production. Experience in both developed and developing countries shows that this new approach not only produces a cleaner environment but also results in substantial savings for industry and society.

Technology adoption and implementation: Technology transfer and acquisition strategies are very important to developing countries like Kenya. Policies should be geared towards acquiring and utilizing essential, appropriate, efficient and modern technologies for national development. Strategies defined to achieve this objective should address the following:

a) Encouraging and facilitating the acquisition and development of strategic technologies essential for national development;
b) Establishing a system capable of identifying and acquiring essential local and foreign technologies; and
c) Encouraging and facilitating the design processes and technology development.

7.2.5. Status of Industries that have Adopted Cleaner Production Technologies

A total of 25 cleaner production projects have been implemented in Nairobi, Nakuru, Mombasa and Thika. These industries fall in the edible oil, soap, plastics, printing, chemical, wood, paper converter, pesticides, electroplating and leather tanning sectors. In 2003, the total quantifiable environmental and economic benefits that resulted from recommendations that were implemented by these enterprises include:

Savings	Kshs 91.2-114 million
Energy saved (Kg oil equivalent)	300,000 kg
Reduction in toxic chemicals (metric tons)	120,000 tons
Reduction in water consumption (metric tons)	200,000 tons
Reduction in waste material (tons)	412,000 tons

Benefits of cleaner production: Some of the benefits of cleaner production include improvement in product quality, working environment, company and product image, environmental cost reduction, new market opportunities and compliance with regulations. Cleaner production and waste minimization reduces operating costs, reduces risk to liability, reduces end-of-pipe treatment, improves process efficiency, enhances public image, protects human health and the environment and improves employee morale.

7.2.6. Impacts of Industry on Environment

Industrial development exerts pressure on biodiversity, water resources, air quality and transport infrastructure. Some of the main environmental concerns associated with industrial developments in general include:

a) Increased demand on natural resources,
b) Population growth and settlements around industrial sites,
c) Increased waste generation,
d) Increased energy use,
e) Potential occurrence of disaster and associated risks, and
f) Increased road traffic and vehicle emissions.

These pressure need to be addressed in order to safeguard the environment in accordance to the principles of sustainable development.

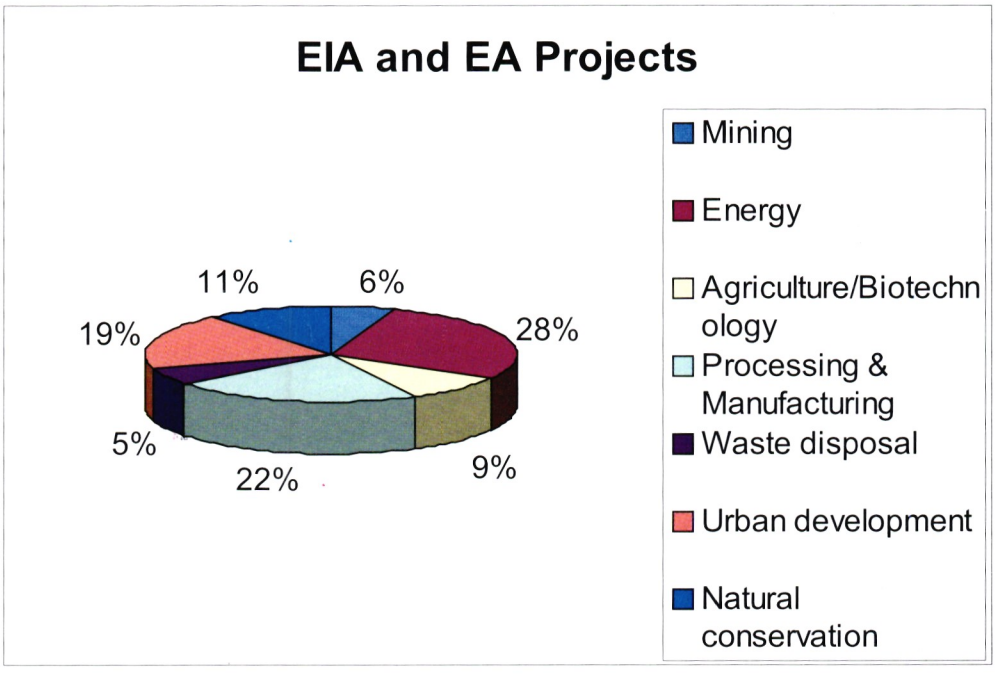
7.2.7. Environmental Standards and Regulations

The Kenya Bureau of Standards (KEBS) is the custodian of all standards in Kenya. It coordinates the development of standards in the country. KEBS ensures that manufactured and imported goods meet the mandatory Kenya Standards. The Standards fall in the following categories; glossaries or definitions of terminology, dimensional standards, performance standards, standard methods of test, codes of practice and measurement standards.

NEMA has developed regulations and standards on environmental impact assessment and audit, water quality, waste management and chemicals, ozone layer and radiation, conservation of biological resources and access to genetic resources, and is in the process of

drafting additional regulations on air quality, noise pollution and economic instruments. Further, EIA and Audit reports from various sectors have been received and analyzed as indicated in figure 7.1. The findings of each audit review are communicated to the proponent including any observation peculiar to the project. NEMA plans to recruit environmental inspectors to strengthen the enforcement of compliance.

Figure 7.1. Status of EIA and Audit reports received by sector



In addition, NEMA has registered over 700 EIA and EA Experts to assist enterprises in the preparations of EIA and EA reports. At the end of 2004 over 4000 reports were received by NEMA for review. NEMA has sent improvement orders where necessary to assist in compliance with required standards.

7.2.8. Institutional Arrangements for Enforcement

EMCA 1999 mandates NEMA to implement and enforce environmental standards and regulations in collaboration with relevant lead agencies. Some of the constraints to enforcement of standards include inadequate capacity and awareness at all levels, especially as it relates to sustainable development issues and the consequences of pursuing industrial growth without incorporation environmental costs.

7.3. MINING, QUARRYING AND SAND HARVESTING

7.3.1. Introduction

Mining in Kenya is regulated by the Mining Act (Cap 306), which was enacted in the 1940s together with the accompanying regulations. The Act is presently being reviewed in order to promote mineral resource development through private sector participation.

Mineral potential: The country has great potential for mineral resources development and exploitation. Currently, there are more than 200 local and foreign companies and individuals carrying out activities related to exploration and exploitation of mineral resources in Kenya.

About 140 large well-established exploration and mining companies and smallscale artisanal operators are involved in the extraction of base metals, industrial minerals, gemstones, chemical minerals and dimension stone throughout the country (Table 7.2).

Table 7.2. Distribution of mining and prospection operations

No. of Companies	Type of Minerals Mined	District Found
11	Base metals (Gold, Silver, Copper minerals, Iron Ores, Lead, Chromite)	Transmara, Migori, Homabay, West Pokot, Turkana, Siaya, Kakamega, Vihiga, Kuria, Nandi, Saburu, Kilifi, Kwale, Taita Taveta, Meru
23	Industrial Minerals (Fluospar, Titanium minerals, Diatomite, Vermiculite, Limestone, Gypsum, Silica, Feldspar, Clay minerals, Magnesite, Quartz)	Marakwet, Kwale, Nakuru, Samburu, Kajiado, Machakos, Kilifi, Turkana, West Pokot, Nandi, Tana River, Wajir, Makueni, Taita Taveta, Kiambu, Nyeri, Kisii)
112	Gemstones (Ruby, Saphire, Rhodolite, Tsavorite, Tuormaline, etc)	Taita Taveta, West Pokot, Kwale, Isiolo, Machakos, Kilifi, Mwingi, Turkana, Kajiado, Meru, Samburu, Baringo)
5	Chemical Minerals (Soda Ash, Salt, Carbon Dioxide, Hydrocarbons)	Kiambu, Kajiado, Mombasa, Kilifi, Malindi, Mwingi)
18	Dimension Stone (Granite, Marble, Limestone)	Vihiga, Nandi, Marakwet, Mombasa, Kilifi, Machakos, Kajiado)

Source: Mines and Geological Department

Mining methods in the country involve excavation of the ground for the purposes of extracting minerals, building stone and sand. The potential negative environmental impacts by mining and quarrying activities include:

a) Disturbance of flora and fauna, water and topography;
b) Degradation of air and visibility from airborne particles;
c) Noise and vibrations leading to disturbance of humans, wildlife, and damage to structures, including houses in certain instances;
d) Accidents leading to injury and loss of life;
e) Abandoned gaping quarries that pause danger to animal and human life.

Mining operations however, have contributed significantly to the economic development of the country through the creation of employment opportunities, creation of a local supply of raw materials for industry, generation of export revenues, alleviation of poverty through the provision of additional alternative livelihoods, development of infrastructure and social facilities such as roads, power supply, schools and health facilities.

Mineral production in 2003 was worth Ksh. 8.2 billion compared to Ksh. 7.4 billion the previous year. As such, the country earned more than Ksh. 5 billion from export of minerals in the same year as compared to Ksh. 4 billion in 2002, an increase of 4%. Earnings from mineral resources contribute more than 1% to GDP. This trend is expected to rise with the advent of the amended mineral law. The production trends, quantities and values of some selected industrial mineral are presented in figures 7.2 – 7.5

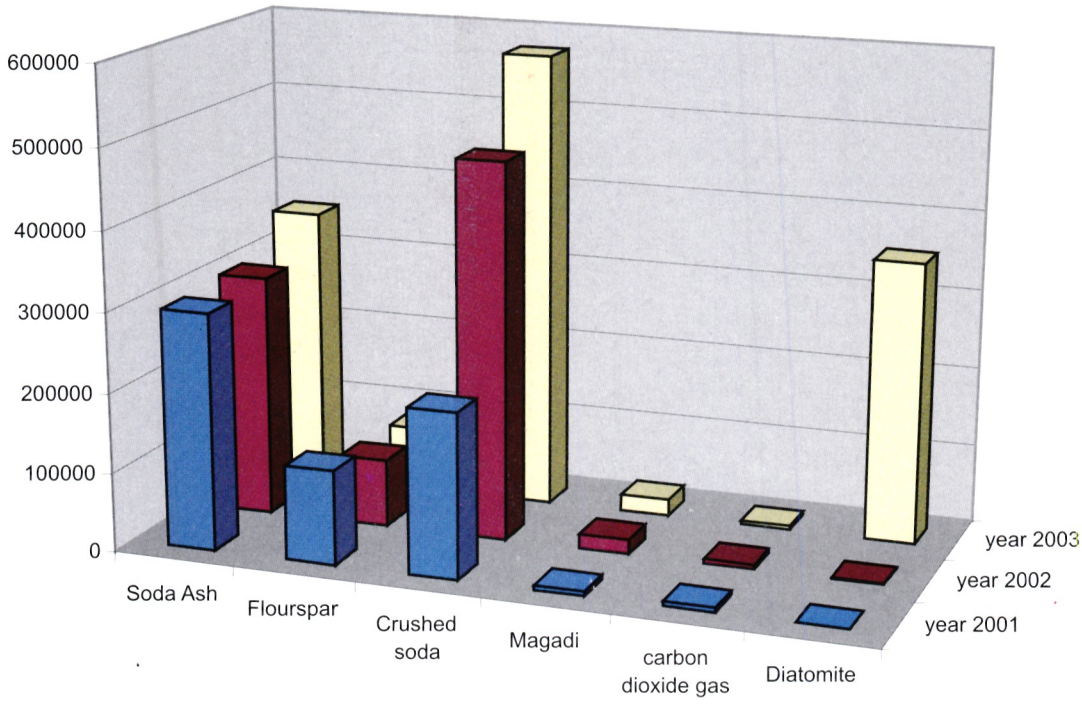


Figure 7.2. Quantity of some industrial mineral production, 2001 – 2003 (m^3 tonnes)
(Source: Mines and Geological Department records).

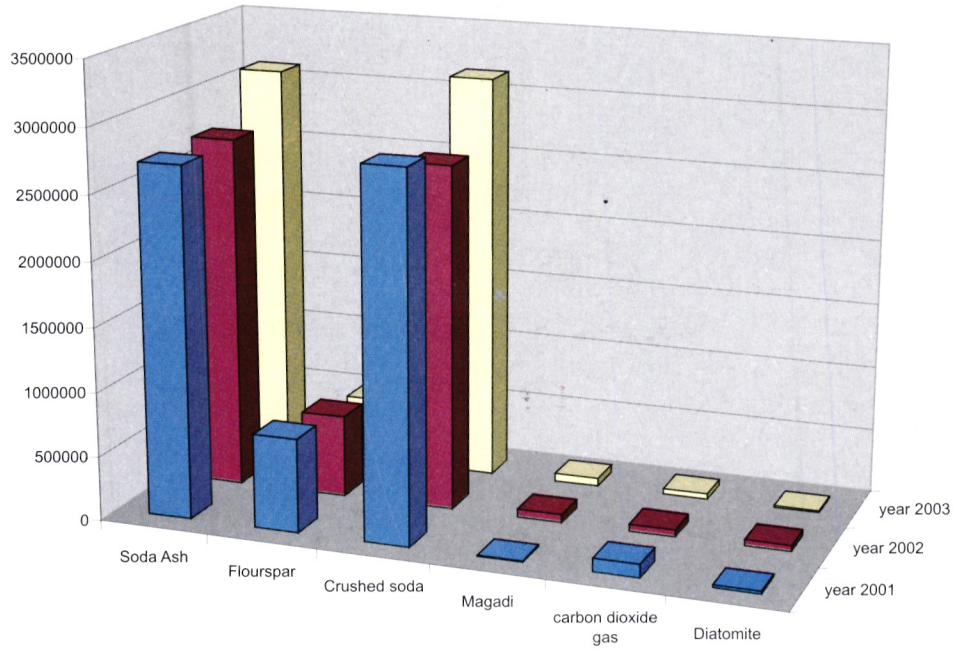


Figure 7.3. Value (in KShs) of industrial minerals produced, 2001 - 2003

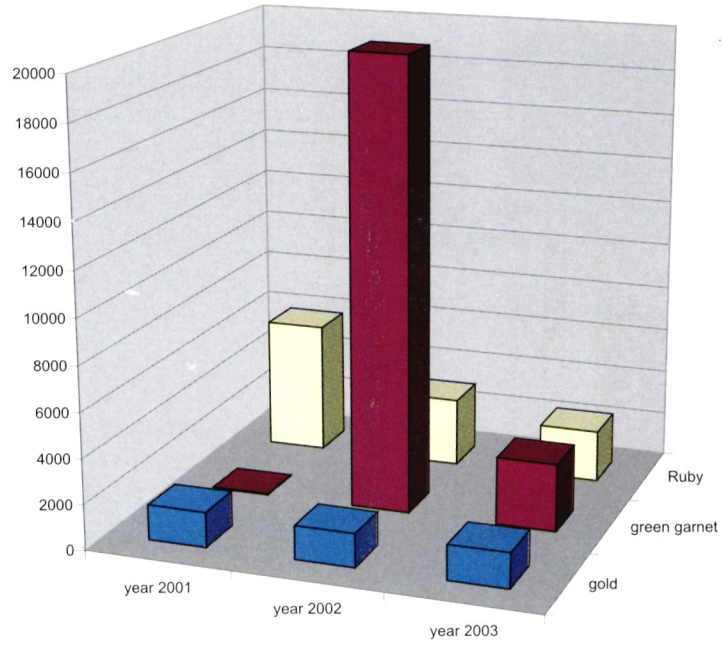


Figure 7.4. Quantity (in kgs) of gold and gemstones produced, 2000 - 2003

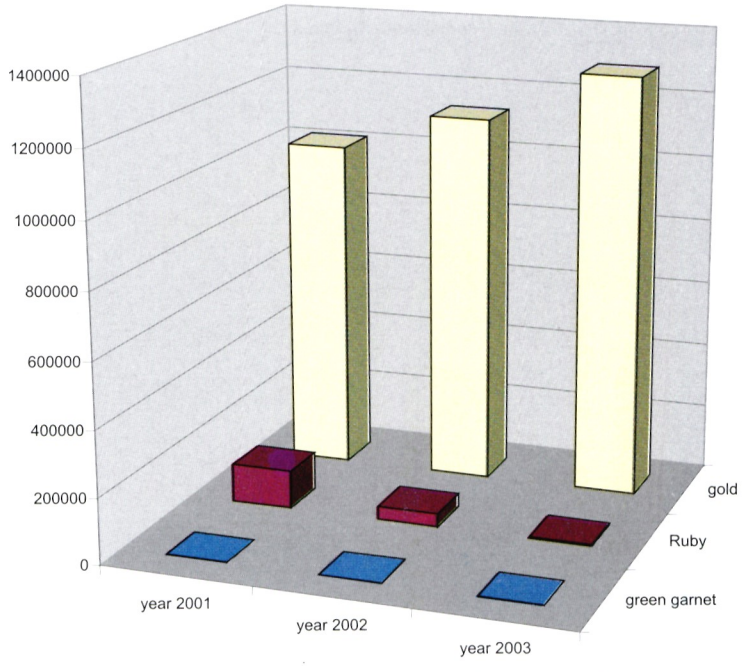


Figure 7.5. Value (in KShs) of gold and gemstones produced, 2001 and 2003

7.3.2. Status of Mining in Kenya

The following minerals are extracted in different parts of the country:

Gold	Copper Minerals	Gypsum	Plaster of Paris
Silver	Asbestos Soda	Ash (Trona)	Vermiculite
Talc	Kyanite	Soap stone	Mica
Lime	Kaolin	Diatomite	Pegmatite
Magnesium	Kaolin	Bentonite	Carbon Dioxide
graphite	Magnesite	Mica	Chromite
Fluorspar	Building Materials	Hydrocarbons	

Further, recent exploration has revealed additional mineral resources to include:

Base metals: Gold, silver, galena, copper and iron ores.

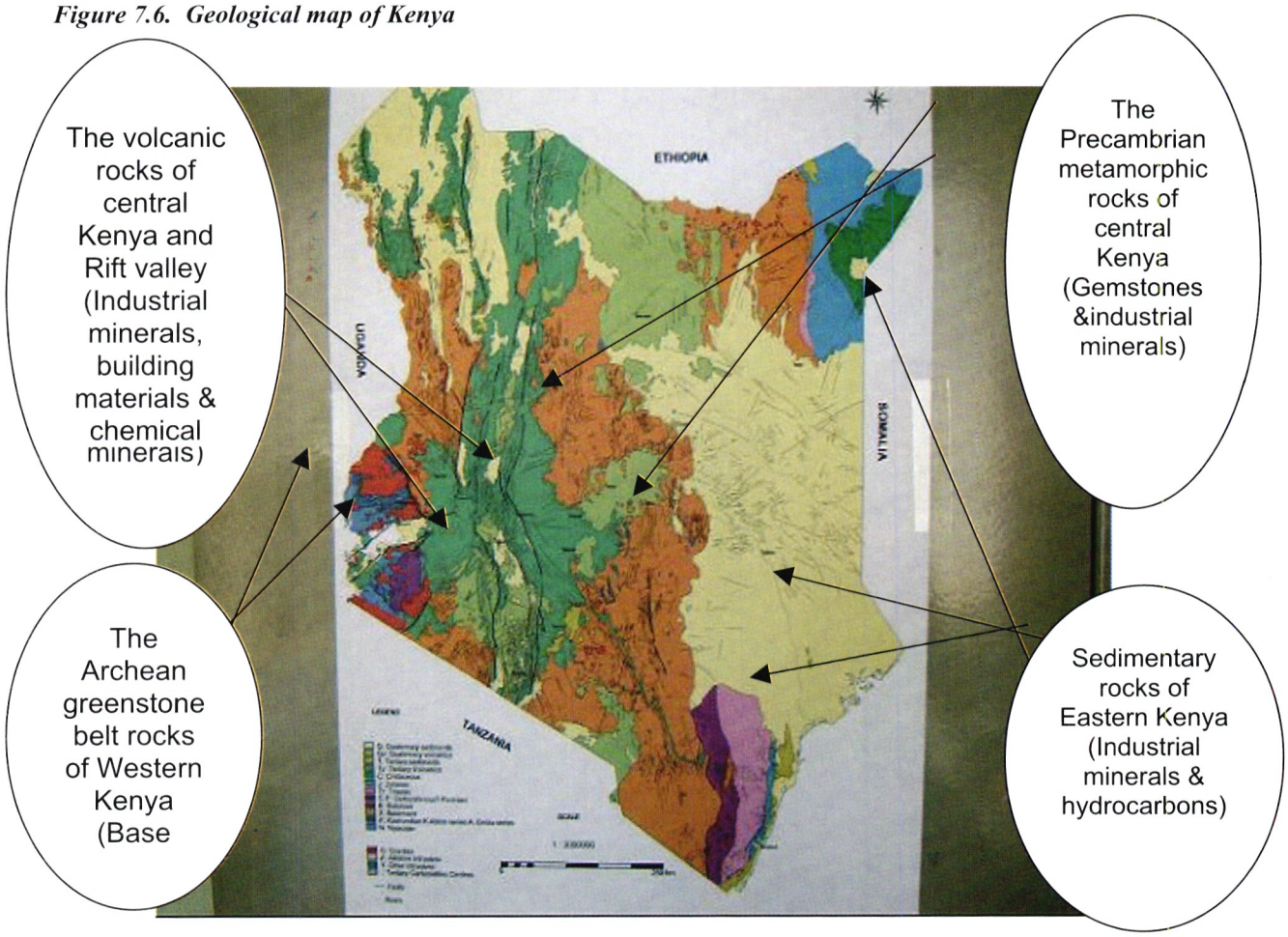
Industrial minerals and building materials: Barytes, dolomite, guano, feldspar, fluorspar trona, kunkar limestone, glass sands, shale, quartz, building stone, granite, marble, diatomite, Kaolin, Wollastonite, Bentonite, Titanium Minerals Fluorspar etc.

Gemstones: Aquamarine, amethyst, varieties of garnets, varieties of ruby, tourmaline, tsavorite, sapphires, beryl halite, etc.

Chemical Minerals: Soda ash, salt, carbon dioxide, hydrocarbons.

These minerals are located within specific geological environments as indicated in the geological map of Kenya (Figure 7.6).

Figure 7.6. Geological map of Kenya



Geological Map of Kenya ***(Mines and Geological Department)***

Kenya's mining industry is dominated by the production of non-metallic minerals, mainly, fluorspar, vermiculite, barites, limestone and lime products including various varieties of gemstones. These are typically found within the metamorphic terrains of central Kenya. Soda ash (trona), diatomite, carbon dioxide and a variety of building materials are found within the central Rift Valley volcanic rocks.

Metallic minerals such as gold, silver and copper have their potential within the greenstone belt of Western Kenya and parts of Rift Valley. The sedimentary basins are endowed with minerals such as gypsum, titanium and hydrocarbons.

Unexploited economically viable mineral resources: Recent detailed mineral exploration in the country has revealed a number of mineral resources that are economically viable but remains unexploited. These include largely industrial minerals, construction and building materials and a few heavy metals.

Quarrying and sand harvesting: Quarrying and sand harvesting activities are regulated by the relevant local authorities under the Local Government Act. However, the Mines and Geological Department intervenes where commercial explosives are used in the extraction of building and construction materials and where environmental reconstruction is concerned.

There are over 90 registered quarries scattered all over the country whose major works include the extraction of stone for various uses such as ballast, limestone, gypsum, pozzolana and lime for cement manufacture, dimension stone and building stone for the construction industry. Some of the quarries registered by the Mines and Geological Department in various districts in the country, which use commercial explosives in their operations are listed table 7.3.

Table 7.3. Number of quarries and materials extracted by district

Districts	No. of Quarries	Materials Extracted
Nairobi	**13**	**Ballast /Building Stone**
Trans Nzoia	1	Ballast
Kericho	2	Ballast
Uasin Gishu	5	Ballast
Kisumu	8	Ballast /Limestone
Mombasa	8	Ballast /Limestone/Dimension stone
Kilifi	2	Limestone/Ballast /Salt
Makueni	1	Ballast /Dimension stone
Taita	2	Gemstones/Building Stone
Kwale	2	Limestone/Gemstones
Kiambu	3	Building Stone/Ballast
Thika	2	Building Stone/Ballast
Nyandarua	1	Ballast/Building Stone
	4	Building Stone, Dimension Stone/Ballast
Muranga	1	Building Stone
Maragwa	1	Building Stone
Kajiado	8	Marble/Pozzolana/Limestone/Dimension Stone/Ballast/Soda ash
Mbeere	1	Ballast
Laikipia	1	Ballast
Marsabit	2	Gemstones/Ballast
Nakuru	3	Ballast/Building Stone
Vihiga	1	Dimension Stone/Gold
Kakamega	2	Abandoned gold mines
Meru	1	Building Stone/Ballast
West Pokot	1	Gemstones
Transmara	1	Gold
Nyeri	1	Ballast/Building Stone
Kisii	2	Ballast/Soap Stone
Bomet	1	Ballast
Marakwet	2	Fluorspar/Dimension Stone
Narok	1	Ballast
Maragwa	1	Building Stone/Ballast

Numerous other quarries exist all over the country. These are licensed and controlled by various local authorities and in certain instances by the Forest Department; these quarries have been responsible for the serious damage to the environment.

Industrial minerals: Titanium minerals are found along the coast, while large amounts of limestone and marble lies within the Mozambique rock system in north, central and southern Kenya. Phosphates associated with the carbonatites are found in western Kenya; while radio active and rare earths are found in Mrima and Shimba Hills; diatomite in the south and north Rift Valley; clay materials in the Mozambique system rocks and those associated with the volcanic rocks in central Kenya; guano in a number of volcanic caves in the Rift Valley; and graphite in Laikipia, Marsabit and Taita Taveta districts.

Construction and building material: Large amounts of volcanic rocks are quarried and used as aggregate in most parts of central Kenya, pumice and tuffs (variety of building stone) and aggregate associated with eruptive central volcanic cones on the floor and flanks of the Rift Valley.

Heavy metals: Chromite is found in the Mozambique belt rock in northern and north-western Kenya; iron ore in the Samia hills of western Kenya; copper minerals in Kakamega, Butere, Homa Bay, Nandi, Migori, Trans Mara and Vihiga districts.

Chemical minerals: Largely hydrocarbons mainly coal occur in the Mui Basin currently under going exploration and evaluation. There is also potential for hydrocarbons within the Exclusive Economic Zone and the Continental shelf.

7.3.3. Constraints/Challenges

Currently, the mineral sector is operating under the Mining Act, which was put in place in the 1940s. The Act is considered by investors as an impediment, prompting the government to initiate its overhaul in order to make investments in mining more attractive and conform to environmental concerns. This should attract more investors, particularly local small-scale miners while ensuring sustainable exploitation of mineral resources and the environment.

One of the greatest challenges facing the mining sector is the lack of economic incentives and disincentives which would assist in the rehabilitation efforts. Appropriate economic instruments for the sector would ideally provide for definition of property rights, charges and fees, insurance bonds and market creation.

Past and present environmental problems associated with the extraction of minerals in Kenya include:

a) The existence of dangerous open shafts, some as deep as 100 feet and linked to underground tunnels, which pose danger to the local inhabitants and their livestock (Plate, 7.1);
b) Abandoned large open pits have become breeding ground for mosquitoes (Plate, 7.2);
c) Atmospheric pollution by dust rich in silica arising from manual pounding of the gold bearing ore may cause various respiratory complications such as silicosis; mass wasting of land slopes as a result of poor mining practices (Plate 7.3).
d) Panning taking place on flowing streams contributes to water contamination and siltation on riverbeds (Plate 7.4)



Plate 7.1:
Machinery fallen into one of the concealed old shafts.



Plate 7.2:
An open cast mine filled with water posing risk to people and animals.



Plate 7.3:
Land degradation on slopes caused by gold mining.



Plate 7.4: *Panning taking place on flowing streams causing contamination of river water*

***Occurrence of Quarries in Kenya*:** Quarries are found scattered in various parts of the country some of them have been abandoned (Table 7.4).

Table 7.4. Abandoned quarries

a) Nairobi Province

	District	Type of Quarry	Areas	Materials Extracted
	Nairobi	Building stone Aggregate	Ruai, Njiru, Ngong Kayole, Dandora, Embakasi	Tuff Ballast

Sources: Mines and Geological Department records

b) Eastern Province

	District	Type of Quarry	Areas	Materials Extracted
	Machakos	Building Sand Dimension stone Limestone	Machakos Matuu Athi River	Ballast Granite, Limestone Sand for construction
	Meru South	Building stone	Mutonga river	Tuff
	Mwing	Building sand Gypsum and limestone Mining Gemstones	In most river beds	Sand for construction
	Kitui	Building sand	In most river beds	Sand for construction
	West Pokot	Mining Building sand	Panning in river beds using mercury	Gold Sand for construction

Source: Mines and Geological Department records and district SoE reports

c) Rift Valley Province

	District	Type of Quarry	Areas	Materials Extracted
	Samburu	Gemstone mining Building sand	Masiketa	Sand for construction Emerald, sapphire, garnets.
	Narok	Building stone Building sand		Tuff, hardcore, Sand for construction & Ballast
	Keiyo	Dimension stone Building sand	Keiyo hills In a number of river beds	Pink Limestone Sand for construction
	Nandi	Building stone & dimension stone, Building sand, Gold mining	Kabiyet Sand from most streams, Gold from Lasos	Pink granite, Sand for construction, Abandoned gold mines
	Kajiado	Gypsum Limestone Graphite Soda ash Salt	Kajiado Bissel Magadi	Gypsum Limestone Salt and soda ash Graphite
	Barongo	Building sand, Aggregate Building stone Gemstone mining		Sand for construction Ballast, ruby, tuff
	Nakuru	Building stone Aggregate Building Sand	Slopes of the Menengai, Naivashia, Njoro, Bahati, Subukia. Nakuru west, Naivashia	 Tuff Ballast Sand for construction
	Trans Nzoia	Building Sand	In river beds	Sand for construction
	Kericho	Aggregate	Kericho west	Ballast.
	Transmara	Gold	Kilgoris/Lolgorian	Gold

Source: Mines and Geological Department records and district reports

d) Coast Province

	District	Type of Quarry	Areas	Materials Extracted
	Mombasa	Building stone Aggregate Dimension stone	Mombasa Mariakani Kambe Limestone	Coral Limestone Ballast Mariakani sandstone
	Kilifi	Salt harvesting		Salt
	Taita Taveta	Gemstones Graphite, Kyanite, asbestos, Kaolin Iron Ore Building Sand	Kasigau, Murka Ronge Maktau	Ruby, Tsavorite Graphite, clays, kyanite asbestos, iron Sand for construction etc.

Source: Mines and Geological Department records and district SoE reports

e) Central Province

	District	Type of Quarry	Areas	Materials Extracted
	Thika	Building stone	Kerichwa valley	Tuff Ballast
	Kiambu	Building stone		Tuff Ballast
	Nyandarua	Building stone		Tuff Ballast

Source: Mines and Geological Department records and district SoE reports

f) North Eastern Province

	District	Type of Quarry	Areas	Materials Extracted
	Wajir	Limestone Gypsum	Wajir El wak	Limestone Gypsum
	Ijara	Building Sand	In dry river beds	Sand for construction

Source: Mines and Geological Department records and district SoE reports

g) Western Province

	District	Type of Quarry	Areas	Materials Extracted
	Vihiga	Dimension stone Brick making Abandoned mines & Panning in river beds	Kima Tigoi, Chavakali Viyalo	Granite Brick products Sand for construction Gold
	Kakamega	Abandoned mines & Panning in river beds	Rosterman Ikoloman	Gold
	Butere Mumias	Abandoned mines & Panning in river beds	Bukura	Gold

Source: Mines and Geological Department records and district SoE reports

h) Nyanza Province

	District	Type of Quarry	Areas	Materials Extracted
	Kisumu	Aggregate Building sand	Kisumu West In Rivers i.e. Kibos, Nyamasaria, etc	Ballast Sand for construction
	Gucha	Soapstone	Tabaka	Soapstone.
	Nyado	Building stone		Aggregate
	Homa Bay		Gold mining	Gold
	Migori	Abandoned mines	Macalder Mines	Gold and copper

Source: Mines and Geological Department records and district SoE reports

7.3.4. Rehabilitation Efforts

Very little rehabilitation works have been undertaken on old mines and quarries in the country due to lack of clear regulatory tools and mechanisms. The enforcement of relevant provisions of EMCA 1999 will go a long way in managing negative impacts of mining, quarrying and sand harvesting.

Some old quarries and mines have been reclaimed and restored close to the original state through replanting of appropriate tree species. Such rehabilitation efforts have been

undertaken by Bamburi Cement Company which turned the mined areas into a tourist site (Haller Park). This is an example of what should be done by all quarry and mining operators. The newly reclaimed mined areas could be used as sources of firewood, fish ponds and watering points for livestock.

It is the responsibility of individual mine owners, the local authorities who license them and the Ministry of Roads and Public Works, to rehabilitate abandoned quarries in the country.



Plate, 7.5:
Woman working in a mining site as an indication of increased poverty levels

7.4. TRADE

Domestic trade has experienced an increasing influx of sub-standard imported products due to liberalization. A number of these products (batteries, tubes and tyres, electronics, motor metallic components of machinery and equipments) have short shelf-life and therefore contribute to increasing volume of wastes. This in turn has contributed to the mushrooming dumpsites and junkyards posing an environmental hazard.

Table 7.5. Major agricultural exports of Kenya

Commodity	Unit Tonnes	1 999	2000	2001	2002	2003
Coffee (un-roasted)	Tonne	71581	86 982	**63 608**	49479	58 650
Fish and fish Preparations	Tonnes	15951	16855	**18 536**	18 252	19462
Horticulture	Tonne	200 624	193918	193 230	262 931	346 136
Maize (raw)	Tonnes	40 520	448	420	158763	3128
Meals & flour of wheat	Tonnes	21 288	11049	8845	1793	345
Pyrethrum extract	Tonnes	623	165	235	81	123
Sisal	Tonnes	16 830	16753	17 857	19482	21 723
Sugar confectionary	Tonnes	8628	13 343	16436	18815	20 519
Tea	Tonnes 260	177	217 282	270 473	272 707	262 175

Source: Economic Survey, 2004

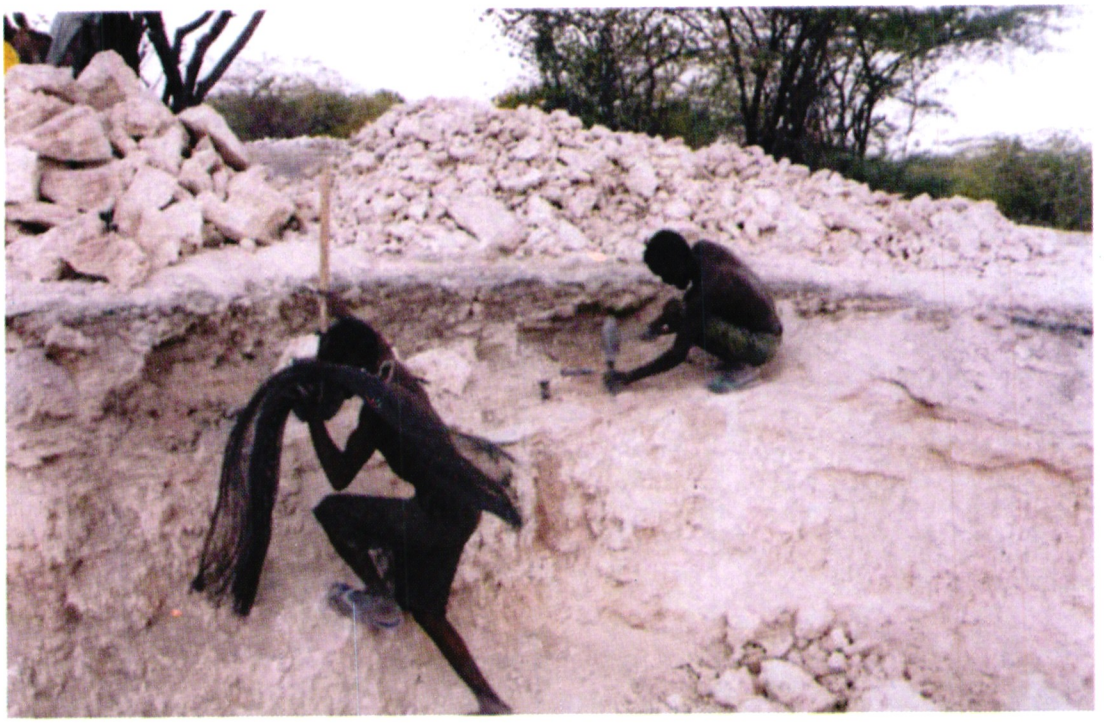


Plate 7.6. Mining of limestone is an important income generating activity in Wajir and other parts of North Eastern Province

7.4.1. Types of Traded Agricultural-based Products

Agriculture is the dominant sector accounting for about 24% of the GDP as documented in the Economic Survey, 2004. Agro-based exports, which accounts for 60% of total exports is a major contributor to foreign exchange earnings mainly from tea, coffee and horticulture. Agriculture also provides employment and livelihood to an estimated 75% of the total population. Due to its importance, further investment in this sector remains a matter of priority.

Kenya's exports are mainly agro-based and include pyrethrum, tea, cut-flower, french-beans, horticulture, petroleum products and coffee.

Horticulture: Horticulture has undergone rapid expansion over the past two decades to become a leading export commodity. In 2003, the sector contributed about 26.7% of total export earnings. Currently, horticultural activities cover about 250,000 ha with total annual production valued at US$ 610 million (Investment Promotion Centre, 2004). Most horticultural farmers are small holders (80%), accounting for 60% of horticultural export produce.

Tea: Tea is a leading export commodity accounting for about 24% of export earnings in 2003. The tea industry employs over 2 million people directly (involved in tea farming, manufacturing, and marketing), excluding those involved through retail outlets and transportation. The production of tea increased to 293,670 tonnes in 2003, of which 262,175 tonnes (US$440 million) was exported (GoK, Economic Survey, 2004)

Coffee: Although coffee has for year been an important export product, its earnings have declined from 11% in 1998 to 5% in 2003 of total export earnings. Like other markets in the country, coffee market has also been liberalized.

Pyrethrum: Pyrethrum is also an important crop in Kenya's economy as it offers livelihood to approximately 200,000 households with an estimated population of a million people. The current value of pyrethrum exports is estimated at US$ 25 million per annum. Pyrethrum exports in the country rank fifth after tea, horticulture, tourism and coffee. Kenya has been the leading world producer of natural pyrethrum for more 60 years producing between 65% and 75% of all pyrethrum traded in the world per year (Investment Promotion Centre, sector profile on agriculture).

Livestock: The livestock sector contributes about 10% of GDP, over 30% of the farm-gate value of agricultural commodities, employs over 50% of the agricultural labour force, and earns considerable foreign exchange through the exports of hides, skins, dairy products, live animals and canned beef. Kenya's dairy sector is one of the largest in Sub-Saharan Africa with an estimated 3.2 million dairy cows that produce about 2.5 million litres of milk annually. Livestock is mainly in the hands of small-scale farmers, accounting for about 80% of total milk production.

However, livestock production has immediate impacts on environment including overgrazing, exposing land to agents of erosion and human wildlife conflict as nomadic communities move with their livestock into national parks and reserves in search of pasture.

Sugar: Kenya currently produces about 70% of sugar for domestic consumption requirements. There are six major sugar factories with an annual production capacity of between 550,000 and 600,000 tonnes. The sugar sub-sector is also liberalised following the removal of price controls, although import controls still exist (100% suspended duty on sugar imports). Some of the key problems affecting the sugar industry are; inefficiency, low productivity, weak management, distortions in the sugar market, inadequate credit facilities for sugarcane development, droughts and fires.

Cotton: Cotton is an important crop in view of its potential to provide new opportunities for poverty alleviation due to its labour intensive production requirements. Currently, there are about 14,000 small-scale cotton growers with an annual lint production of about 20,000 bales, compared to the peak production of 70,000 bales in 1984/85.

The poor performance of the cotton industry is as a result of negative gross margins of seed cotton produced, amounting to US$0.04 per kg, largely due to high production costs in the face of global decline in lint prices (Ikiara and Ndirangu, 2003). Major cost drivers are pesticides, lack of extension services and poor infrastructure.

However, through the AGOA initiative, Kenya's exports of clothing and investment in the textile sector have experienced remarkable growth. Cotton production is insufficient to meet the local demand reducing the country's capacity to produce high quality and competitive fabric. The option of sourcing fabric from other AGOA-eligible Sub- Saharan African countries is limited by the fact that the region does not meet the fabric requirements of its apparel sub-sector due to various supply constraints.

***Oil Crops*:** Kenya imports over 95% of her total edible oil requirements, estimated at 200,000 tonnes and costing the country US$90 million annually. The oil is mainly imported from Malaysia as palm oil. Kenya has the potential to grow a variety of oilseeds but of major importance are sunflower, simsim, soya beans, rapeseed, coconut, castor, groundnuts and sunflower.

7.4.2. Impacts of Agricultural Production on Land Use

Some of the impacts on land use resulting from agricultural production include continued clearance of vegetation for more farm land leading to land degradation, excessive use of chemicals, fertilizers and pesticides; leaching of the soil due to intense irrigation; and monoculture of cash crops such as tea, coffee and horticulture.

7.4.3. Fishery

The fisheries sub-sector contributes about 5% of GDP and employs over 60,000 people directly with an additional 5,000 indirectly dependent on the fish industry (IPC, sector profile on agriculture). There are three types of fish farming practices in Kenya, namely warm water fish farming (tilapia, bass and common carp); cold mountain farming (trout); and coastal saline water fish farming (prawns). Lake Victoria alone produces over 90% of the fish in Kenya with the dominant species as the Nile Perch, used for filleting in fish processing factories. There are 25 fish processing factories in Kenya with a total processing capacity of 25,000 tonnes per year.

Impact of fish processing and fish products on land use: The processing of fish and the disposal of fish by-products by the small fishermen groups poses a major environmental problem. Quite a great amount of fish is processed at the shore leaving behind un-disposed waste which is often washed back into the water systems by the tides and flood waters.

7.4.4. Agribusiness

In Kenya, agribusiness is one of the most vibrant activities of the economy consuming considerable amounts of chemicals, fertilizers and pesticides.

7.5. SERVICES

The key services that have a bearing on land use and environment in general include telecommunication, transport (air, road, railway), port services, water, sewerage and health services.

7.5.1. Telecommunication

Kenya has a fairly developed postal and telecommunication network. Fixed telephone line connections increased marginally from 326,000 in 2001 to 332,000 in 2002, but declined by 1.8% in 2003. This sluggish growth is attributed to the stiff competition from mobile phones. The number of mobile phone subscribers increased from 630,000 in 2001 to 1.068 million in 2002 and to 1.097 million in 2003.

Some of the constraints include inadequate capital for investment in modern infrastructure for expansion, frequent vandalism of equipment and shortage of material especially for the line plant.

Impact on land use: Telecommunication activities adversely affect land use through:

- Use of wooden poles resulting to felling of trees and reduction in vegetation cover;
- Rapid growth of mobile phones has resulted in new kind of non-biodegradable wastes

such as used air-time cards consisting of aluminium covers; and
- Use of insecticides and wood preservatives on posts.

Other impacts of telecommunications equipment on land use were investigated by PCC as indicated in Box 7.1 and plate 7.6.

Box 7.1. Mobile phone base stations investigated by PCC

The Committee received numerous complaints resulting from increased number of mobile phone base transmiss ion station (BTS) installations mainly in urban areas due to the increase in mobile phone users (Plate 9.3). The major concern was the effects of the radiations emitted by the base stations on human health.

The Committee established that there is no conclusive scientific evidence on their exact effects on human health. It therefore recommends that NEMA in consultation with the Communication Commission of Kenya and other relevant lead agencies should formulate standards and guidelines to regulate this fast growing sector, as the existing standards and regulation appear inadequate. In addition, mobile services providers should adhere to health–based guidelines and should apply precautionary measures to protect people from unknown effects of radio frequencies.

Plate 7.7. Mobile phone base transition station



7.5.2. Water, Sewerage and Health Services

The overall goal of the government is to ensure that all Kenyans have access to safe drinking water within a reasonable distance. Current estimates indicate that nearly 75% of the country's urban population have access to safe drinking water, while 50% of the rural population have access to potable water *(Economic Survey, 2004).* However, these proportions are declining as a result of non-performance of some existing water supply schemes. This has necessitated a change in water policy approach to that of participatory management embodied in the Water Act of 2002.

Domestic and industrial waste management has remained a serious environmental problem in most urban areas. In Nairobi, only 45% of the generated garbage is collected, while the private collectors can only deal with 7%, leaving 48%. Efforts are underway to completely privatise waste management in Nairobi whose collection is expected to be more efficient and effective.

The vision of the health sector in Kenya is to create an enabling environment for the provision of sustainable quality healthcare that is acceptable, affordable and accessible to all. However, there are enormous challenges in working towards sustainable waste disposal systems.

Impacts of health and sewage on land use

a) Declining proportion of people with access to safe drinking water within a reasonable distance resulting in more time devoted to fetching water particularly by women.
b) Pollution through domestic and industrial waste mainly in most urban areas.
c) Poor disposal of medical wastes posing serious health risks to people. Some medical waste such as expired drugs, used syringes and other items meant for incineration end up in the municipal dumpsites where they continue to pose great danger to both unsuspecting humans and animals.

7.5.3. Road Transport

The present road transport network range from tracks to multi-lane urban and sub-urban highways. The system is divided into classified and unclassified roads, with a total network of 151,000 km.

Out of the 62,667 km classified road network, 7,943.2 km are of bitumen standard, 26,180.8 km gravel standard and the rest are earth standard. The classified roads network falls under the Roads Department of the Ministry of Public Works, while the unclassified network falls under county councils, the Ministry of Environment and Natural Resources, the Ministry of Tourism and other organizations.

Impact of roads on land-use: Road transport has the potential to cause environmental damage if the appropriate mitigative measures are not embraced. These include increasing noise pollution and clearance of vegetation and prime agricultural land to make room for road construction.

7.5.4. Air Transport

Kenya has three major international airports, namely Jomo Kenyatta International Airport (JKIA) in Nairobi, Moi International Airport (MIA) in Mombasa and Eldoret International Airport. Flights volume at JKIA increased to 67,787 in 2002 from 62,572 flights in 2001, a growth of 8.3%. On the other hand, international flights increased from 31,898 in 2001 to

36,030 flights in 2002 posting a 13% growth. There was a slight improvement in domestic air travelling by 3.5%.

***Impact of air transport on land-use*:** Air transport negatively impacts on land use through:
a) Emission of gaseous pollutants;
b) Utilization of large tracks of land for the construction of airports; and
c) Solid waste disposal.

7.5.5. Railways

The Kenya Railways, which is charged with railway operations mans a fleet of about 156 locomotives along the 2,700 km long route connecting Mombasa, Nairobi, Malaba, Nakuru, Kisumu, Butere, Voi, Taveta, Nanyuki, Eldoret, Kitale, Gilgil and Nyahururu.

The Kenya Railways also provides freight services within the country and handles transit traffic to and from land-locked countries in the East African region. The main commodities ferried include agricultural and industrial goods such as coffee, dairy products, grains, sugar, cement, fluospar, containers, paper, petroleum products, salt, soda ash and timber. The railway also operates train freight service from Mombasa to Kampala and container-carrying trains (railtainers) daily between Kipevu (Mombasa) and the inland container depot at Embakasi (Nairobi).

7.5.6. Waterways and Ports

An inland waterway service is operated on Lake Victoria for the movement of freight and passengers within Kenya lake region. Mombasa Port on the other hand has been experiencing increased cargo handling, mainly occasioned by the restructuring of Kenya Ports Authority. The number of ships docking increased by 54.8% from 1,111 ships in 2001 to 1,720 ships in 2002.

Cargo handling increased by 12.6% in 2003, compared to an increase of 0.5% in 2002. Overall, cargo imports went up by 19.8%, while cargo exports decreased by 14.2%. The installation of modern cargo screening equipment at the port of Mombasa has greatly enhanced the flow of cargo traffic and eased the identification of incoming goods. This in turn has improved security measure around the port operations as well as screening the illegal entry of counterfeit and sub-standard goods.

Impact of waterways on land use: Discharge of effluents into the water systems adversely affects the flora and fauna in these ecosystems.

7.5.7. The Financial Sector and Business Support Services

***Banking sector*:** The banking sector has been fairly stable. The number of commercial banks dropped from 48 in 2001 to 44 in 2002 and to 43 in 2003, while the number of non bank financial institutions declined from three in 2002 to two in 2003 including two mortgage finance companies and four building societies. In addition, foreign exchange bureaus increased from 48 in 2002 to 52 in 2003.

The market share of the banking institutions continued to be dominated by the ten largest commercial banks, which accounted for 77.3% of all deposits held by the banking institutions in 2002 as compared to 72.0% in 2001. In 2003, the banking sector was relatively well capitalised with an estimated average risk weighted capital adequacy ratio of 17.2%, which is well above the 12% minimum requirement. This capitalisation has largely been attributed to

increased profits.

Capital Markets Authority: The Capital Markets Authority (CMA) has played a major role in spearheading reforms in capital markets. This is aimed at increasing investor confidence with the stock market reorganised into four independent segments in 2001.

In 2002, the number of listed companies dropped from 54 to 51, the number of stockbrokers remained at 18, investment advisors were 25, five authorised depositories and one dealer. During the year, two investment banks and two collective investment schemes participated in the market.

Insurance Industry: In 2003, there were 42 registered insurance companies, of which 39 were licensed to conduct business. Two of these operated as closed funds and one insurer was under statutory management. The $870 million industry has faced a number of challenges including reduced investment income, under-cutting of premium rates, fraudulent practises and narrow investment portfolios. Other insurance intermediaries were 187 licensed brokers, 1,057 registered insurance agencies, 18 loss assessors, 23 risk surveyors, 171 insurance loss adjustors and five risk managers.

7.5.8. Tourism Services

The tourism sector is the second biggest foreign exchange earner after agriculture, accounting for about 15% of total export earnings and generated US$343 million in 2003 *(Economic Survey, 2004)*. The sector provides employment to thousands of people both directly and indirectly.

Kenya's tourism sector recorded a 14.5% growth in visitor arrivals in 2003 against a 0.8% growth in 2002. The growth is attributed to a combined aggressive marketing by the government, Tourism Board, hoteliers and tour operators. The industry had suffered great losses due to terrorist attacks earlier experienced, which resulting in travel advisories against Kenya by the United States government.

The major attractions include diverse wildlife resource attractions, outstanding hotels and game lodges. With its network of well-managed national parks, national reserves, marine parks, biosphere reserves, archaeological sites, and striking scenic beauty and sandy beaches along coral reef sheltered waters. The most preferred tourist attractions in Kenya are the coastal beaches, game reserves and national parks. Other tourist attractions include animal orphanage, museums, snake parks and historical sites.

Visitors to museums, snake parks and historical sites increased from 603,000 in 2002 to 686,000 in 2003. However, the number of visitors to national parks and national reserves declined from 1.7713 million in 2002 to 1.5406 million in 2003. In order to extend the length of stay of holidaymakers in Kenya, the government welcomes investments in the development of inland "resorts" situated close to the national parks and reserves.

In 2003, holidaymakers accounted for 60%, business visitors 15.9%, while transit visitors 19.1% of the number of visitor arrivals. Overall, visitors on holiday decreased by 6.6% in 2003 mainly as a result of adverse travel advisories made during the year by UK and USA. However, those on business increased significantly by 45.7% in 2003, an increase that was attributed to the visits made by foreigners interested in investing in Kenya after the new government came to power.

The year 2003 also recorded increased conference tourism activities. Local conferences increased from 754 in 2002 to 805 in 2003, while international conferences rose from 115 in 2002 to 126 in 2003 *(Economic Survey, 2004)*.

To revamp the industry, the Kenya Tourism Board, Kenya Tourism Development Corporation and the Ministry of Tourism and Information stepped up tourism promotion abroad through conducting fairs in Europe and South Africa. The Board also organized a Miss Tourism contest with the aim of promoting tourism both locally and overseas, while the Kenya Utalii College continued to play a leading role in training personnel for the tourism industry.

Similarly, the potential for the domestic market has not been fully exploited. There is also potential to identify other tourist attractions besides the existing national parks, reserves and the beaches. Participation in such investment ventures will greatly expand the industry.

7.5.9. Hotels

Hotels, Bed nights and Occupancy: According to the Ministry of Tourism and Information (MTI) there were a total of 2,228 hotels in Kenya. Most of the hotels were based at the Coast: 46 hotels with 28,743 beds, 48 of which in 2001(14,185 beds) are classified as 4 or 5 star. There are 433 hotels in Nairobi with 15,684 beds. Of these, 18 hotels (4,339 beds) are classified as 4 and 5 star. National parks and reserves have 67 hotels with 5,735 beds. Hotels in other parts of the country numbered 1,272.

The tourism sector has made significant contributions to Kenya's national economic development mainly through:

a) Increasing foreign exchange earnings and the associated multiplier effects;
b) Providing employment opportunities both directly and indirectly to about 180,000 and 300,000.
c) Providing a major market for the products of the informal sector, especially handicrafts and curious.
d) Contributing to international goodwill and socio-cultural understanding.

Impact of hotel industry on land use: Hotels generate solid wastes some of which lack appropriate treatment facilities. The disposal of effluents, detergents and solid wastes contribute to degradation of natural habitats.

7.5.10. Laundry Services

This is one of the fastest growing businesses with high use of chemical detergents. The sector offers numerous employment opportunities in the detergent and laundry industries. However, laundry services impact negatively on the environment through the release of effluents into natural water systems.

Impact of laundry services on land use: Laundry services are a major source of chemical pollutants, especially those dumped into the environment through discharge of effluents. This is exacerbated by lack of sewerage and effluent treatment facilities.

7.5.11. Hawking

Since Kenya liberalized her economy in the 1980s, hawking has increased significantly in all the urban centers. There are three main categories of hawking, namely hawkers of local and

imported products, vegetable and fruit hawkers, and street traders with specific areas of operation.

Impact of hawking on land-use: Hawking is associated with littering of streets in towns, especially Nairobi and Mombasa. Inadequate infrastructure for effective waste collection and disposal, has lead to accumulation of solid waste. Recent attempts by the Local Government to control and manage hawking in Nairobi City has alleviated the problem through allocation of alternative sites to registered hawkers outside the central business areas. This has eased congestion and reduced petty crimes in the city.

Table 7.6. Total international trade 1998-2002 (kshs. million)

Description	1998	1999	2000	2001	2002*
Export (FOB)					
Domestic Exports	114,448	115,406	119,764	121,434	131,394
Re-exports	6,735	7,153	14,763	26,156	37,889
TOTAL	121,183	122,559	134,527	147,590	169,283
Imports (CIF)					
Commercial	190,538	198,808	240,473	285,107	254,006
Government	7,251	6,592	7,331	5,001	3,704
TOTAL	197,789	205,400	247,804	290,108	257,710
Balance of Trade	- 76,606	- 82,841	- 113,277	142,518	88,427
Total Trade	318,972	327,959	382,331	437,698	426,993

Source: Economic Survey 2003

7.6. DUMPING, COUNTERFEITS AND SUBSTANDARD GOODS

7.6.1. Counterfeit and Substandard Goods

Counterfeiting is a malpractice that is posing great challenges to the economy, resulting in the downsizing of some local operations, closing or relocation to other countries considered as having lower operating costs.

In general counterfeit goods have short shelf life as compared to the genuine products. Large quantities of these materials are disposed of within a short period, resulting in the accumulation of waste. The wastes also affect human health in many ways as some are non-biodegradable and most cannot be recycled. External sources are mainly imports that constitute the infringement of trademarks, patents, copyrights and geographical indications. Internal sources mainly constitute use of franchise containers and package materials.

7.6.2. Impacts of Counterfeit and Substandard Goods on the Environment:

The problem of counterfeiting and dealing with substandard goods persists, partly because of:

- Poor vigilance and prosecution of those who contribute to dumping;
- Public awareness on the nature of merchandise in our markets. There is a growing need to educate the consuming public that cheap is not necessary convenient. In fact, at the end of the day it may turn out to be more expensive.
- Laxity on the part of law enforcement authorities, particularly with regard to investigation and prosecution. There is some growing need to be more vigilant and to take initiative to

scrutinize businesses. For instance, although the trade licensing fee was abolished, there is need to enforce business registration and licensing as a means of obtaining information on the types of businesses being done. Hawkers or any other person found to make, package or offer for sale counterfeits and/ or substandard goods should be arrested and prosecuted. Only then can we manage to kill illegal trade in Kenya.

The extend and scope of counterfeiting is difficult to quantify due to its sophisticated nature. A study conducted by WHO Counterfeit Working Group in 1999 indicated that between 10% and 20% of drug samples in developing countries failed quality tests due to infringement of copyright.

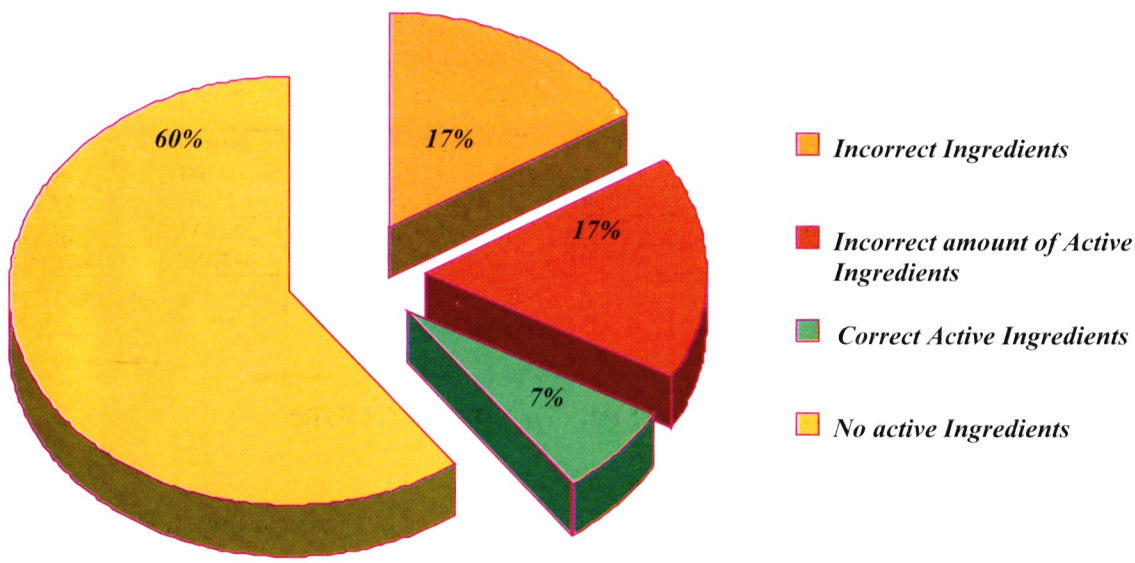


Figure 7.7. ***Counterfeit in Pharmaceutical industry***

Impacts of counterfeit goods on health systems and the economy

Counterfeit products in Pharmaceutical industry poses a very serious problem to human health and safety because the products have no impact on illnesses, thus prolonging treatment time. Further, counterfeit anti-biotics can reduce protection and increase resistance, while the vaccines do not immunise. This results to use of public funds on medication. The economy suffers from loss of taxes and revenues, loss of employment. The economy also suffers reduced growth, lowers capacity, innovation and incentives.

Impact on Companies

Loss of revenue, reduced incentives for research and development;
Loss of corporate image due to counterfeiting;
Litigation issues; and
Loss of intellectual property rights.

7.6.3. Trade and Genetically Modified Organisms

Genetically modified organisms (GMOs) and products are produced through genetic engineering. Trade in GMOs and LMOs is expected to be conducted with the full knowledge and consent of all affected persons. However, most developing countries that receive food

aid, often get GMO products without the prior informed consent of the receiving party thus contravening the provisions of the Cartegena Protocol on Biosafety. The National Biosafety Committee (NBC) ensures that biotechnology related research applications are thoroughly scrutinised before going to field trial and the subsequent release to the environment.

7.6.4. Constraints to Trade

The linkages between trade and environment are many and very complex. This is because all opportunities and inputs into the trading and manufacturing patterns rely on the environment. Trade and consumption patterns lead to discharges of waste into the environment. Several constraints affect trade as analysed below.

Infrastructure: Physical infrastructure has a direct bearing on the performance of most of the sectors in the economy. The current poor status of physical infrastructure in the country has lead to increased production costs and loss of competitiveness for the local products.

***High cost of utilities*:** The essential utilities such as electricity, telecommunications and water are needed to support trade. This reduces competitive on the production of goods and services.

Narrow product base: Exports are heavily depended on agricultural products. This over reliance on a few agro-based products exposes the country to vulnerability of price and market fluctuation in the international markets.

***Finance*:** Limited financial resources hinder availability of capital to start new business ventures, expansion and re-stocking of existing ones, thus presenting a major constraint to trade development.

***Effects of liberalization*:** Liberalization of trade has lead to flooding of the domestic market by cheap imported and substandard goods. This influx has also lead to accumulation of wastes due to the high turnover of counterfeit goods. In most cases, the associated duties and taxes accruing from such goods often not remitted to the government resulting to loss of revenue.

High Cost of Inputs: Trade in locally manufactured products is heavily dependent on imported raw materials, capital equipment and spare parts. Continued survival and growth of the sector will depend on it being competitive in both the local and external markets with regard to product, price and quality.

7.6.5 Impact of Trade on Land Use

A large proportion of the population is involved in trade. The small and medium enterprise (SMEs) alone employed close to 3.7million people and accounted for over 43% of Kenya's total export earnings in 2002 contributing about 18% of the GDP. These enterprises have grown significantly since independence due to high population growth and rural-urban migrations. Most of these firms are engaged in industrial activities such as tanning, brick and tile making, automotive repair, wood finishing, metal works which have potential to cause intensive pollution. As such, the cumulative and collective impact of all on the environment is equivalent or even more than that of other industrial establishments.

According to a 1998 study by United Nations Industrial Development Organisations (UNIDO) on "Ecologically Sustainable Industrial Development", the *Jua Kali* enterprises and

other SMEs in Kenya escape the EIAs, yet many of them impact negatively on the environment, generating different types of wastes that pollute the environment and contaminate air and soils. The rapidly increasing and unplanned SMEs generate additional discharge of pollutants, petroleum and chemical wastes into the soil and water system.

7.6.6. Measures and Strategies for Improving Trade

The following are the proposed measures for addressing the existing problems and promote investments and trade development.

Legal framework: The government will review, enact and enforce laws and regulations pertaining to trade practices in order to make it easier for enterprises to thrive and grow. For instance, about 12 trade related acts are being reviewed.

***Infrastructure*:** Infrastructure plays a fundamental role in the development and expansion of trade. The government efforts are on-going towards ensuring provision of low cost, high quality, infrastructure to support trade. Road upgrading and maintenance, improved railway transport, provision of adequate and efficient power and water supply will be addressed to ensure Kenya's industrial and commercial competitiveness. The efficiency of the port of Mombasa will be addressed to ensure smooth flow of goods in and out of Mombasa.

***Anti-dumping*:** Dumping creates disincentives to domestic manufacturing and production. In order to eradicate this disincentive, the antidumping committee will be strengthened, while at the same time imposing heavy duties on sub-standard goods to discourage dumping. Similarly, the existing machinery for tracking down diversion of transit goods and ensuring full duty payments will be strengthened. Kenya Bureau of Standards and Weights and Measures department will be empowered to seize, confiscate and withdraw substandard goods from domestic market to protect consumers.

***Credit facilities*:** Unavailability of adequate credit to the commercial sector, especially for SMEs is a major impediment to the sector's growth. Local financial institutions, which facilitate credit provision such as commercial banks, and direct foreign investors, should expand their lending bracket. The government is determined to increase support to these institutions in order to enhance incentives to the industrial and trade sectors.

Export Promotion: The government will encourage diversification of exports through review of EPZ and MUB incentives for extension to all goods and services.

***Public- Private Sector Partnership*:** The government will continue to work closely with the private sector to formulate trade policy, to identify markets and product diversification opportunities and negotiation of appropriate regional and international trade agreements.

a) Examine the effectiveness of structural adjustment programmes and trade liberalization reforms in Kenya.
b) To an enabling economic environment for businesses to thrive.
c) Trace trade impact of the reforms at the macro and micro economic levels.
d) Analyze trade reforms and relate to export bias overtime and provide a series of required actions to reverse negative effects.
e) Implement strategies that facilitate development trade through formulation and implementation of policies that can improve both domestic and external trade
f) Ensure protection of consumers from trade malpractices, such as fraudulent manipulations of weighing and measuring equipment.

g) Collect analyze, store and disseminate trade information.
h) Monitor the changes brought about by liberalization, globalization of world trade systems, in order to cushion the trade sub-sector for such changes
i) Ensure that he country reaps maximum benefits from international and regional agreements.
j) Negotiate favourable terms for Kenya exports in bilateral and multilateral trade fora, in order to promote economic integration and develop trade through regional bodies.
k) Promote export-oriented trade

7.6.8 International Agreements

There are many relevant international MEAs, national policies (Sessional Paper No. 1 of 1986, Trade Licensing Act Cap. 497), EMCA 1999 and issues related to WTO that affect trade in the country. About 20 of these MEAs have provisions that can affect trade such as banning trade in certain products or allow countries to restrict trade in certain circumstances. Among these are the Montreal Protocol for the protection of Ozone Layer, Basel Convention on the Transboundary Movement of Hazardous Wastes, Convention on International Trade in Endangered Species (CITES) and the Convention on Biological Diversity. Through these legal instruments, the government has changed from control and regulation to that of a facilitator, thus creating a better and competitive environment to support trade.

7.7 OUTLOOK

Industrial development depends on availability of raw materials. It is therefore necessary that plans for industrial development must provide for sustainable supply of raw materials without degrading the environment.

The impacts of industrial products on the environment depend on their components and the receiving environment. Additionally, by products and waste (emissions, effluents and solid) from industrial operations have varying impacts on the environment and human health and safety. It is therefore important demand EIA and EA licences from NEMA should made conditions for licensing any activity. The country should strengthen current initiatives to promote cleaner production technologies.

The country has a promising mining sector, whose expansion may be aided by the ongoing review of the Mining Act. Mining and quarrying are extractive activities, whose impacts include degradation of the environment, while removal processing and transportation of the product(s) has potentially significant impact on the environment. Previous and ongoing mining and quarrying operations are of great concern to environmental and public health and safety. EMCA requires regulatory and licensing authorities to make EIA and EA conditions for licensing.

The service sector, which covers transport and communication, financial, tourism, and trade impacts on the environment and human in many ways. The impacts include pollution by wastes, biodiversity degradation and landscape disfiguration. Some of the significant impacts include litter, plastic/polythene, emissions form transport, effluents, chemicals and hazardous/toxic substances. Current efforts to enforce compliance with environmental audit regulations should go a long way in mitigating the impacts.

CHAPTER EIGHT

POPULATION DYNAMICS AND HUMAN SETTLEMENTS ON LAND USE

8.1. INTRODUCTION

Population is the total number of people existing in area at a given time. It is characterized by total size, growth rate, density, age, distribution (including mean age and demographic dependency ratio), sex ratio and regional distribution. These characteristics are influenced indirectly through changes in one of the three basic determinants of population change fertility, mortality and migration.

8.2. POPULATION DYNAMICS

8.2.1. Population Size and Growth Rates

The national inter-censual growth rate declined from 3.4% in 1969 to 2.9% in 1999. By international standards, a population growth rate of 3% and above is considered high. Such a growth rate results in increasing demands on all types of resources required to meet the basic needs in terms of food, health, education and shelter. The net effect is a decrease in the resources available for improving the standard of living of the people.

At independence in 1963, the country singled out rapid population growth as a major threat to its development. Subsequently, it formulated the national population policy in 1967, whose thrust was to reduce the high fertility rate through family planning. Kenya was the first country in mainland sub-Saharan Africa to adopt a population policy.

The population size grew fast between 1969 and 1979 due to a rising fertility and declining mortality; it slowed down between 1979 and 1989 partly due to a falling fertility; and it slowed down further between 1989 and 1999 due to a continued fall in fertility and a rise in mortality.

There were variations in the population growth rates within the provinces. The percentage change in population size has been on the decline in Central and Eastern provinces since 1969, while Nyanza, Rift Valley and Western provinces experienced a rapid increase during the 1979-1989 period followed by a decline in the 1989-1999 period. The increase in Nairobi province during the 1989-1999 period is attributed to net in-migration from other provinces, while the unique increase in North Eastern province may be accounted for by the influx of refugees from neighbouring countries.

Figure 8.1. Total population of Kenya for census years 1969, 1979, 1989, and 1999 and the Projections for years 2001, 2005 and 2008

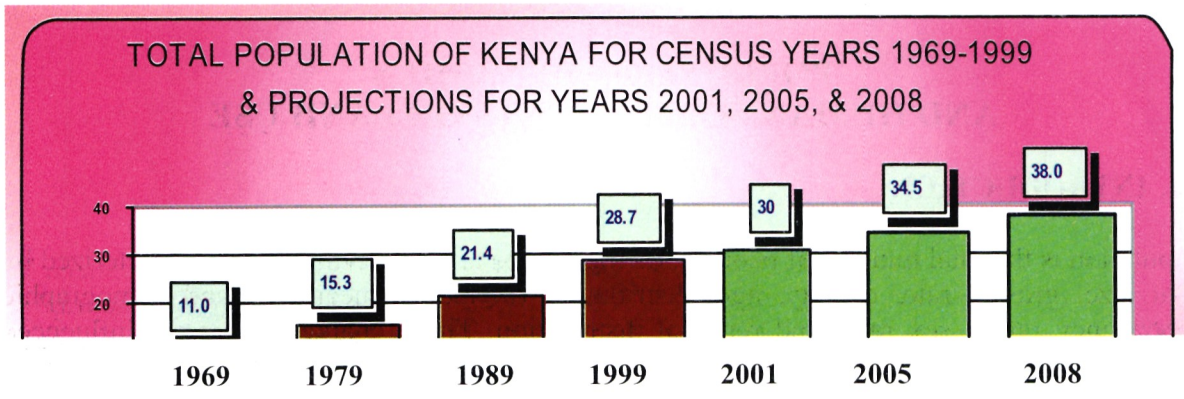
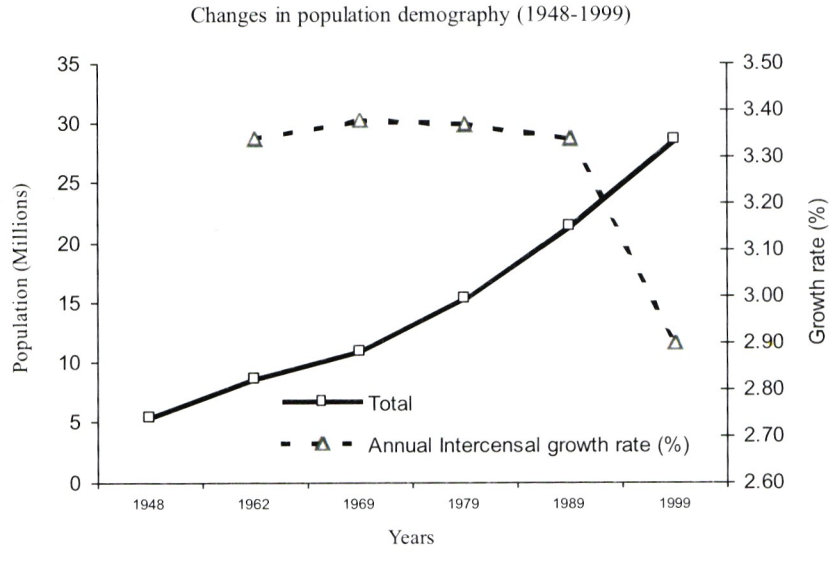


Figure 8.2. Changes in national human population demography, 1948 - 1999



Source: CBS, Population Census 1969, 1979, 1989 and 1999

8.2.2. Age-Sex Composition

The needs of a population vary with age and sex. Between 1969 and 1989, the population aged below 15 years was about 48%, dropping to 44% in 1999. The population aged 15-64 years increased from 48% in 1969 to 53% in 1999. Those aged 65 years and above remained at 3% over the 30-year period. Kenya's dependency ratio in 1999 was 90, having dropped from 105 in 1989. Age and sex characteristics are very useful in formulating national policies and planning for socio-economic development.

Figure 8.3. Comparison of population density by age group

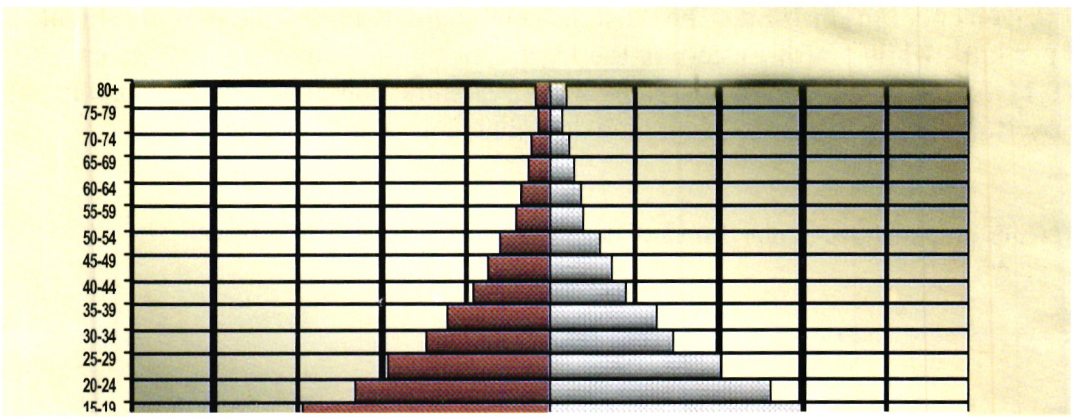
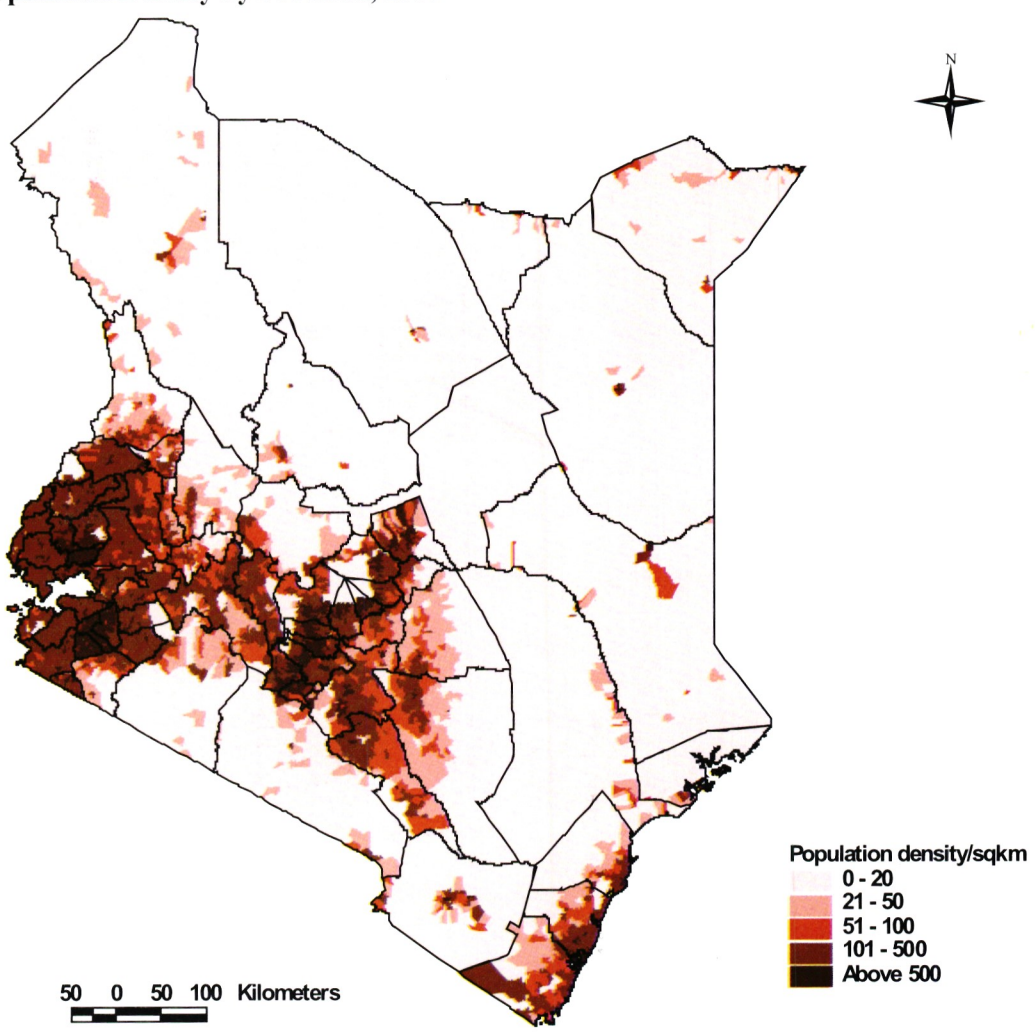


Figure 8.4. Population Density by Province, 1999

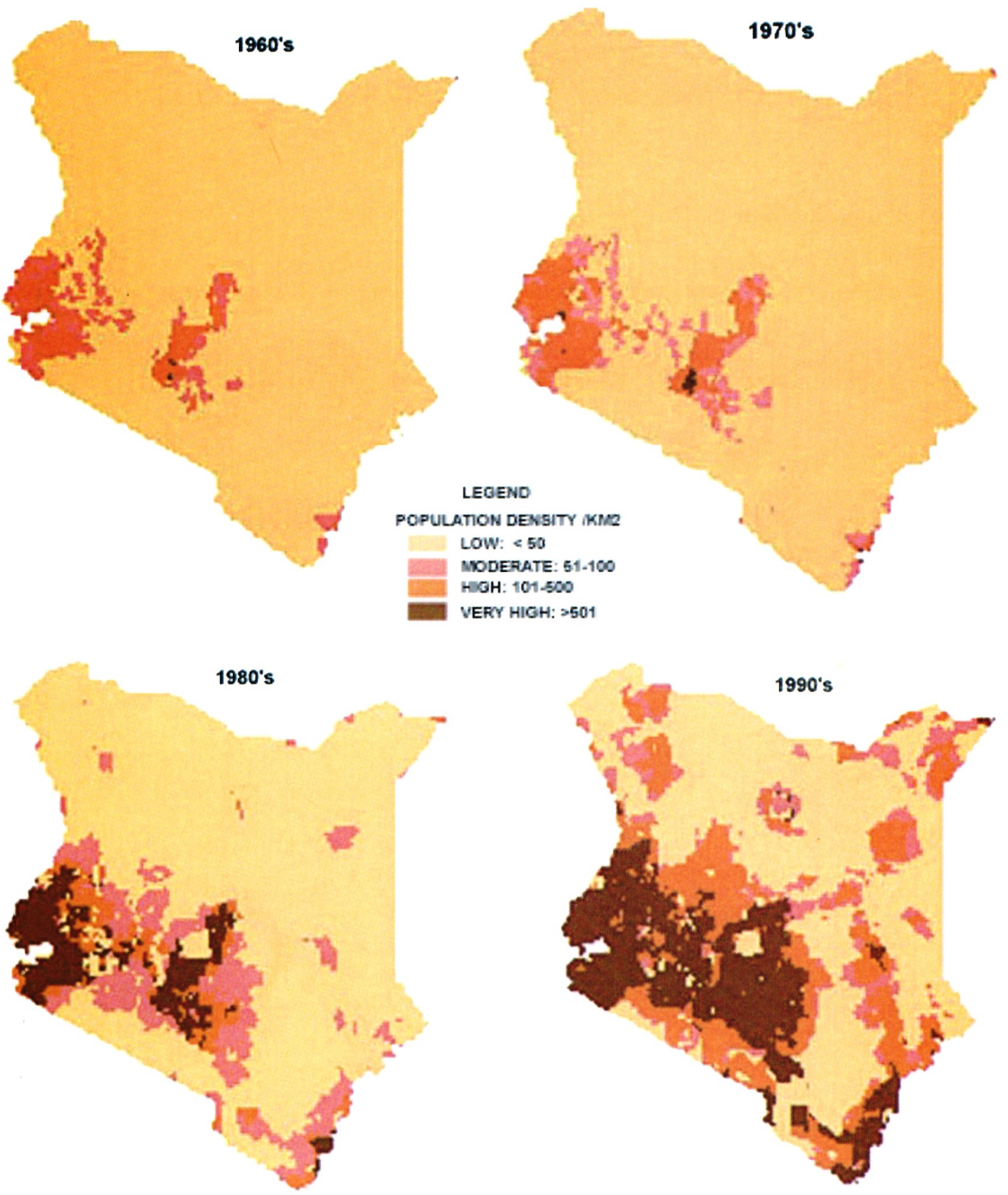


Source: 1999 Population and Household Census

8.2.3. Population Distribution

Kenya's population is unevenly distributed with 49 persons per km^2 in 1999, an increase from 37 persons per km^2 in 1989. The most densely populated province is Nairobi with 3079 persons per km^2, while North-Eastern is the least densely populated with 8 persons per km^2 (Figure 8.1). As the population increased over the years, the population density also increased thereby exerting increasing pressure on land and related natural resources.

Fig. 8.5. Trends in spatial population distribution and density between 1960 and 1990



Source: CBS and Population Census; 1969, 1979, 1989 and 1999

8.2.4. Fertility

Fertility contributes to the increase in size and shape of the age and sex structure of a population. The continuing high population growth is a result of population momentum gathered during the rapid growth period whereby the large number of individuals born during the last two decades are now entering their childbearing years.

Fertility rates have generally declined in most areas of the country. However, population growth is still soaring due to high levels of fertility in some parts of the country. Variations in fertility levels reflect differences in the level of social and economic development along with variations in contraceptive use. Based on the analysis of past census data:

a) The mean number of children per woman is on the decline for all age groups and particularly so for younger women.
b) The crude birth rate has been declining from 54 births per 1000 people in the 1970s to 48 in the 1980s and then further to 41 in the 1990s.
c) The total fertility rate dropped from 7.8 in the 1970s to 6.6 in the 1980s and then to 5.0 in the 1990s.
d) Secondary education was associated with reduced fertility.
e) The 1999 fertility rate for married women was 6.1, while that for single women was 3.4.

8.2.5. Mortality

Mortality is one of the contributing factors to population change. Apart from decreasing the size of a population, it also influences the shape of the age and sex structure of a population. Improvement in public health and hygiene brought about by the scientific and economic welfare have altered the course of population history through dramatic reductions in mortality. This led to staggering increases in the rate of population growth.

Declines in mortality have also played an important role in high levels of population growth. Low cost technologies such as antibiotics, vaccines and improvements in nutrition and increased agricultural production have reduced mortality throughout the country. Based on analysis of past census data:

a) There was consistent decrease in child mortality between 1962 and 1989. However, between 1989 and 1999, child mortality increased, especially for children of younger mothers.
b) Attainment of primary level of education of a mother was associated with an average reduction of 25% in child mortality as compared to the mortality of children whose mothers had never been to school. A reduction of 48% was associated with attainment of secondary level of education.
c) children born in Nyanza province were three times more likely to die by age 5 compared to those born in Central province.
d) The crude death rate declined from 17 per 1000 people in the 1960s to 14 in the 1970s and further to 10 in the 1980. However, it rose to 12 in the 1990s.
e) Infant mortality rate fell from 119 per 1000 people in the 1960s to 88 in the 1970s and then to 66 in the 1980s; there was a sudden increase to 77 in the 1990s.
f) There was a consistent increase in the expectation of life from 49 in the 1960s to 54 in the 1970s and then to 59 in the 1980s. This dropped to 57 in the 1990s.

8.2.6. Migration

The factors that stimulate migration vary by region. They include search for higher education, food availability, water, forage, prospecting for employment, improved infrastructure, land, and recreational facilities. Based on past census data:

a) Migration patterns within Kenya for the period 1969 and 1999 did not change implying that the push and pull factors in the provinces and districts remained unchanged over the period;
b) Emigration rates were higher in Nyanza, Central, Eastern and Western provinces than in the other provinces;
c) Resettlement districts include Laikipia, Kajiado, Trans Nzoia, Uasin Gishu, West Pokot, Lamu and Tana River;
d) The proportion of people living in urban areas has been increasing from 10% in 1969 to 15%, 18% and 27% in 1979, 1989 and1999 respectively; and
e) Apart from Nairobi which is 100% urban, Coast province has the second largest urban population with a share of 37% followed by North Eastern 15%, Rift Valley 14%, Nyanza 10%, Central 10% Western 8% and Eastern 6%.

Migration propensities vary by age with young adults exhibiting the highest likelihood of moving – fueled by education and employment prospects. Due to the large younger generation there is increasing levels of urbanization as the individuals respond to the pull of urban opportunities.

8.2.7. Impacts of Population Dynamics on Land Use

Each individual uses environmental resources and contributes to environmental degradation and pollution. Each individual requires food, the production of which requires land for agriculture or other forms of sustenance production. The scale of resource use and the level of wastes produced vary across individuals and cultural contexts.

Today's rich consume disproportionately large amounts of energy and produce an equally disproportionate amount of waste. As incomes rise, consumer aspirations change leading to rising pollution levels due to increased production processes meant to meet increased consumer demand.

Income is important when considering environmental implications of population composition. Population pressures and poverty interact to result in unsustainable use of resources in an effort to meet short-term livelihoods. Lower levels of development and income are associated with greater local environmental pressures. Poverty can induce people to use resources without consideration of the effects or implications for future generations.

Rising population increases demand for food crops production, hence expansion of agricultural land becomes necessary. Additionally, the young family units demand their own land holdings. The result is progressive sub-division of family land into small land parcels. Unfortunately, some holdings are too small to support subsistence needs. 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 severe impacts of drought.

Continued population growth and desire for land, have resulted in people settling in wildlife migration corridors and other wildlife dispersal habitats leading to human-wildlife conflicts. The impacts of these factors include decline in wildlife numbers over the years (Table 4.5). For a large number of Kenyans, inadequate access to basic means of livelihood (food, safe water, shelter, healthcare and education) is an everyday reality. Wood-fuel provides about

70% of the nation's energy requirements and 90% of the rural energy requirements (Table 8.1). 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.

Harvesting of trees for charcoal has moved to more ecologically fragile areas, especially water catchments and rangelands. As the natural vegetation cover is destroyed through soil erosion and degradation, the ecological conditions are changed affecting the livelihood of people and survival of wildlife.

Water consumption has risen greatly more than the rate of population growth. Per capita water consumption stands at below 704 cubic metres against World Health Organization (WHO) standard of 1000 cubic metres. The high level of this resource use is worrying.

Population migration eases environmental pressures in some areas, while increasing pressures in others. For example, rapid urbanization has outpaced the development of infrastructure and environmental resources, resulting in high levels of air pollution and water contamination.

Table 8.1. Percent of households by main type of cooking fuel by province in 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.

8.2.8. The Impact of Refugees on the Environment

Kenya is signatory to the 1953 Geneva Convention on refugees. The country has hosted refugees mainly from Somalia, Ethiopia, Sudan and Uganda. Most of the 200,000 refugees are housed in Dadaab and Kakuma camps of Garissa and Turkana respectively. The refugees have stayed in the camps since 1993 and their use of natural resources is degrading the environment. The use of fuelwood, building poles, grass and poaching of wildlife by refugees have created conflicts with other resource users. The species most targeted for fuelwood include *Cordia sirensis* (bisg-som) and *Delbargia* spp (Dei Dei-som) and kordobo (som). The UNCHR refugee fuelwood programme is implemented by GTZ in both Kakuma and Dadaab refugee complexes. This project buys dry fallen fuelwood from local communities in about 15 harvesting zones within a range of 50 – 100km from the refugee camps but contracts local communities to harvest wet wood for Kakuma refugee camp.

the latrines are sinking, leaving the land to subside creating unusual valleys and open pits. These are posing new challenges to the lives of the Liboi community.

The hunting of wildlife, especially the herbivores has depleted food for carnivores like the lion and hyena. Environmental assessments done in the area shows that communities are loosing a lot of livestock and human lives to lions and hyenas in Liboi. Hunting and poaching of wildlife by the refugees is currently active at Lagh Bogol area (180km from refugee camps in Wajir) and 100km towards Garissa District. This is threatening the existence of the endangered Hirola species in Arawale National Reserve of Bura Division, Garissa District.

Biomass survey of wet and dry fuelwood around refugee camps in Garissa shows that refugee impacts are most severe within a range of 0-35km where debris and non-economic quantities of fuelwood were found. Ground cover was over 60% in areas far from camps (70km away), while it was less than 10% in areas close to the camp (5km).

The large population of refugees are also putting pressure on ground water resources as one camp could have more than five boreholes within a range of less than 3km. Other impacts are associated with cultures and social influence. The refugees are enterprising and start small enterprises such as wheelbarrow shops (i.e. hawking of small business). This has severe impacts as it generates polythene paper wastes. There have been reports of deaths of livestock associated with ingesting plastic materials. This contributes to loss of livelihoods in this fragile ecosystem.

Mitigation measures include the formation of environmental working groups (EWG), formation and strengthening of Divisional Environment Committees in the refugee impacted areas of Garissa and Turkana Districts.

8.2.9. Responses to the Impact of Population on the Environment

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. 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*.

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 International Conference on Population and Development (ICPD) programme of action complements Agenda 21 on Environment and Development. *The National Population Policy for Sustainable Development* 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.

8.3. HUMAN SETTLEMENTS AND INFRASTRUCTURE

8.3.1. Characteristics of Human settlements

Most of the Kenyan population lives in the high to medium potential areas in Western, Nyanza and Central Provinces and in some parts of Eastern and Rift Valley provinces. Nyanza, Western and Central provinces population density was 350, 282 and 406 person/km^2 respectively (Table 8.2). Although the country's 12% of the land continues to accommodate most of the population, the semi-arid lands continue to attract numbers far in excess of its carrying capacity.

Since independence in 1963, the country has registered a high rate of urbanisation of about 6% per annum. Nairobi city accounted for 51%, 36%, 34% and 28% of the urban population in 1969, 1979, 1989 and 1999 respectively. Mombasa municipality's population rose from 383,452 to 665,018 (73% rise) between 1969 and 1999 (Table 8.3).

Table 8.2. The population size and density by province

Province	Total population	Area in km^2	Density
Nairobi	2,143,254	696.1	3079
Central	3,724,159	13,220	282
Coast	2,487,264	82,816	30
Eastern	4,631,779	153,473	30
North Eastern	962,143	128,124	8
Nyanza	4,392,196	12,547	350
Rift Valley	6,987,036	182,539	38
Western	3,358,776	8,264	406
TOTAL	**28,686,607**	**581,677**	**49**

Source: Republic of Kenya, Central Bureau of Statistics. The 1999 National Population Census.

Table 8.3. Growth of urban centres by actual population size, 1962 – 1999

Size of centre	*1962*	*1969*	*1979*	*1989*	*1999*
100,000	523,079	756,359	1,321,566	2,371,158	3,316,603
20,000 – 99,999	61,707	79,582	568,099	822,971	3,852,778
10,000 – 19,999	44,005	685	149,756	257,775	259,564
5,000 – 9,999	69,862	71,396	154,181	232,259	154,187
2,000 – 4,999	49,002	81,886	122,094	194,554	170,380
Total	749,651	989,908	2,315,696	3,878,697	7,753,512
% of national total	7.8	9.9	15.1	18.0	27.0

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

The population of urban centres, which accounted for 7.8% of the total population in 1962 increased to 9.9%, 15.1%, 18% and 27% in 1969, 1979, 1989 and 1999 respectively (Table 8.4). The 20 urban centres with population over 99,999 accounts for 43% of the urban population. The 102 of 276 urban centres with population size over 19,999 account for 92% of the urban population. The three largest urban centres account for 40% (with Nairobi,

Mombasa and Kisumu accounting for 28%, 8% and 4% respectively) of the urban population according to the 1999 National Population Census (Table 8.4).

Table 8.4. Growth of Some Selected Urban Centres, 1969-1999

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

Source: Republic of Kenya, Central Bureau of Statistics. National Population Census 1969, 1979, 1989 and 1999.

8.3.2. Settlement Planning

Most urban centres lack approved physical development plans, most of which were prepared in the 1960 and 1970s. A few of them have been revised to cope with rapid urban growth. The existing Nairobi city master plan is already 57 years old, 22 years older than the maximum life of a master plan. The master plans of Mombasa and Kisumu municipalities were prepared in the 1960s and have not been revised to cope with urban growth and development. Most urban growth, which took place during the last two decades have occurred mainly outside the planned area leading to massive growth of slums and informal settlements. Nairobi city is still guided by the master plan that was approved in 1948. All urban centres in Kenya are characterised by slum and informal settlements. For example, 60% of Nairobi city residents live in slum settlements. Kenyan urban poverty level is estimated at 60%. Most of the urban poor live in the slum and informal settlements. The main features of slum and informal settlement are inadequate infrastructure, services and housing (water and sanitation, roads, educational and health facilities).

Problems affecting urban settlement are enhanced by poor enforcement of physical plans leading to the mushrooming of informal settlements as investigated by PCC (box 8.1).

Box 8.1. Cases relating to informal urban settlements

It was evident from the investigations carried by the Public Complaints Committee that the urban environment is rapidly deteriorating due to:

a) Mushrooming of unplanned human settlement;
b) Increase in human population resulting in overstretched institutional capacities;
c) Inadequate sanitation facilities;
d) Inadequate medical/health facilities;
e) Unsafe water; and
f) Technological advancement e g mobile phones.

Cases investigated indicate the worsening state of access to clean water and sanitation services leading to severe environmental degradation and health problems

It was observed that there are many unlicensed activities operating in urban centres which have not been subjected to environmental audits; consequently, their negative effects on the environment remain unchecked. Failure by lead agencies to enforce the various sectoral laws from which they draw their mandate was noted as a major contributing factor. General breakdown in the urban infrastructure is seen to contribute to the general environmental deterioration. The Committee established that public perception and attitude have largely contributed to poor urban environment

In view of the foregoing findings, there is urgent need to enhance awareness on proper environmental management to ensure that all activities which are governed by the provision of EMCA should comply with environmental impact assessment and environmental audit regulations.

8.3.3. Human Settlement Infrastructure

Since the 1970s, the government has undertaken a number of policy measures to develop human settlement infrastructure and services. The following are some of the policies and strategies that have been implemented to address the infrastructure and service provision challenges: growth centre policy, rural trade and production centre strategy, district focus for rural development policy and slum upgrading strategy. However, these policies have made little impact on infrastructure and service provision. However, the growth centre and rural trade and production centre policies benefited only a limited number of centres. Most of these policies are either dormant or abandoned as they did not make provision for the operation and maintenance of infrastructure, which have deteriorated and are in a state of disrepair. Most of the infrastructure developed through these strategies have failed to stimulate the expected human settlement development. For example, the growth centre policy has failed to redirect human settlement away from Nairobi City and Mombassa Municipality.

The Nairobi Situation Analysis (UN-HABITAT and Government of Kenya 2002) indicates that the number of informal settlements and their population has been increasing rapidly since 1971 at a rate of 7-12% annually, compared to the national rate of less than 3% per annum (Table 8.5).

Table 8.5. Informal settlements in Nairobi city

Year	No. of informal settlement	Population (Number)	Population (%)
1971	50	167,000	33
1990	78	200,000	40-50
1993	36	748,991	55
1995	133	1,886,166	60

Source: UN-HABITAT and Government of Kenya, 2002

8.3.4. Sewerage Systems

Only 30% of the gazetted urban centres in Kenya have sewerage systems causing serious environmental and health problems. Main sewer systems in most urban centres suffer from constant breakage or leakage and inadequate capacity to handle their full load. Discharge of effluents pollute rivers, streams and dams; making water unsafe for domestic and livestock consumption. Management of solid wastes in urban areas is increasingly becoming a major concern.

Human settlement planning and management is guided principally by the Physical Planning Act of 1996, the Local the Local Government Act, EMCA and the Environmental (Impact Assessment and Audit) Regulations of 2003. The Physical Planning Act of 1996 provides the statutory framework for the planning and management of all physical developments in Kenya and provides for the preparation and implementation of Local and Regional Physical Development Plans. The Act bestows the responsibility to plan and enforce development control on local authorities. The Local Government Act governs the creation and operation of local authorities, which empowers them to plan in order to ensure orderly development of all land under their jurisdiction.

Physical development plans prepared by the Physical Planning Department are usually left to local authorities to implement. However, local authorities have inadequate capacities to implement these plans, in terms of personnel and finances. Inadequate human capacities in physical planning is not only a phenomenon in local authorities but also the central government with only about 100 planners. Save for Nairobi city, all other local authorities depend on the Director of Physical Planning for planning and development control.

8.4.HOUSING

In Kenya, demand for shelter has always outstripped supply. This has led to very poor shelter conditions, spreading of slum and squatter settlements in urban centres and their peripheries as well as the prevalence of low quality housing (Tables 8.6 and 8.7. This situation is largely due to rapid urbanization and widespread poverty. This is aggravated by inappropriate and ineffective 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 people. 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. The housing problem facing the country is being addressed through the central government, local authorities, the National Housing Corporation, private sector,

professionals, employers, cooperatives, private developers, individuals, civil society organisations and development partners.

The diversity of Kenya's population demands that provision of housing would best be managed if the needs of different income groups are known. The National Housing Development Programme is designed to serve three income categories - low, middle and high. About 70% of requirements needed for housing development should be given to the low income category, 26% to middle income and about 5% to high income category (Table 8.8).

Table 8.6. 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 8.7. 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

Table 8.8. Housing requirements for urban centres

	Low Income Housing	Middle Income Housing	High Income Housing	Total Requirements
Nairobi	31,233	11,560	2,352	45,155
Mombasa	3,779	1,251	254	4,886
Kisumu	1,649	610	124	2,384
Median Size Towns	11,236	4,161	489	16,245
Other towns	53,597	19,832	4,037	77,487

The National Housing Development Programme proposes the development of over 65,000 housing units to relieve overcrowding in Kenya's urban centres (Table 8.9). Housing units which need to be upgraded during the 1990-2010 period are given in Table 8.10. Of the total housing units proposed for upgrading, 50% is for low income, 40% for middle income and 10% for high income groups. An average of 18,267 units should be upgraded every five-years.

Table 8.9. Housing units needed to relieve overcrowding by income group in major urban centres

	Low Income	Middle Income	Total
Nairobi	18,287	2,031	20,319
Mombasa	1,978	219	2,198
Kisumu	964	107	1,072
Other Towns	31,382	3,486	34,869
Total	51,190	6,574	65,768

Table 8.10. Number of house units planned for upgrading by income group

	Low	Middle	High	Total
Nairobi	2,257	3,822	564	5,644
Mombasa	244	305	61	610
Kisumu	119	142	29	298
Median Size Towns	812	1,015	203	2,030
Other towns	3,875	4,82	968	9,685
Total	7,306	9,133	1,825	18,267

As demand for low-cost housing continues, especially in major urban centres, new ways of providing housing ought to be sought. The diminishing land for housing development will require that better methods be devised to maximize the scarce amount of available land. The National Housing Development Programme proposes to develop high-rise housing schemes for the construction of apartments that will house several families on smaller land units. This concept minimizes on the use of land.

The current shortage of houses in the country, especially in urban areas coupled with lack of affordability has resulted in the mushrooming of uncontrolled slums. Slums improvement is proposed under the National Housing Development Programme. The approach calls for rehabilitation and improvement of existing slums. Improvement involves the provision of clean running water, better sewer services and the roads. A number of private agencies are already operating slum improvement programmes, including the National Co-operative Housing Union (NACHU), The Undugu Society, and a number of Non-governmental Organizations (NGOs).

The Ministry of Lands and Housing coordinates all housing matters including the implementation of the National Housing Policy and the National Housing Development Programme (Table 8.11). The Ministry of Local Government, under which Local Authorities fall, is in charge of preparing national housing regulations and guidelines for local authorities in the implementation of shelter programmes and related infrastructure services.

All projects at district and lower levels will have to be incorporated in the District Development Committee programmes for effective monitoring.

Table 8.11. Institutional Framework for Implementing Housing Programmes

Level	Lead Or Co-ordinating Agency (EIS)	Number In Country	Main Functions
National	Ministry of Land and Housing	1	National policy and programme planning National Co-ordination and Monitoring
	National Housing Corporation	1	Chief implementation agency
	Ministry of Local Government	1	Preparation of National body at district level for decentralised implementation

8.5. HEALTH AND ENVIRONMENT

8.5.1. Pollution and Waste Management

The generation of domestic waste has become an increasing environmental and public health problem in many parts of the country. This is partly due to rapid expansion of urban areas, rural to urban migration, spurred by high population growth rates. This has the effect of generating huge amounts of domestic wastes that pollute the environment. In some cases, the amount of waste generated is overwhelming. The problem is exacerbated by inadequate planning, inefficiency, and inadequate capacity, poor technology and weak enforcement of existing legislation by authorities.

Most of the urban areas in the country are faced by domestic waste management problems. In most towns, waste management is inadequate and a significant portion of the population does not have access to waste collection. Only 32 out of 174 local authorities have any form of sewerage collection and disposal infrastructure. Examples of districts without a single sewerage plant include Kuria, Isiolo, Gucha, Homa Bay, Makueni, Trans Mara, Narok, Ijara, and Wajir. Only 40% of waste generated in urban centers in the country is collected. In Nairobi, the capital city generates about 2000 tonnes/day of solid waste of which 68% is domestic waste. However, the city council collects only 400 tonnes/day of the solid waste. Mombasa the country's second largest city generates about 750-tonnes/day.

About 83% of households in the country have access to some type of sanitary facilities. Out of these 11% have flush toilets, 63.8% have traditional pit latrines and 8.4% have improved ventilated pit latrines. Most of these facilities are located in urban areas where 94.9% have improved sanitation as opposed to 78.3% in rural areas.

The government has come up with several initiatives with a view to prioritising domestic waste management issues. The initiatives include the Public health Act, Local government Act, EMCA, Policy paper No. 6 of 1999 on Environment and Development, Formulation of environmental (waste Management) regulations and standards. Other activities geared towards improved domestic waste management are the ongoing slum upgrading programme, privatisation of solid waste disposal in urban areas and the proposed use of economic instruments to deal with the plastic paper menace.

8.5.2. Radiation

The Radiation Protection Act (Cap 243) provides for the protection of radiation workers, members of the public and the environment from the dangers arising from the use of devices or materials capable of producing ionizing radiation.

Naturally Occurring Radioactive Material (NORMS) are widespread in nature and generally very diluted. In many resource-based industries, normal industrial practices may increase the concentration of NORM elements to levels where special precautions are needed for handling, storing, transporting, and disposing of the elements. In Kenya, several sites with elevated concentration of NORMs have been the subject of environmental radiation studies. One such hot spot is the Mrima Hill in Kwale District.

Application of various types of radiation emitting radionuclides is found in various sectors of our economy such as in medicine, agriculture, industry, research and teaching. Radionuclides used are mainly sealed sources and to a small extent, unsealed sources. Such sources include (but not limited to) tirium (H-3) carbon-14, phosphorus-32, sulfur-35, cromium-51, iodine-131, indium-111.

Release of radionuclide into the environment will result in ambient environmental contamination which will subsequently result in the contamination of the food chain. Stringent operational regulatory controls must therefore be put in place to safeguard against accidental releases, while promoting and enhancing the accruing benefits.

The modern world is full of devices which, either directly or indirectly, act as sources of Non-Ionizing Radiation (NIR). These sources produce NIR in electromagnetic (EM) spectrum of wavelengths/frequencies ranging from 100nM to static fields. In general, NIR tends to be less hazardous to humans than ionizing radiation (ionizing radiation has a wavelength less than 100nM or a photon energy greater than 12.4 electron volts).

8.6. POVERTY AND THE ENVIRONMENT

About 56% of people in Kenya are classified as being absolutely poor (living on less than a dollar a day), of which 11.4 million live in rural areas. The Poverty Reduction Strategy Paper of 2001-2004 identified causes of poverty as low agricultural productivity and poor marketing, declining economic growth, high level of inequalities, gender imbalance, land and other productive assets, high education costs, bad governance and corruption, poor delivery of service, HIV/Aids, unemployment and low wages, insecurity and ethnic tensions, disability and vulnerability. The interaction between the poor and the environment has resulted in undesirable consequences that have accelerated the levels of poverty in the country.

8.6.1. Land Degradation

As a result of being economically deprived, the poor engage in farming practices, which rely on rainfall, inadequate input application (fertilizer, pesticides etc) and inappropriate technologies. As a result, the production potential of the land declines due to the nutrients being exhausted.

In central parts of Kenya, Kisii districts and Western province, increasing population has lead to uneconomical sub-division of land (Table 8.12). This has generally contributed to land exhaustion and therefore diminished output per unit area resulting in migrations to the pastoral areas. These migrations often result into inappropriate land-use practices including crop farming in fragile ecosystems. The result is the increasing scarcity of water and pasture to pastoral communities that have resulted in more poverty and inter-ethnic conflicts.

8.6.2. Poverty and Water Resources

Access to safe water is estimated at 70% in urban areas, but significantly lower in urban slums at about 50%. Access to safe water is estimated at 48% in rural areas. Though significant efforts have been put in place to improve access to potable water, about 13.7 million people have no access to clean water countrywide. Further, 5.7 million people have no access to sanitary facilities countrywide (Ministry of Water Resources, MTEF report 2003).

Table 8.12. Mean land holding sizes (acres)

	Poor (In the District)	Poor (Outside the District)	Poor (Total)	Non-Poor (In the District)	Non-Poor (Outside the District)	Non-Poor (Total)
Central Rural	1.7	0.2	1.9	1.9	0.4	2.3
Coast Rural	4	0.3	4.3	4.2	0.5	4.7
Eastern Rural	5.8	0.1	5.9	4.3	0.2	4.5
Nyanza Rural	3 5	0 2	3.7	2.8	0 2	3.0
Rift Valley Rural	4.8	0 5	5 3	5.6	0.9	6.5
Western Rural	2.9	0.3	3.2	3 9	0.5	4.4
Total Rural	4.0	0.3	4.3	0.0	5.7	5.7
Nairobi	0.1	1.6	1.7	0.0	5 7	5 7
Total Urban	0 3	1.2	1.5	0.3	3.6	3.9
Nation	3.3	0.5	3.8	3	1.1	4.1

Source: Government of Kenya (2000) Second Report on Poverty in Kenya volume II - Poverty and Social Indicators

8.6.3. Deforestation and Fuel-wood Consumption

Poverty and deforestation are related in a number of ways as most households depend on non-commercial fuel for heating and cooking needs such as fuel wood or charcoal. Increased poverty leads to increased demand for fuel wood leading to depletion of the forestry resources.

Between 1995 and 2020, the demand for wood for both construction and fuel will double (Table 8.13). The demand for fuelwood will increase from 2 million cubic meters to over 4 million cubic meters. This consists of over 70% of the total energy consumed in the country. It is noteworthy that as a general trend fuel wood is the dominant source of energy in rural areas and among the urban poor in the form of wood and charcoal respectively. This implies that any dangers to the environment must be addressed by focusing on how best to improve energy consumption among the poor population. The figures above can be compared with projected supply of wood (Table 8.14).

Table 8.13. Projected demand for fuel wood and construction wood ('000 m^3)

Product	1995	2000	2005	2010	2015	2020
Fuel wood	20107	23947	27693	31720	35880	40133
Poles and posts	1219	1435	1689	1989	2335	2736
Total	21326	25382	29382	33709	38215	42869

Source: Kenya forestry Master plan, 1994

Table 8.14. Wood biomass inventory, current trends ('000,000M^3/)

Year	1995	2000	2005	2010	2015	2020
Indigenous forests	228	224	219 212		203	193
Woodlands and bushlands	595	590	586 582		577	573
Farmlands and settlements	88	112	136 160		186	212
Gazetted forest plantations	51	44	37 32		27	21
Total	962	970	978 986		993	999

Source: Kenya Forestry Master plan, 1994

8.6.4. Consumption and Production Patterns

Fuel wood consumption is also significant as an ozone depleting practice with significant carbon emissions experienced in the process of charcoal burning and general wood clearing for cultivation. More importantly, the reduction in forest cover denies the country its status as a net carbon sink, further complicating the already bad situation.

Production patterns have the potential to strain the environment and natural resources, with serious impacts on the well being of society. Choice of agricultural methods, foods grown, clearing of lands and use must be factored in the analysis of causes of environmental degradation (Table 8.15).

Figure 8.6. Percentage of income used to procure basic needs

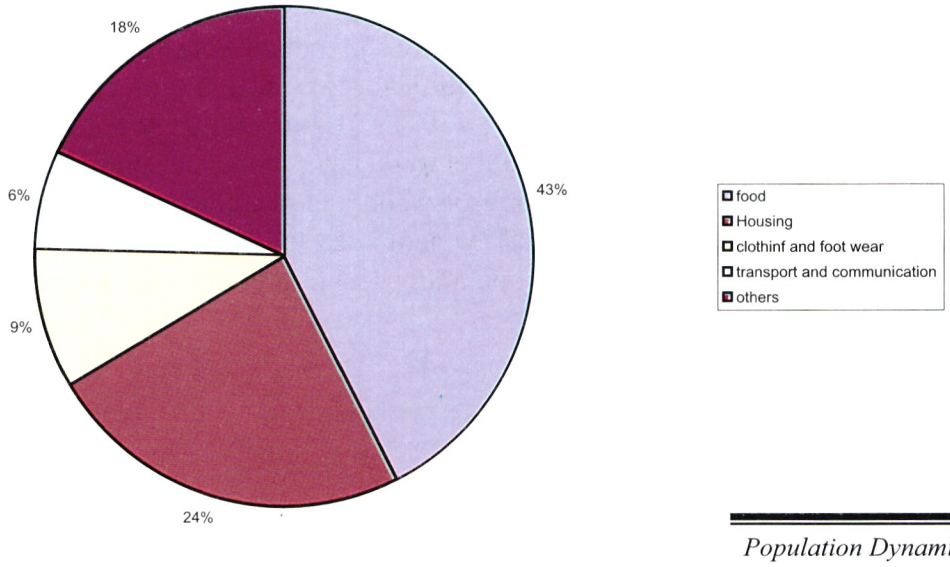


Table 8.15. Land Utilized for agricultural production

Commodity	Hectares (000)	Percentage of Total
Milk/beef/mutton	3,240.00	47.410
Maize and beans	1,587.00	23.222
Other Starchy root crops	490.00	7.170
Sorghum and millet	280.00	4.097
Coffee	179.00	2.619
Wheat	150.50	2.202
Cotton	145.00	2.122
Fruits	150.00	2.195
Sugar	151.00	2.210
Tea	177.00	2.590
Potatoes and vegetables	108.00	1.580
Sisal	75.21	1.101
Cashew nuts	37.95	0.555
Groundnuts	25.53	0.374
Barley	20.01	0.293
Sunflower	15.18	0.222
Pyrethrum	1.38	0.020
Rice	1.24	0.018
Tobacco	0.07	0.001
Total	**6,834.07**	100.000

Source: Government of Kenya: Strategy for Revitalizing Agriculture (2004-2014) March 2004

Much of land degradation in Kenya is attributable to poor land management practices. This problem is made worse due to poverty, making land users have fewer opprtunities to obtain information and learn about appropritate land use technlogies. It must be understood that although agricultural options available to the poor are limited by physical and climatic conditions, many opprtunities exist to improve and promote sustainable use of natural resources.

Poor households have little or no access to agricultural extension services. In a report by the Ministry of Planning and National Development, 76% of those surveyed did not receive any kind of extension services (Table 8.16). The lack of knowledge of new farming technologies by the poor leads to use of inappropriate practices. New farming methods such as mixed cropping, crop rotation and contour ploughing are rarely practiced. On the contrary, when the best agricultural land has been used up more marginal land has to be used for subsistence farming.

Table 8.16. Households-receiving advice from the extension services (%)

Have Received		Have not received	
Very poor	25.8	74.2	100.0
Poor	19.6	80.4	100.0
Average	26.3	73.7	100.0
Rich	34.7	65.3	100.0
Total	24.2	75.8	100.0

Source: Ministry of Planning and National Development, Kenya Citizen Report Card on Service Delivery: Are services being delivered to the poor, Nov. 2003

The poor face the problem of high cost of fuel wood and charcoal and the long hours women have to take to search for wood fuel. The demand for fuel wood is likely to outstrip the supply in a short while.

8.6.5. Gender and Labour

The distribution of active population by economic activities reveals a gender-based division of labour. The economically active females are concentrated within agriculture where in all cases they account for more than 53% of the population, men predominate in all the other sectors. For instance, men outnumber women in fishing registering a ration of 20:1, construction (17:1) and transport (13:1); the figures are somewhat more equitable in sales (2:1) and manufacturing (2.4:1).

Women dominate amongst the unpaid family workers; 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%. 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.

About 58,000 children of school going age are involved in child labour of which 92% are exposed to various occupational hazards. The other 7.9% are provided with protective devices in their workplaces. The proportion of working children to total population aged 5-17 years is high in the rural areas (19.7%) than the corresponding proportion of urban areas (9.0%) (Table 8.17). Rift Valley had the highest (23.7%) proportion of working children, while Nairobi accounted for 5.0%.

Table 8.17. Per cent of working children by age, sex and place of residence in 1999

Age Group	Sex	Total	Rural	Urban
5-9	Boys	26.9	30.4	5.7
	Girls	24.3	27.5	5.6
	Total	**25.6**	**29.0**	**5.6**
10-14	Boys	39.5	43.8	9.2
	Girls	35.0	38.9	11.5
	Total	**37.3**	**41.4**	**10.5**
15-17	Boys	48.0	52.1	22.1
	Girls	42.8	46.6	25.1
	Total	45.4	49.4	23.8
Total	**Boys**	**36.340.3**	**10.5**	
	Girls	32.4	36.0	12.6
	Total	**34.43**	**38.2**	**11.6**

Source: Population census 1999

8.6.7. Cultural Practices

Some cultural practices perpetuate poverty through discrimination based on gender, especially in transfer and usage of land. It also contributes to high dropout among the girls due to early and forced marriages. Little or no education handicaps employment opportunities due to lack of proficiency in more widely used national and international languages. The belief that all members of a family must inherit family land has led to uneconomical land fragmentation. In some cultures, certain food items like fish are

prohibited in the belief that fish is a snake, while others believe that chicken are birds not worthy to be taken as food.

Despite the negative aspects of cultural practices, culture in some instances opens up opportunities of disadvantaged groups. The diverse cultures of the Maasai, for example, are a tourist attraction, which earns the country considerable foreign exchange despite isolated cases of exploitation.

8.6.8. Poverty Reduction Strategies/Responses

Early efforts geared towards poverty reduction in Kenya included the land resettlement and land reform measures that targeted rural development programmes. Other interventions include the Social Dimensions of Development programmes intended to address a broad range of economic and social problems experienced by low income and vulnerable groups.

Subsequent policy documents and papers including all the National Development Plans, the National Poverty Eradication Plan (1999-2015), its Action Plan (2002-2005) and Economic Recovery Strategy on Wealth and Employment Creation (2003-2007) are all focused on poverty eradication.

The governments commitment to proper environmental management is further demonstrated by the enactment of the Environmental Management and Coordination Act of 1999 and the subsequent creation of the National Environment Management Authority (NEMA) to promote and ensure sound environmental planning and the integration of environmental concerns into the national planning processes. The government is further committed to ensuring that environmental resources are sustainably utilized and conserved by communities through effective participatory management practices.

8.6.9. International Agreements

The World Summit for Social Development held in Copenhagen in March 1995 and attended by representatives of 185 countries and over 100 Heads of State and governments made firm commitments to poverty eradication. In light of the commitment, the United Nations declared poverty as an overarching goal of international action and decided that 1997 – 2006 was the first decade of poverty eradication.

In September 2000, the United Nations adopted the Millennium Declaration. In subsequent meetings, an agreement was reached on key elements of a framework on global agenda of attaining peace, security and development in the context of goals, targets and indicators, commonly referred to as the Millennium Development Goals (MDGs). One of these MDGs is ***"Halving extreme poverty and hunger by 2015".*** This goal aims at halving the proportion of people whose income is less than $1 a day and halving the proportion of people who suffer from hunger between 1990 and 2015.

8.7. OUTLOOK

Governance
The Ministry of Lands and Housing which coordinates all housing matters should facilitate rapid implementation of the National Housing Policy and the National Housing strategy incorporating environmental concerns in housing regulations and guidelines for local authorities in the implementation of shelter programmes and related infrastructure services.

Population dynamics
The National Population Policy for Sustainable Development addresses various issues including population and the environment. In order to consolidate the gains realized in population and environment programmes, more effort is need to promote awareness on interrelationships between population, environmental concerns and development planning. It is also important to formulate a land use policy and enact regulatory measures to control land fragmentation. More effort will be put to ensure effective monitoring and evaluation of projects and their sustainability.

Human Settlement
Rapid urbanization has outpaced the development of infrastructure and environmental resources, resulting in high levels of air pollution and water contamination. The current shortage of houses in the country, especially in urban areas coupled with lack of affordability has resulted in the mushrooming of uncontrolled slums. It is necessary to prioritize implementation of human settlement planning, including the National Housing Development Programme as well as rehabilitate and improve existing slums, including provision of clean running water, better sewer services and the roads.

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.

Poverty
There is need to build on existing initiatives by strengthening ongoing process that take into consideration participatory planning and integration of environmental concerns into development planning and decision-making, while enhancing sustainable use of resources. 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.
- Conserving and sustainably managing biodiversity resources.
- Reducing the high rates of deforestation.
- Mitigating the adverse impacts of climatic change and other atmospheric conditions.
- Promoting environmentally sound management of chemical products.
- Improving access to and quality of fresh water sources.
- Improving living conditions in urban areas.

CHAPTER NINE

CONCLUSION

The State of Environment report for 2004 focuses on Land Use and the Environment. The report present new information on land use issues as they affect various segments of the environment.

Land is the critical resource base of most activities affecting the environment. Land use types, patterns and practices greatly affect the state of the environment. The need to develop a comprehensive national land policy is considered important in guiding the development of appropriate strategies for the administration and management of land, harmonising legal instruments for land and integrating environmental concerns into development plans and policies. The report highlights the need to undertake cumulative and strategic environmental assessments in order to better understand how policies, plans and programmes impact on various sectors over time.

The Kenyan economy is predominantly based on agriculture, whose products are subject to market fluctuations, unfair competition from subsidized foreign products as well as the effects of liberalization and globalization. There is increasing demand for products, which contribute to good environmental and human health including products of organic farming. Sustainable development too demands that agricultural practices must ensure the continued productive potential of the land.

Agrochemicals enhance food security but its use must be guided by stringent management measures and increased awareness on their appropriate use, while maximizing on opportunities for enhanced health and safety. The need to minimize risks requires urgent attention in view of the increasing use of agrochemicals and their misuse, which have occasionally resulted in human and livestock fatalities.

It is noted that livestock production in the ASALs should be enhanced through the development of sustainable management strategies for land resources, increased security and enhanced conflict resolution mechanisms. More importantly, there is need to promote land use types and practices that respect specific carrying capacities and land suitability.

Biodiversity resources in the country have been reduced by human activities including clearing of vegetation for human settlements and agricultural productivity. It is necessary therefore to adopt policies that support protection of natural resources, including biodiversity as well as enhanced use of indigenous knowledge. The Forest Bill once enacted should promote conservation and expansion of forest cover as well as maximize on the benefits associated with forest resources. Furthermore, attention should be given to the below ground biodiversity including supporting research on opportunities for their contribution to enhanced industrial activity and soil fertility.

The adoption of cost-effective, drought and flood management systems as well as the provision of early warning data/information for averting potential risks are best achieved through close collaboration between relevant lead agencies such as Kenya Meteorological

Department (KMD), Central Bureau of Statistics and the Department of Resource Surveys and Remote Sensing (DRSRS). Early warning information should be disseminated for periods longer than three months to allow adequate time to put in place appropriate measures to avert disasters.

The new energy policy identifies options in developing sustainable renewable energy sources in order to safeguard the country from further degradation resulting from the over-reliance on biomass energy. Additionally, industries are encouraged to adopt cleaner production technologies to minimize pollution and waste generation. Partnership with private sector in energy sector is viewed as a potentially beneficial arrangement.

Sustainable industrial and trade development depend on an environment that facilitates competitiveness and quality products. The development of such an environment thrives best in a conducive legal regime efficient infrastructure reduced operating costs and affordable credit facilities especially to small and medium enterprises (SMEs).

Human population impacts on all aspects related to land. Human immigrations into ASALs has introduced agricultural practices not appropriate to those very fragile ecosystems. The increasing poverty levels have resulted in unsustainable use of natural resources and the mushrooming of slums and other informal settlements. Pollution of water due to poor waste management has heightened risks to human and environmental health. It is therefore necessary to enhance awareness on the importance of adopting land use practises that are environmentally sensitive and enhance carrying capacities of specific areas.

According to the complaints received by the Public Complaints Committee (PCC) there is a clear indication that the state of environment remains fragile with many threats. Although significant progress has been made in the field of legislation and institutional reform, concerted and systematic efforts must be made to enhance environmental management. Concrete steps aimed at implementing the policy and enforcing the law must be taken by all the relevant lead agencies. Above all, the Kenyan people must maintain vigilance over their environment for present and future generations. The success of the Public Complaints Committee as a public watchdog over the country's environment depends on such vigilance.

The 2004 SoE report provides information, which should guide all stakeholders on issues of land use and their impacts on the environment. It has documented the relevant policy interventions, strategies and other measures as well as the potential actors to ensure implementation using the most appropriate and sustainable production and consumption practices. This is aimed at halting the current trend of environmental degradation through unsustainable land use practises.

The Board of Management has decided that the theme of the 2005 SoE report will be Pollution and Waste Management. The theme will address some of the serious threats to our environment.

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ACRONYMS

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
BGBD	Below Ground Biodiversity
BOD	Biological Oxygen Demand
BTS	Base Transmitting Stations
CBD	Convention on Biological Diversity
CBO	Community Based Organization
CBS	Central Bureau of Statistics
CFC	Common Fund for Commodities
CEA	Cummulative Environmental Assessment
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
CMA	Capital Markets Authority
CMS	Convention on Migratory Species
CKRC	Constitution of Kenya Review Commission
CP	Cleaner Production
CPT	Cleaner Production Tehnology
CPR	Contraceptive Preference Rate
DDT	Dichlorodiphenyl tricholorethane
DEAP	District Environment Action Plan
DEC	District Environment Committee
DFI	Direct Foreign Investment
DNA	Deoxyribo-Nucleic Acid
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
EM	Effective Microbes
ERS	Economic Recovery Strategy for Wealth and Employment Creation
ESH	Environmental Sanitation and Health
EAWLS	East African Wildlife Society
EPZ	Export Processing Zone
FAO	Food and Agriculture Organization of the United Nations
FD	Forest Department
FEWS	Famine Early Warning Systems
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
ICRAF	International Council for Research in Agroforestry
IGAD	Intergovernmental Authority on Development
IMF	International Monetary Fund
ILO	International Labour Organization
ILRI	International Livestock Research Institute
IK	Indigenous Knowledge
IPM	Integrated Pest Management
IPP	Independent Power Producers
ISO	International Standards Organisation
IUCN	International Union for Conservation of Nature and Natural Resources
JICA	Japan International Cooperation Agency
JKIA	Jomo Kenyatta International Airport
JKUAT	Jomo Kenyatta University of Agriculture and Technology
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
LASDAP	Land Authority Services Delivery Action Plans
LATF	Local Authority Transfer Fund
LBDA	Lake Basin Development Authority
LGA	Local Government Act
LIMS	Land Information Management Systems
LIS	Land Information System
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 and Natural Resources
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
MSEAs	Micro and Small Scale Enterprises
MTA	Material Transfer Agreement
MTI	Ministry of Trade and Industry
MTEF	Medium Term Expenditure Framework
MUB	Manufacturing Under Bond
MW	Megawatt
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
NARIS	National Agricultural Research Institute
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
NLP	National Land Policy
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
NORMS	Naturally Occuring Radioactive Materials
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

PIIP	Public Interest Intellectual Property Advisors
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
PRTR	Polluter Release and Transfer Register
RCMRD	Regional Centre for Mapping of Resources for Development
RCU	Regional Coordinating Unit
REA	Regional Environment Agreements
R&D	Research and Development
RER	Radiation Emergency Response
RF	Radio Frequency
RPB	Radiation Protection Board
SACCO	Savings and Credit Cooperative Society
SAP	Structural Adjustment Programme
SEA	Strategic Environmental Assessment
SERC	Standards and Enforcement Review Committee
SIT	Sterile Insect Technique
SRDP	Special Rural Development Programme
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
UNESCO	United Nations Educational Scientific and Cultural Organisation
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
USAID	United States Agency for International Development
VIP	Ventilation Improved Pits
WCK	Wildlife Clubs of Kenya
WEHAB	Water Health Agriculture and Biodiversity
WHO	World Health Organization
WSSD	World Summit on Sustainable Development
WTO	World Trade Organisation
WWF	Worldwide Fund for Nature

ANNEXES

Annex 1. Prevalence of Poverty by Constituency

Ranking	Constituency	% of population below poverty line	Number of poor
COAST PROVINCE			
1	Ganze	81.8	89,308
2	Kinango	72.8	115,452
3	Magarini	66.5	69,609
4	Taveta	51.2	20,579
5	Kaloleni	74.7	131,522
6	Wundanyi	63.9	30.802
7	Bura	31.2	19,894
8	Mwatate	58.1	29,770
9	Msambweni	61.0	90,053
10	Bahari	61.7	108,970
11	Matuga	51.0	58,402
12	Malindi	62.2	68,744
13	Garsen	39.9	24,552
14	Lamu East	40.8	13,116
15	Voi	60.6	38,475
16	Galole	36.9	13,556
17	Lamu West	57.0	42,685
EASTERN PROVINCE			
18	Moyale	70.2	26,325
19	Kitui South	74.4	84,893
20	Ntonyiri	36.0	60,853
21	Tigania West	62.0	69,444
22	North Horr	61.6	24,196
23	Mwingi North	62.6	95,816
24	Mwingi South	61.1	82,927
25	Igembe	56.9	98,878
26	Tharaka	63.3	62,452
27	Tigania East	58.9	72,843
28	Mutito	67.0	59,664
29	Kaiti	65.6	72,171
30	Mbooni	63.8	105,212
31	Masinga	63.1	65,595
32	Kitui West	66.9	92,582
33	Mwala	63.9	93,885
34	Isiolo South	54.5	8,117
35	Yatta	61.6	72,518
36	Makueni	66.5	128,223
37	Kangundo	59.8	106,249
38	Kitui Central	72.7	107,770

39	Laisamis	41.1	14,826
40	Kilome	59.8	47,131
41	Runyenjes	57.5	74,605
42	Kibwezi	54.1	98,314
43	Machakos Town	54.7	81,979
44	Saku	55.5	13,477
45	Nithi	58.1	112,639
46	South Imenti	42.0	60,395
47	Manyatta	53.4	57,475
48	Central Imenti	43.3	53,665
49	Isiolo North	51.9	26,948
50	Siakago	69.4	46,987
51	North Imenti	40.5	68,245
52	Kathiani	56.7	64,660
53	Gachoka	58.7	57,506
CENTRAL PROVINCE			
54	Gatundu South	30.2	33,724
55	Gatundu North	38.5	37,485
56	Kandara	38.3	57,887
57	Kigumo	34.2	39,462
58	Kangema	32.7	18,520
59	Ndaragwa	27.4	21,438
60	Kipipiri	36.4	26,337
61	Mathioya	31.5	34,146
62	Kiharu	27.2	44,452
63	Kinangop	36.0	47,340
64	Maragwa	39.1	39,179
65	Juja	34.4	27,412
66	Ol-Kalou	33.4	45,163
67	Gatanga	39.2	63,697
68	Mukurwe-ini	35.7	29,010
69	Othaya	26.2	21,349
70	Gichugu	34.6	39,705
71	Ndia	31.5	27,824
72	Mwea	44.2	53,150
73	Tetu	33.7	26,763
74	Githunguri	22.3	26,455
75	Mathira	25.3	35,822
76	Nyeri Town	34.2	17,557
77	Kerugoya/Kutus	34.6	32,311
78	Lari	29.7	31,413
79	Kieni	30.7	42,199
80	Kiambaa	20.6	31,839
81	Limuru	22.9	22,933
82	Kabete	16.9	30,681
RIFT VALLEY PROVINCE			
83	Samburu East	35.2	9,052
84	Baringo North	44.8	35,152
85	Chepalungu	54.5	63,608

86	Aldai	46.9	58,504
87	Bomet	50.8	86,545
88	Kipkelion	45.1	66,976
89	Mosop	43.1	49,914
90	Mogotio	48.3	19,526
91	Kuresoi	42.0	70,550
92	Kwanza	50.5	74,617
93	Narok South	53.9	104,895
94	Emgwen	47.3	68,974
95	Narok North	50.7	66,071
96	Cherangany	45.7	64,057
97	Keiyo South	37.9	31,882
98	Turkana North	60.4	79,101
99	Sigor	54.6	62,517
100	Baringo East	56.9	35,144
101	Kacheliba	50.2	29,638
102	Kilgoris	57.6	91,338
103	Samburu West	47.7	36,248
104	Marakwet West	41.3	30,659
105	Eldama Ravine	43.5	31,443
106	Eldoret North	48.6	82,523
107	Laikipia West	37.0	56,912
108	Sotik	49.5	64,855
109	Eldoret South	40.1	47,604
110	Buret	47.6	56,729
111	Kajiado South	52.2	52,420
112	Keiyo North	39.7	20,308
113	Nakuru Town	36.2	3,367
114	Belgut	48.6	76,808
115	Saboti	46.1	98,583
116	Marakwet East	41.4	26,335
117	Eldoret East	36.4	49,718
118	Laikipia East	36.4	33,460
119	Baringo Central	39.4	39,899
120	Turkana Central	65.8	87,010
121	Kapenguria	53.4	61,096
122	Rongai	46.2	61,731
123	Subukia	34.1	49,657
124	Konoin	50.7	64,712
125	Tinderet	52.8	79,727
126	Turkana South	54.6	37,371
127	Molo	39.9	67,956
128	Ainamoi	50.3	56,482
129	Kajiado Central	46.6	34,514
130	Naivasha	36.5	66,308
131	Kajiado North	39.3	51,797
WESTER PROVINCE			
132	Butula	68.4	61,271
133	Mt. Elgon	54.	69,841

134	Funyula	67.0	48,227
135	Nambale	67.1	85,566
136	Amagoro	49.8	78,220
137	Sirisia	57.4	98,074
138	Bumula	51.3	65,260
139	Mumias	63.4	83,515
140	Kimilili	59.7	124,764
141	Khwisero	63.4	55,401
142	Malava	54.1	102,761
143	Butere	61.5	62,144
144	Matungu	59.4	63,612
145	Vihiga	55.1	40,805
146	Ikolomani	69.6	62,902
147	Webuye	59.0	86,867
148	Lurambi	62.0	101,801
149	Kandunyi	56.6	66,005
150	Lugari	63.1	100,321
151	Shinyalu	66.7	88,197
152	Emuhaya	57.9	87,329
153	Sabatia	58.6	61,085
154	Hamisi	58.4	77,843
155	Budalangi	67.8	30,976
	NYANZA PROVINCE		
156	Kuria	79.5	108,754
157	Bonchari	69.3	55,741
158	South Mugirango	60.9	72,559
159	Kasipu-Kabondo	70.1	116,621
160	West Mugirango	71.1	85,824
161	Gem	67.8	89,726
162	Karachuonyo	71.5	87,831
163	Bomachage	59.9	97,476
164	Bondo	69.5	76,284
165	Rarieda	70.8	78,010
166	Gwassi	65.0	46,559
167	Mbita	71.4	49,841
168	Kitutu Masaba	64.7	105,662
169	Nyakach	58.0	62,404
170	Bobasi	61.4	95,929
171	Nyando	61.6	60,869
172	Kitutu Chache	67.0	112,954
173	Ugenya	59.8	100,406
174	North Mugirango Bor	68.0	124,305
175	Alego	65.5	97,548
176	Kisumu Rural	69.4	82,708
177	Nyaribari Masaba	56.4	57,787
178	Kisumu Town East	59.9	35,258
179	Muhoroni	52.9	54,427
180	Nyaribari Chache	57.1	56,026
181	Ndhiwa	70.5	89,532

182	Uriri	46.8	38,326
183	Nyatike	50.1	51,729
184	Migori	47.1	51,504
185	Kisumu Town West	60.0	36,947
186	Rangwe	70.2	81,407
187	Rongo	47.1	68,111
NAIROBI PROVINCE			
188	Kamukunji		
189	Kasarani		
190	Embakasi		
191	Lang'ata		
192	Westlands		
193	Starehe		
194	Makandara		
195	Dagoreti		

Source: Economic Survey 2004

Note: North Eastern status not available

Annex 2. Summary of Multilateral Environmental Agreements (MEAs) Relating to Land-use Policies and Legislation in Kenya

Convention/Protocol/Amendment	***Date of Ratification (Kenya)***	**Focal point**	***Domestication Statute***
1. Convention on Biological Diversity	26th July 1992	▪ NEMA; ▪ KWS; ▪ Ministries in charge of Forests & Agriculture	▪ EMCA 1999 ▪ Fishing Act (Cap 378) ▪ Wildlife (Conservation & Management) Act (Cap 376) ▪ Forest Act (Cap 385) ▪ Seeds & Plant Varieties Act (Cap 324) ▪ Plant Protection Act (Cap 324)
2. Cartagena Protocol on Bio-safety	24th January 2002	▪ NEMA	▪ EMCA
3. United Nations Framework Convention on Climate Change (UNFCC)	30th August 1994	▪ NEMA	▪ EMCA
4. Kyoto Protocol to the UNFCC	February 2005	▪ NEMA	▪ EMCA
5. United Nations Convention to Combat Desertification (UNCCD)	24th June 1997	▪ NEMA ▪ Forestry Department ▪ Ministry of Agriculture	▪ EMCA ▪ Forest Act ▪ Agriculture Act
6. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	13th December 1978	▪ Kenya Wildlife Service (KWS)	▪ Wildlife(Conservation & Management) Act (Cap 376)
7. Bonn Amendment to CITES	13th April 1987	▪ KWS	▪ As in (6) above
8. Gaborone Amendment to CITES	4th November 2002	▪ KWS	▪ As in (6) above
9. Convention for the Protection of the World Cultural and Natural Heritage	5th June 1991	▪ National Museums of Kenya ▪ Kenya Cultural Centre	▪ Antiquities and Monument Act (Cap 215) ▪ National Museums Act (Cap 216) ▪ Kenya Cultural Centre Act (Cap 218)
10. Convention on the Wetlands of International Importance especially as waterfowl (Ramsar Convention)	5th June 1990	▪ NEMA	▪ EMCA
11. Paris Protocol to the Ramsar Convention	Not ratified	▪ NEMA	▪ EMCA
12. Regina Amendments	Not ratified	▪ NEMA	▪ EMCA
13. Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)	1st May 1999	▪ KWS	▪ Wildlife (Conservation & Management) Act (Cap 376)
14. United Nations Convention of the Law	2nd March 1989	▪ Attorney General	▪ EMCA ▪ Maritime Zones Act (Cap) 371

14. United Nations Convention of the Law of the Sea	2nd March 1989	▪ Attorney General	▪ EMCA ▪ Maritime Zones Act (Cap) 371
15. Convention on the Control of Transboundary Movement of Hazardous wastes & their Disposal	1st June 2000	▪ NEMA	▪ EMCA
16. Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa	25th March 2004	▪ NEMA	▪ EMCA
17. African Convention on the Conservation of Nature & Natural Resources		▪ Ministry of Agriculture ▪ KWS	▪ Agriculture Act (Cap 318) ▪ Wildlife (Management & Coordination) Act
18. Agreement on the Preparation of a Tripartite Environmental management Program for Lake Victoria	5th August 1994	▪ Ministry of Water Resources ▪ Ministry of Agriculture ▪ Ministry of Livestock and Fisheries ▪ Kenya marine & Fisheries Research ▪ KARI	
19. Nile Basin Treaty	1959		

It is in light of Kenya's active participation in these MEAs, that one gleans the country's commitment to supporting environmental protection and rational management of natural resources.

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Annex 4.1. DPSIR Analysis for Land Policy and Environment

Issue	Drivers	Pressure	State	Impact	Response
Conflicting laws relating to land	• Demand for land • Lack of a land policy • Increasing human population • Poor enforcement of existing laws	• Population increase • Commercialization of land • Cultural perception of land as the only primary valuable asset	• High population density in H&MPL • Sub division of land into uneconomic units • New immigrants in to ASALs	• Land degradation • Increased conflict related to land utilization • Food insecurity • Changed land use patterns • Human/wildlife conflicts • Loss of biodiversity and destruction of habitats • Increased levels of poverty	• On-going formulation of a land policy • Enactment and implementation of EMCA of 1999, Water Act of 2002, Physical Planning Act of 1996 • Formulation of Energy Policy 2004
Encroachment into forest land	• Demand for forest goods and services	• High demand for forest resources • High population growth	• Very low forest cover on watershed areas • Highly degraded forests	• Forest resource degraded • Destruction of water catchments areas • Floods, landslides	• A draft Forest Bill and Policy that promotes stakeholder involvement in integrated ecosystem management
Loss of biodiversity	• High demand for biological resources • Bioprospecting • Globalization	• High demand for biological resources • Increased poverty levels • High population growth	• Establishment of NEMA to conserve and manage biological resources • Some endangered species nearing extinction and some cannot perform their ecological functions	• Most biological resources nearing extinction, endangered	• National Biodiversity Strategy and Action Plan (NBSAP) in place • Establishment of NEMA to ensure proper environmental management • National self-capacity assessment project on-going • Tools to monitor progress developed
Degraded land and reduced agricultural productivity	• Need for raw Materials for Industrialization • Climate change	• Land scarcity • Uneconomical land units • Demand for land and natural resources	• Food insecurity • Frequent famines • Malnutrition associated complications • Highly degraded lands with low fertility	• High level of Poverty • Natural Resources Degradation • Environmental disasters such as floods, frequent droughts and landslides	• Community desertification fund and Environmental Restoration Fund established • National Action programme developed and is being implemented
Poor/inadequate shelter conditions	• Demand for housing	• Demand for building materials • Increasing population	• Poor quarrying and sand harvesting practices • Forest and wetland encroachment	• Loss of ecological services • Abandoned quarries • Increased population dose	• Legislation for sitting of quarries and mines • Testing radioactivity concentration • Provide alternatives
Radiation					
Polluted environment through radiation	• Poor governance of radioactive materials • Inadequate awareness on consequences	• Poor mining practices • Poor management of radioactive materials	• Overstretched medical facilities • Polluted environments • Herbal medicine • Traditional	• Increase mortality due to radiation • Poor health • Ecological contamination	• Alternative diagnostic and therapeutic tools & methods • Education • Research

	consequences related to exposures to radiation		medicine • Traditional healers • Increased incidences of radiation related illness	al contamination	
Health and safety concerns due to radioactive material	• Accumulation of radioactive wastes	• Lack of proper storage for long periods of time • Inadequate public awareness	• Poor management of radioactive waste by generators • Lack of a designated radioactive waste management operator	• Contamination of storage site • Environmental contamination	• Enact and enforce waste management regulations
	• Need for improved road infrastructure • Demand for road construction materials, some being radioactive	• Rehabilitation of road networks • Upgrading of roads • Construction of new roads	• Wide redistribution of construction materials that may contain NORMs • Quarries in land containing NORMS	• Increased public exposure to radioactive materials • Environmental contamination • Increased health incidents related to radiation	• Legislation testing radioactivity levels • Countrywide radiation mapping
	• Increasing demand for mobile phone service	• Advances in communication technology in line with global changes	• Inadequate control of the establishments of communication masts and base stations • Inadequate information on health risks associated with mobile phones	• Public exposure to NIR • Environmental contamination • Adevers e medical and social effects	• Review of radiation legislation to regulate non-ionizing radiation
Disposal of radiation material	• Accumulation of radioactive wastes	• Lack of proper storage for long periods of time • Pile up • Public awareness	• Stored on site by waste generators • Lack of a designated radioactive waste management operator • No designated graveyard	• Potential loss of control • Contamination of storage site • Environmental contamination	• Enact and enforce waste management regulations
Increased incidences of cancer	• Exposure to radiation	• Population increase • Increased incidence and variants of cancer	• Isotope therapeutic technique on the increase • X-rays scattered countrywide	• Effective cancer management • Cancer treatment • Increase in population dose • Environmental contamination	• Radiation Protection Act: (Review) • EMCA • Radioactive waste management regulations

Annex 4.2. DPSIR Analysis for Land Use and Agriculture

Issue	Pressure	State	Impacts	Response
Rapid expansion of cultivation	• High population growth and increased demand for food • Increased demand for land	• Only 12% is high to medium potential lands (HMPL), while encroachment of degraded land has further degraded it	• Land use conflicts • Shift of agriculture to arid and semi-arid areas • Loss of forest cover and biodiversity • Loss of soil fertility • Conflicting government policies	• Formulation of a national land and land use policy (ongoing) • Development of strategy for Revitalizing Agriculture (SRA), National Agricultural Research Programme, EMCA, Special Food Security programme for Kenya, NAEP, NALEP
Poor agricultural practices	• Rapid increase in human population • Agricultural expansion	• ASALs Supports 30% of the country's population, 50% of livestock and most of the wildlife • Growing non-conventional livestock • Cattle rustling in ASALs • Unsustainable exploitation of fisheries	• Loss of soil fertility • Monoculture and loss of biodiversity • Increased use of chemical	• Formulation and implementation of the Poverty Reduction Strategy Paper (PRSP), National Action Plan to Combat Desertification, Arid Lands Resources Management Project, Arid Lands Development Policy (2004), ongoing formulation of a national land policy
Change in land use	• Over-exploitation of natural resources • Expansion of agriculture • Need to own land as a primary asset	• Increased population migration into ASALs • Rapid expansion of urban settlements • Changing land tenure system	• Over-grazing, land degradation (soil erosion, loss of soil fertility, loss of biodiversity), land use conflicts • Sub-division of land into uneconomic sizes	• Enactment and operationalization of EMCA, Physical Planning Act • Formulation and implementation of Arid Lands Development Policy (2004), and the ongoing national land policy
Droughts	• Climate change • Human encroachment into fragile habitats	• Cyclic droughts occur frequently in the ASALs and periodic in the high potential areas	• Shortage of water resources, death of livestock, wildlife, fish and other flora and fauna, increased conflict between people and wildlife, and drying of wetlands	• Drought monitoring, famine early warning, Sustainable water and pasture management projects in the ASALs, Arid Lands Resources Management Project,
Pest and diseases	• Weather conditions and climatic variability • Type of crop and livestock breed	• Crops, livestock pests and diseases are common in all seasons but increases during the dry seasons	• Loss of yields and productivity, food shortage, loss of biodiversity, loss of income and increased poverty	• Crop protection policy, • Pest and disease control • Kenya Agricultural Productivity Project etc
Inadequate agricultural credit	• Poor macro-economic performance • Political interference	• Poor performance of the Agricultural Finance Corporation, Kenya Farmers Association, Cooperative societies • Limited number of banks	• Decline in agriculture sector performance • Decline in rural employment • Increased poverty	• -Policy commitment towards revitalizing the Kenya Farmers Association and AFC to provide credit

Low prioritization of agricultural research and development	• Competing budgetary demand and poor growth of the national economy • Low priority given to research	• Less than 1% of total budgeted allocation is directed for agricultural research. This makes national research priorities donor-driven and not addressing current national needs.	• Limited research and development • Use of low quality inputs by majority farmers. • Poor agricultural yields	• Implementation of the National Agricultural Research Programme (NARP) and the Kenya Agricultural Productivity Project
Poor quality inputs and low adoption rates of new technologies	• Poverty • High cost of inputs • Low incomes • Culture and traditions	• Most farmers use poor quality inputs such as seeds, fertilizers, pesticides and limited use of quality animal breeds • Inadequate supply of good quality inputs • Limited number of farmers that adopt new technologies	• Poor performance of agriculture and livestock sector leading to low yields and food insecurity • Degradation of the environment • Poor research, extension and farmer linkages	• Several policies, actions and programmes being implemented and others being reviewed • Research activities and technology transfer being promoted to enhance capacity
Poor rural infrastructure	• Limited budgetary allocation for rural infrastructure development • Misappropriation of funds for road construction/repair.	• Most rural infrastructure, especially roads are in dilapidated conditions	• Poor access to markets • Spoilage of fresh agricultural and livestock produce • Poor marketing structures	• The Kenya Roads Board established to improve road infrastructure. • Rural electrification programmes initiated
Commodity price fluctuation	• Participation of middlemen in marketing • Globalization • Subsidized imports	• Low commodity prices offered to farmers (both at local and international levels)	• Low commodity prices • Low income to farmers • Increased poverty levels	• Institutional reforms on-going to enhance commodity pricing and marketing
Agro-chemical use	• Need to increase crop and livestock yields • Increased demand for pesticides, acaricides, etc.	• Increasing amount of obsolete and banned agrochemicals being sold to unsuspecting farmers • Misuse of agrochemicals • Eco-system pollution	• Environmental contamination and pollution • Human health and safety endangered • Low agricultural production	• Environmental policies • Agro-chemical control Acts • Consumer education • Safe use projects

Annex 4.3. DPSIR Analysis for Land use and Biological Diversity

Forest

Issues	Driving force	Pressure	State	Impact	Response
Deforestation	• Poverty/political patronage • Population increase	• Competition for allocation of forestland, over exploitation of forest products (e.g. logs, poles, post etc) and medicinal and water • High demand for forest products	• Forest cover declining from 3% to less than 2% in forest reserves, Abuse of the Shamba system • Encroachment into forest areas	• Loss of forest cover, biodiversity and depletion of water catchment areas	• Forest Bill 2005, forest policy, participatory forest management, restructuring of Forest Department, enactment of EMCA and water Act 2002,Land use policy initiated
	• Poor forest management	• Uncontrolled grazing, mining, • Illegal cultivation, and logging	• Forest degradation	• Loss of forest cover and biodiversity	• Forest Bill 2005 and collaborative forest management approaches • Establishment of nature reserves
	• Lack of affordable energy alternatives	• Charcoal burning	• Forest degradation, increased forest fires.	• Low regeneration of forests, soil erosion, • Illegal logging in plantation and indigenous forests	• Forest Bill 2005 and collaborative forest management approaches • A policy on energy and wood fuel initiated • Establishment of nature reserves
	• High demand for hardwood products	• Illegal logging in indigenous forests	• Certain tree species classified as threatened • Low supply of timber from government forests creating artificial high demand,	• Loss of forest biodiversity	• Collaborative forest management approaches • Establishment of nature reserves
Agricultural Biodiversity					
Loss of biodiversity	• Preference for high yielding exotic species	• Population increase • Pests and diseases • Drought • Floods • Destruction of natural ecosystems • Use of agro-chemicals	• Exotic crops have steadily assumed dominance e.g., maize, wheat, rice, etc. • Most traditional foods crops have drastically declined in importance as have livestock • Indiscriminate use of chemicals kill non-target pollinators	• Loss of biodiversity • Increased susceptibility to diseases • Loss of pollination and reduced production	• Promotion of integrated pest management systems • Implementation of the Kenya Pollinator Initiative
Indigenous Knowledge					
Indigenous knowledge	• Erosion of cultural values on biodiversity	• No documentation • Modernization of societies	• Recognized by government as important • Recognized in the CBD under Article 8j. Being implemented at local level	• Preservation and conservation of biodiversity based on cultural values e.g. sacred sites of cultural sites	• Formation of KENRIC by NMK for documenting indigenous knowledge • Various projects ongoing ones as indigenous vegetation between NEMA and UNDP, indigenous leafy vegetables by NMK/PGRI

• Access and Benefit Sharing and Drylands Biodiversity					
Loss of biodiversity	• Commercial benefits derived from biodiversity • Expansion of agriculture • Unsustainable use of dryland biodiversity	• Competition for genetic resources, • Need to generate income by local communities and individuals • Flush floods • Inadequate food for humans, animals and wildlife animals • Competition for resources • Insecurity • Rapid population increase • Inappropriate use of ASALs e.g. non-ASAL crops • Encroachment for settlements	• Increasing cases of access without appropriate benefit sharing arrangements • Lack of information on prospecting activities in the country • No policy on access and benefit-sharing, • Lack of a comprehensive institutional framework on access and benefit sharing • Overgrazing • Overstocking • Overgrazing • Droughts • Famine and starvation for humans, livestock and wild animals • Reduced vegetation cover • Refugees • Displaced persons and animal	• Over exploitation of preferred species • Loss of potential benefits • Overgrazing Deforestation • Water scarcity • Low water table • Reduced biodiversity • Desertification • High population densities with negative impact on biodiversity	• Development of regulation on access and benefit sharing by NEMA • Afforestation and Reforestation • Water harvesting e.g. pans, dams • Development of ASAL crops e.g. Aloe spp. Harvesting natural ASAL products e.g. gum Arabic • Peace and conflict resolution • Land-use policy
Wildlife					
Rapid decline of wildlife population	• Human population increase • Expanding cultivation • Human settlements in wildlife habitats • Land sub-division and fencing • Expansion of infrastructural developments (roads, etc) and industrialization • Good prices for ivory, tusks and for bush meat	• Competition for resources such as water and pasture and food • Encroachment of the parks and reserves • Pollution from industrial, domestic and agricultural waste • Increased development along the beaches • Poverty	• 8% of land is gazetted as protected land for wildlife • Over 60% of wildlife live outside protected areas • Some animals such as elephants, baboons gazelles cause damage to crops and cause human injury, while others such as lions and leopards predate on livestock and cause human injury • Some parks are near industrial development areas e.g. Nakuru and Nairobi National Parks • Poaching of some animals such as elephants and rhinos causes a decline in numbers	• Drastic decline in wildlife population • Encroachment is a big issue and some protected areas especially along the coast have no land beacons. • Habitat destruction • The habitat is degraded and this reduces productivity • Cultivation on Tana river forest and tree felling and irrigation schemes have led decline in Crested Mangabey, and Red Columbus • Numbers of elephants and rhinos are fluctuating	• Kenya is a signatory to many conventions dealing with conservation e.g. CBD, CMS, CITES, • Fencing of some parks, • Establishment of community sanctuaries, • Surveying and establishment of boundaries for protected areas Translocation of animals, • Land use policy being developed • Proposed review of Wildlife Act • Promoting research and monitoring of the impact of human settlements • Promoting co existence through creation of awareness on the value of biodiversity • *Security of animals to continue receiving support* • The elephants to continue being in appendix 1 of CITES

Land degradation	• Fragmentation of land especially in the migratory corridors and buffer zones and poor land use practices • Change of land use	• Lack of policies on land use especially relating to dry lands • Human wildlife conflict • Conversion of wetlands to agricultural uses • Expansion of agricultural and settlements into wildlife habitats	• Land utilisation has remained as a real problem since it is not clear • This is a problem especially in Laikipia, Tsavo and Transmara regions • Animals such as Sitatunga found in Saiwa Swamp National Park are threatened	• Poor natural resource management • Crop damage and human injury occurs in some areas bordering the parks • Reduced tourist visitation • The loss of biodiversity hence leading to poor tourist visitation	• Lobbying to influence land use policies to be developed that will favour biodiversity conservation • 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. Wild Policy is being developed* • *Corridors and buffer zones should be mapped* • Kenya is a signatory to the Ramsar convention and hence it is committed to conservation of critical habitats

Annex 4.4. DPSIR Analysis for Land Use and Water Resources

Issue	Drivers	Pressures	State	Impacts	Responses
Water sources	• Climate change • Degradation of water catchments areas • Increased demand for food and forest products	• Increased human population • Increased demand for water • Cultivation expansion into water catchments	• Per capita water supply (640 m^3 pc) less than global recommended (1000 m^3 pc) • Unpredictable rainfall patterns and quantities • Inefficient water abstraction, conveyance and utilization technologies	• Conflict between users • Floods and droughts • Progressive catchment degradation • Deterioration of water quality • Inter-basin water transfer • Decreasing ground and surface water quantities	• Water sector reforms • Micro& macro water conservation • Environmental quality standards, regulations and guidelines • Water Act 2002 • Forest Act revision
Shared water resources	• Scarcity of shared resources	• Increase population and water demand • Introduction of alien/invasive species • Increasing human activity in virgin habitats & catchment areas • Excess water use for agriculture at expense of other uses	• Catchments are getting degraded through unsustainable resource utilization • Nutrient input from runoff and pollutant deposition	• Eutrophication • Declining economic productivity • Reduced water flows • Siltation and increase in salinity • Conflicts	• Cooperation through regional and international treaties • Basin wide studies • Integrated water resource management plans
Water availability and utilization	• Investment in the water sector	• Population growth • Inadequate financial resources	• National water master plan (1992) • Safe water unavailability (84% urban, 34 % rural) • Decreasing government role in water resource management	• Illegal water abstraction • Unsustainable water supply, operation and maintenance • Rationing of available water • Migration to ecologically sensitive areas • Decrease in economic productivity	• National water policy • Water Act 2002 • EMCA1999 • Private sector participation in water sector • Action plan for the Millennium Development Goals
Water Quality	• Absence of conventional (public and other) water supplies • Low priority in government and other partner ranking for water development • Weak application regulatory frameworks	• Water stress/scarcity • Stiff competition for water • Poor economic status impeding capacity to mitigate prevalent negative impacts • Low/no budget in municipal plans for land use practices to enhance water quality conservation	• Sewerage development not commensurate with water supply • Increasing private sector, NGO, CBO participation in water sector • Increasing water vending • Increased rainwater harvesting • Policy conflicts between water and land based natural resource management	• High infant and maternal mortality • Exploitation in consumption of more expensive bottled water. • No incentives for catchment conservation	• Action plans for Millennium Development Goals • Water Act of 2002 • EMCA of 1999 and subsidiary legislation • Public health Act
Water harvesting	• Inadequate government investments • Negative attitudes with respect to cost-sharing in water sector • Drought • Supply driven water supply initiatives	• Low per capita income • Low water supply per capita • High operation & maintenance costs • Decreased investments in supporting infrastructure • Unpredictable weather impacts	• Unsuitable, inadequate surfaces for harvesting • Inadequate technological awareness or uptake • Food insecurity, conflicts	• Pollution and land degradation • Desertification • Social displacement • Increased mortality • Environmental disasters • Water pollution • Reduced land carrying capacity • Erosion and reduced reservoir capacity	• Millennium Development Goals • Increased NGO activity in water sector • Water Act 2002 • Regional cooperation • Strategic plans in land management

	• Inadequate storage facilities	• Population increases • Low prioritization • Inadequate food and fodder • Water source depletion • Reduced access to water supplies			
Disasters	• Deforestation • Drought and dry-spells due to water reduction • Increasing population • Inadequate contingency funds • Floods	• Inadequate rain • Human, wildlife and livestock population concentration near few water points/sources • Disease outbreaks from poor /inadequate waters.	• Droughts likely between 3 to 10 years • Over reliance on natural resources • ASAL highly vulnerable • Inadequate synergy between agriculture, environment a factor in drought • Peoridic floods in Lake Victoria basin, River Tana basin, etc.	• 2.3 m Kenyans in need of relief • Malnutrition and death • Loss of livelihood • Destruction of property • Soil erosion • Mud and land slides • Water pollution • Destruction of water conservation structures • Siltation of water storage structures • Improved hydropower generation capacity • Destruction of physical infrastructure • Increase in water borne diseases	• Drought preparedness and management project • Emergency response plans • Water supply, sanitation, hygiene and nutrition responses • Development of early warning systems • Establishment of disaster unit in NEMA • Establishment of food reserves

Annex 4.5. Analysis of Land use and Energy Resources

Issue	Drivers	Pressures	State	Impact on Land use	Responses
Unsustainable demand for biomass energy	• Population increase • High poverty levels hindering affordability of alternative energy • Relative ease of access • Traditional energy source	• Lack of affordable and appropriate alternatives • Increased demand by industry • Increasing population • Increased demand for biomass energy	• Primary source of energy particularly in rural areas • Contributes 68% of total national energy consumption • Agro-forestry contributes over 84% ob biomass energy	• Loss of forest cover due to increased demand on biomass energy particularly charcoal burning • Loss of biodiversity • Depletion of soil moisture, thus impacting on alternative land use • Land degradation • Air pollution • Soil erosion	• For large biomass plantation, EIA must be carried out before establishment • Seeds or planting materials are subjected to phytosanitary certification • Relevant provisions of EMCA, 1999 • Ratification of UNFCCC • Use of efficient wood conversion devices
Hydro electric Power production, transmission and distribution	• Demand for rural electrification • Economic and industrial development	• Highly desired due to its versatile nature • Demand by expanding industrialization • Diminishing alternate sources • Rapid urbanization	• Current consumption low with only 15% national access rate • Distribution countrywide very low as compared to 32% for developing economies	• Loss of livelihoods, biodiversity and reduced agricultural productivity • Displacement of human population • Water use conflicts • Loss of wildlife habitats	• Implementation of EIA as stipulated under EMCA, 1999 minimizing negative impacts • Relevant communities involved in project identification and implementation
Geothermal energy production, transmission and distribution	• Available potential • Electricity demand • Increased population	• Demand by rapidly growing population • Diminishing alternative sources	• Contributes 124 MW to national grid • Geothermal energy has a high potential for expansion	• Surface and ground water contamination • Disturbance of cultural resources, historical sites, vegetation, wetlands, surface • Land use conflicts Disturbance of humans and wildlife by noise from seismic surveys, drilling, pumping and processing facilities	• Use of mufflers to reduce noise, minimization of ecological impacts, • EIA carried out to minimize negative impacts or environmnet • Local community needs be identified and at all stages of the project
Fossil fuel transportation, distribution and use (Oil and Gas)	• Versability of use • Increasing demand by industry, transportation, etc.	• Increased population • Rapid expansion of transport system	• All fossil fuels imported • Processing done at Kipevu Oil Refineries • Oil products transported to other parts of country by Pipeline and road tankers	• Air and water pollution from accidental oil spills • Loss of biodiversity • Deforestation • Habitat fragmentation • Loss of land use due to placement of pipelines and substations • Hazards of pipe leakages or burst	• Minimization of land use impacts by restoration of disturbed land along the right of way. Regular monitoring for leakages. • Careful sitting of pipelines to avoid sensitive and critical habitats • Pre-project EIA • Ratification of UNFCCC
Fossil fuel exploration	• Foreign exchange requirements • Demand to identify local oil supply • Drain on foreign exchange	• Increased population growth • Industrialization • Increased demand for fossil fuels	• Exploitation for oil has been on-going in various parts of the country	• Disturbance of cultural resources, historical sites, vegetation, wetlands, surface drainage and wildlife	• Concessioning of exploratory blocks • EIA is now a requirement for oil exploration

				• Ecological disruption • Land use conflicts • Degradation of surface water	
Oil spills	• Accidents • Marine oil tankers	• Poor regulations • Demand for oil • Increased population	• Accidental spills have been reported at the Coast	• Degradation of beach areas • Water pollution • Wildlife poisoning • Effects on plants	• Containment measures of accidental spills • Spill mitigation equipment and emergency response plans
Wind power generation and solar energy	• Demand for alternative energy sources • Promotion of renewable energy • Reduced over-reliance on fossil fuels and electricity	• Increased population • Industralization	• A wind atlas has been developed • Most areas in the country endowed with wind energy • Some installations have been put in place contributing to the national grid with a big potential for expansion	• Land clearing for wind turbines • Disturbance of fauna and flora	• Encourage use of land beneath the turbine for other uses such as agriculture, grazing etc • Duty waivers on solar PV equipment

Annex 4.6. DPSIR Analysis for Population Dynamics, Human Settlements and Land Use

Issues	Driving forces	Pressures	State	Impacts	Responses
High population growth	• Weak programmes implementation • Values and traditions	• Increased demand for land	• Population growth of 2.9%	• Increased poverty • Environmental degradation • Strained services (infrastructure)	• Improved implementations of policy and programmes
Rapid rate of urbanisation	• High incidence of poverty. • Improved transport and communication	• Perceived opportunities in the urban areas	• Urbanisation growth of 5.2%	• Increased slum and squatter settlement • Increased poverty	• Growth centre policy. • Rural trade and production.
Slum and squatter settlement	• High rate of urbanisation • High incidence of poverty. • Weak institutions.	• Inadequate housing • High cost of building materials	• 7-12 per cent growth. • 60% poverty • 60% urban residents	• Environmental degradation	• Slum upgrading programme. • New housing policy.
Deteriorating infrastructure	• Low investment in infrastructure provision. • Inadequate provisions for operation and maintenance	• Rapid rate of urbanisation	• Persistent water shortage • Uncollected garbage • Frequent power failure • High cost of power	• Increased cost of doing business. • High cost of living. • Environmental degradation	• Roads fuel levy • New Water Act • Enactment of EMCA and Physical Planning Act
Solid waste	• High population growth rates • Rural-urban migration • Inadequate funds • Rapid expansion of urban areas •	• High rate of urbanisation • Inadequate funding for urban housing, infrastructural services and waste management	• Nairobi generates 2000 tonnes/day and Mombasa 750 tonnes/day • Only 40% waste in urban centres is collected. • Only 32 of 174 local authorities have some form of sewage collection and disposal infrastructure. • Examples of districts without a single sewerage plant include: Kuria, Isiolo, Gucha, Homa bay, Makueni, Trans mara, West Pokot, Narok, Maragua, Ijara Bondo • 4000 tonnes of plastic bags are produced each month in Kenya	• Poor sanitary conditions and incidences of environment related health problems • Pollution	• Ongoing Slum Upgrading programme • Public Health Act; Local Government Act, Environmental Management and Coordination Act. • Privatisation of solid waste disposal in urban areas • Formulation of environmental (waste management) regulations and standards
Sanitation facility	• High population growth rate • Informed public	• Inadequate investment in sanitation services	• 83% of households in the country have access to some type of sanitary facility (11% have flush toilets, 63.8% have traditional pit latrine and 8.4 have ventilated improved pit latrine) • Most of these facilities are located in urban areas	Prevalence of environmentally related diseases	• Public awareness campaigns





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