KENYA STATE OF THE ENVIRONMENT AND OUTLOOK 2010

Supporting the Delivery of Vision 2030

KENYA

State of the Environment and Outlook 2010

Supporting the Delivery of Vision 2030

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TABLE OF CONTENTS

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FOREWORD

The economy of Kenya and the livelihoods of her people largely depend on the utilization of her rich natural resource base. This resource base is increasingly under pressure from human activities, resulting in environmental degradation and depletion. The challenge, therefore, is to ensure sustainable use of our natural capital by striking a balance between its utilization and conservation.

State of the environment (SoE) reports are accepted worldwide as a means of reporting on environmental issues and progress made towards sustainable development. The 2010 SoE Report has been produced in fulfilment of Section 9(2)(p) of the Environmental Management and Coordination Act (EMCA) (Act No. 8 of 1999) which mandates the National Environment Management Authority (NEMA) to prepare annual State of the Environment reports for submission to the National Assembly. The SoE report is therefore an important tool for documenting timely, accurate and relevant information on various facets of the country's environment in order to ensure their sustainable use. More specifically, it provides a basis for efforts to restore environmental integrity and to tap the enormous opportunities which overwhelming environmental challenges such as climate change present.

The government acknowledges that a healthy environment is crucial to delivering Vision 2030, which is Kenya's long-term development blueprint and which is the theme of this SoE report. It has therefore instituted a number of measures to protect the environment. The most important of these is the promulgation of the 2010 Constitution which enshrines a series of environmental rights and provides for a number of environment-related laws. The executive arm of government and the National Assembly have initiated steps to establish the requisite commissions and to enact the environment-related laws stipulated by the new Constitution under the timelines outlined in its Fifth Schedule. In addition, a series of legal and policy responses have been crafted over the last two years to address the environmental challenges that the country is grappling with and include the National Climate Change Response Strategy, the Report of the Prime Minister's Task Force on the Conservation of the Mau Forest Complex and the Biosafety Act (No. 2 of 2009). It has also finalized a number of environmental regulations, standards and guidelines prepared under EMCA, which is the country's framework environmental law. On the regional front, in May 2010, Kenya signed the Nile Cooperative Framework Agreement which seeks to ensure more equitable and sustainable utilization of the waters of the Nile River Basin by the Nile Basin Countries.

The preparation of the 2010 SoE Report has been guided by the Drivers, Pressures, State, Impact and Response (DPSIR); and opportunities frameworks. These frameworks were selected because of their potential to address the delicate nexus between environment and development, the impacts of human activities on the environment and crucially, the impacts of environmental changes on people's livelihoods. A participatory approach was also adopted in preparing the SoE report in recognition of the obvious benefits that accrue from drawing on the expertise of a broad base of stakeholders. Thus renowned Kenyan environmental experts were involved in the SoE process from the outset and were instrumental in selecting the report title and thematic areas, in drafting and providing substantive inputs to the chapters, and in validating the final report. Because this report is conceptualized and written by Kenyans, it documents the environmental challenges that our country is confronted with and the opportunities these present through a Kenyan lens in order to ensure both credibility and national ownership.

I would like to thank NEMA and the other lead agencies, the Ministry of Environment and Mineral Resources staff as well as other stakeholders which played various roles in preparing this publication. I also wish to express my profound gratitude to the Governments of Denmark and Sweden, which through the Danida/Sida supported Environmental Programme Support (EPS), funded the preparation and publication of this report. In addition, I wish to record my appreciation to the United Nations Environment Programme (UNEP) for its invaluable technical support.

I hope that this report will set us firmly on the path to realizing the ambitious goals enumerated under the economic, social and political pillars of Vision 2030 and I wish you all a happy reading.

Hon. John Michuki, EGH, MP

Minister for Environment
and Mineral Resources

PREFACE

Kenya's development is largely dependent on her natural resources' wealth. As such, periodic assessment of the state of the country's environment is an important step in the path to sustainable development. In accordance with the 1999 Environmental Management and Coordination Act (EMCA), the National Environment Management Authority (NEMA) is tasked with preparing annual State of the Environment (SoE) reports for submission to the National Assembly. It is hoped that this report – the seventh and most comprehensive yet—will enable us to better harness the enormous opportunities that our environment presents and to fill the knowledge gap on the magnitude of the environmental challenges that we have to continually confront.

The new Constitution, which was promulgated in August 2010, entrenches a number of environmental rights that are summed up under the overarching right to a clean and healthy environment which is provided for under Article 42. In addition, the Fifth Schedule specifies land, natural resources and the environment as some of the areas where a number of laws need to be enacted within 18 months to 5 years from the date of promulgation. The Constitution also provides for devolution of certain environmental mandates to the county governments where Kenyans at the grassroots can directly contribute to the protection of the environment and benefit from it through the devolved governance structures that will be gradually put in place.

The preparation of this SoE report was characterized by a participatory approach and a broad base of stakeholders was involved in the selection of the report title, the thematic areas and indicators as well as in data collection and compilation. The report was produced using the drivers, pressures, state, impact, and response (DPSIR), and the opportunities frameworks. These were selected because of their capacity to highlight the interlinkages between that state of the environment and the quality of development.

This report establishes an authoritative baseline for the attainment of Kenya's Vision 2030. The primary goal of the country's long-term development blueprint is to transform Kenya into a globally competitive and prosperous nation with its citizens enjoying a higher standard of living by 2030. It is envisaged that this will translate into a higher proportion of Kenyans transitioning from crippling poverty. Vision 2030 aims to progressively realize these goals by implementing a number of five year medium-term rolling plans. Although environmental management is covered under the social pillar of Vision 2030, it is anticipated that this SoE report will act as a timely reminder that environmental integrity and economic development need not be a zero-sum game.

The information contained in this report is an invaluable resource for individuals, business entities, government ministries and agencies which are keen to contribute to the attainment of Vision 2030 in an environmentally sustainable manner. The report is also a useful resource for those who are looking to tap a range of opportunities offered by seemingly insurmountable environmental challenges such as climate change. The underlying message of this SoE report is that long-term development—such as that anticipated by Vision 2030—cannot be achieved without prioritizing environmental imperatives. It is therefore incumbent upon all Kenyans to value the environment as the "goose that lays the golden egg" and support its sustainable use for the benefit of present and future generations.

Ali D. Mohamed, CBS

Permanent Secretary, Ministry of
Environment and Mineral Resources

ACKNOWLEDGEMENTS

The process of preparing the 2010 State of the Environment (SoE) report was operationally supported by the Ministry of Environment and Mineral Resources and coordinated by a secretariat in NEMA which consisted of representatives from a number of lead agencies. These agencies played a crucial role in the development, validation and adoption of national environmental indicators and provided data and information which formed the basis of the chapters of the report. The lead agencies also helped to analyze and interpret the data, and to forecast a range of future environmental scenarios based on the trends that emerged from the analyses. I would therefore like to record my deep appreciation for the support that the Ministry of Environment and Mineral Resources rendered and the time and effort that the various agencies put into the preparation of this report.

I am also grateful to the Governments of Denmark and Sweden, which through the Danida/Sida supported Environmental Programme Support (EPS), funded the preparation and publication of this report. In addition, I am indebted to UNEP which provided technical backstopping for the development of the environmental indicators and which continued to provide advice throughout the entire report preparation process.

I would also like to thank the NEMA Board of Management for providing an enabling environment that made the completion of this report possible and to recognize the role played by the NEMA staff especially the Director, Planning and Research Coordination who oversaw the process of preparing this SoE report.

This report enumerates a number of emerging issues that need to be closely monitored to prevent them from evolving into intractable environmental crises. It is also hoped that the report findings will prompt the full spectrum of stakeholders to take timely action to remedy anthropogenic activities that degrade our environment. Therefore, while this report is an important reference tool, it is also intended to spur institutions and stakeholders into playing their rightful roles in environmental planning and monitoring, and in taking appropriate remedial action to restore environmental integrity.

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ACRONYMS

AAP	Africa Adaptation Programme
AEO	Africa Environment Outlook
AfDB	African Development Bank
AIDS	Acquired Immune Deficiency Syndrome
AMCEN	African Ministerial Conference on the Environment
ASALs	Arid and Semi-Arid Lands
ATMs	Automated Teller Machines
AU	African Union
BCM	Billion Cubic Metres
BPO	Business Process Outsourcing/ Offshoring
BSAP	Biodiversity Strategies and Action Plans
CAADP	Comprehensive African Agricultural Development Programme
CAHOSCC	Conference of African Heads of State and Governments on Climate Change
CBD	Convention on Biological Diversity
CBK	Central Bank of Kenya
CBOs	Community Based Organizations
CCAA	Climate Change Adaptation in Africa
CCK	Communications Commission of Kenya
CDM	Clean Development Mechanism
CFAs	Community Forest Associations
CFCs	Chlorofluorocarbons
CFSK	Computer for Schools Kenya
CGIAR	Consultative Group on International Agricultural Research
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
CLTS	Community Led Total Sanitation
CMA	Capital Markets Authority
CNG	Compressed Natural Gas
COMESA	Common Market for Eastern and Southern Africa
CPI	Consumer Price Index
DALY	Disability Adjusted Life Year
DFIs	Development Finance Institutions
DRSRS	Department of Resource Surveys and Remote Sensing
EAC	East African Community
EBD	Environmental Burden of Disease
EIAs	Environmental Impact Assessments
EMCA	Environmental Management and Coordination Act
EPPs	Emergency Power Producers
ERS	Economic Recovery Strategy
ESP	Economic Stimulus Programme
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FMAs	Forest Management Agreements
FPE	Free Primary Education
FTSE	Free Tuition Secondary Education
GBD	Global Burden of Disease
GCF	Green Climate Fund
GDP	Gross Domestic Product
GHGs	Greenhouse Gases
GMOs	Genetically Modified Organisms
GoK	Government of Kenya
GSPC	Global Strategy on Plant Conservation
GSU	General Service Unit
GTI	Global Taxonomy Initiative
GWh	Gigawatt Hour
HCES	Household Centred Environmental Sanitation
HDI	Human Development Index
HESA	Health and Environment Strategic Alliance
HIV	Human Immunodeficiency Virus
HWTS	Household Water Treatment and Safe Storage
IAEA	International Atomic Energy Agency
IBAs	Important Bird Areas
ICMRM	Integrated Coastal and Marine Resources Management
ICT	Information Communication Technology
ICZM	Integrated Coastal Zone Management
IFAW	International Fund for Animal Welfare
IGAD	Intergovernmental Authority on Development
IPCC	Intergovernmental Panel on Climate Change
IPI	African Network for the International Pollinator Initiative
IPPs	Independent Power Producers
ISWM	Integrated Solid Waste Management
IT	Information Technology
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
JKIA	Jomo Kenyatta International Airport
JVA	Joint Voluntary Agency
KACCAL	Kenya Adaptation to Climate Change in Arid and semi-arid Lands
KEFRI	Kenya Forestry Research Institute
KenGen	Kenya Electricity Generating Company Limited
KENSUP	Kenya Slum Upgrading Programme
KESCOM	Kenya Sea Turtle Conservation Trust
KFS	Kenya Forest Service
KFWG	Kenya Forests Working group
KPA	Kenya Ports Authority
KSh	Kenya Shilling
KWh	Kilo Watt Hour
KWS	Kenya Wildlife Service
LAMCOT	Lamu Marine Conservation Trust
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MDG	Millennium Development Goals
MEAs	Multilateral Environment Agreements
MEMR	Ministry of Environment and Mineral Resources
MFD	Ministry of Fisheries Development
MFIs	Micro Finance Institutions
MFW	Ministry of Forestry and Wildlife
MLD	Ministry of Livestock Development
MNPDV	Ministry of State for Planning, National Development and Vision 2030
MOF	Ministry of Finance
MOMS	Ministry of Medical Services
MOPHS	Ministry of Public Health and Sanitation
MW	Megawatts
NAP	National Action Programme
NBI	Nile Basin Initiative
NBSAP	National Biodiversity Strategy and Action Plan
NCCRS	National Climate Change Response Strategy
NEAP	National Environment Action Plan
NEMA	National Environment Management Authority
NEPAD	New Partnership for Africa's Development
NGOs	Non-Governmental Organizations
NHIF	National Health Insurance Fund
NIB	National Irrigation Board
NMK	National Museums of Kenya
NMS	National Malaria Strategy
NSE	Nairobi Stock Exchange
NWMP	National Water Master Plan
NYS	National Youth Service
PCs	Personal Computers
PMCT	Prevention of Mother to Child Transmission Programmes
PPPs	Public-Private Partnerships
PPR	Pestes des Petits Ruminants
RDAs	Regional Development Authorities
REDD	Reducing Emissions from Deforestation and Forest Degradation
REP	Rural Electrification Programme
SACCOs	Savings and Credit Cooperative Organizations
SAICM	Strategic Approach to International Chemical Management
SANA	Situation Analysis and Needs Assessment
SDM	Summary for Decision Makers
SEACOM	Sea Submarine Communications Limited
SLTS	School Led Total Sanitation
SoE	State of the Environment
STIs	Sexually Transmitted Infections
TEAMS	The East African Marine System
TFR	Total Fertility Rate
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USDA	United States Department of Agriculture
VAT	Value Added Tax
VCTs	Voluntary Counselling and Testing Centres
WASH	Water Sanitation and Hygiene
WASREB	Water Services Regulatory Board
WCED	World Commission on Environment and Development
WHO	World Health Organization
WRI	World Resources Institute
WRMA	Water Resources Management Authority
WRUAs	Water Resources User Associations
WSBs	Water Service Boards
WSSD	World Summit on Sustainable Development

LIST OF FIGURES AND TABLES

Figures

Tables

BACKGROUND AND INTRODUCTION

Introduction

Kenya has been implementing an active environmental management programme including education and public awareness. Most Kenyans are therefore aware of the link between environmental management and human well-being. They know that environmental degradation exacerbates poverty and undermines economic progress. Of course, there are still those who lack appreciation of the ecosystem services that are central to our wellbeing but these are a minority. It can be logically deduced therefore, that Kenya's environmental reporting efforts are beginning to make a significant contribution to sustainable development.

This edition of the state of the environment (SoE) report profiles Kenya's environmental resources as an asset for the country's development under the theme 'Our Environment: Supporting the Delivery of Vision 2030'. To this end, the report highlights the opportunities presented by Kenya's natural resource base to support Vision 2030. It also assesses the state and threats to key resources including land, water, wetlands, biodiversity, forests, coastal and marine resources. In addition, issues related to economics, poverty and gender; and their interlinkages with the environment are discussed.

Despite the substantial opportunities to utilize the environment for sustainable development, there are a number of emerging issues which continue to hinder economic development and improvement of Kenyans' welfare. The key emerging issues mentioned include climate change, poor disposal of hazardous wastes, invasive alien species and environmental justice. The report proposes the development and implementation of effective policies to prevent further environmental degradation and promote human wellbeing.

State of the environment reporting

Context and process

The National Environment Management Authority (NEMA) is required by Section 9 of the Environmental Management and Coordination Act (EMCA) (Act No.8 of 1999) to prepare an annual state of the environment (SoE) report for submission to the National Assembly. The aim of SoE reporting is to capture and present accurate and timely information on the environment and natural resources that is relevant to development in order to inform decision-making. The SoE report also forms the basis for the preparation of operational sector policies, enhancement of the integration of environmental concerns into development processes, and preparation of environmental action plans.

Apart from the national legislative requirements for SoE reporting, Kenya is a signatory to a number of multilateral environmental agreements and is also a member of several international organizations. These bring with them reporting obligations for various aspects of the Kenyan environment. Some of these include the United Nations Environment Programme (UNEP), the World Meteorological Organization (WMO), Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC).

Kenya has been reporting on the state of her environment annually since 2003. A rigorous process for production of SoE Report has thus evolved over time. The entire Kenya SoE process, from the identification of themes through to scenario analysis and endorsement of the final report is a participatory. NEMA, as the lead agency for environmental management coordinates the whole process. Lead agencies, major governmental and non-governmental stakeholders, the private sector and national experts in the different thematic areas are all involved at different levels of the process. Drafts of the report are subject to sectoral review to ensure completeness, relevance and accuracy.

Analytical framework

The Opportunities Framework is the format used for analysis in this report. It is a hybridization of the traditional driver-pressure-state-impact-response (DPSIR) framework that has been commonly used in SoE reporting. This format highlights a chain of causal links starting with **driving forces** (economic and human activities) through **pressures** (emissions, waste) to states (physical, chemical and biological) and **impacts** on ecosystems, human health and functions, eventually leading to political **responses** (policies, legal and institutional frameworks) (UNEP 2006). As much as possible, the report has compiled and analyzed data and indicators to demonstrate positive or negative change.

The **opportunities framework** methodology (UNEP 2006) tries to address the following questions:

- What resources are available at the national and sub-national levels (**resource inventory, state and trends**)?
- What opportunities exist for using the resources to promote poverty reduction and sustainable development (**value/ opportunities and potential**)?
- What are the main challenges that Kenya faces in capitalizing on the opportunities to utilize the resources (**demands/ pressures)**?
- What policy and institutional actions should be taken in order to capitalize on the opportunities. What is the impact (including potential) of each policy on the assets and the environment? (**policy actions**)?
- How might Kenya's various forms of vulnerability be exacerbated by the success or failure to capitalize on opportunities and to effectively avert the environmental costs so far incurred?
- What would be the consequences of Kenya's success or failure to seize the opportunities (**outlook**)?

The data used in this report has come from a variety of sources such as policy and strategic initiatives including the national planning and budgetary processes. The use of the integrated analysis methodology strengthens the cross-cutting nature of environmental management further bringing together different sectoral mandates in support of sustainable development. The end result of this assessment

will be more than just knowing about the state of the environment. It will provide policy-makers and other stakeholders with guidance on how to better manage it.

The structure of the report

The report is divided into four parts. The first part, *Environment, People and Development*, consists of a discussion of environment, economic development, socioeconomic issues including poverty, gender, and climate change in Kenya.

Part two is an analysis of the *State of the Environment*. The chapters contain an integrated assessment of biodiversity, forests and woodlands, land, agriculture and livestock, water, coastal and marine resources, and health and environment. Under each theme, opportunities for sustainably deriving benefits from the resource base and/or reversing environmental degradation are identified. Where the data exist, environmental evaluation of the resources has been included to emphasize the need for safeguarding and improving the remaining asset base in terms of ecosystem and economic goods and services, as well as social value/services at the national and community/household levels.

The third part is a discussion of the *Emerging Issues*. Emerging issues are those concerns that are exerting an increased impact on the environment and the people. They could be completely new environmental phenomena or 'old' issues analyzed in a new light. They could also be those that even though external to the country, pose a potential future threat.

The last part of the report *Environmental Governance – Now and In The Future* contains a chapter on the future of Kenya's environment. It is an analysis of the environmental outlook from 2010 to 2030 and uses the aspirations of Vision 2030 as targets to measure the impact of environmental action over this period. Chapter 11 concludes the report by providing a brief treatment of the various policy options for addressing the myriad of environmental challenges and opportunities tracked into the future in the scenarios chapter.

Eugene Apindi/Quenny

The Advocacy Project/Flickr.com

PART 1
ENVIRONMENT, PEOPLE AND DEVELOPMENT

CHAPTER 1
ENVIRONMENT AND ECONOMIC DEVELOPMENT

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Maurice Nyunja Otieno and Gabriel V. Sanya

Introduction

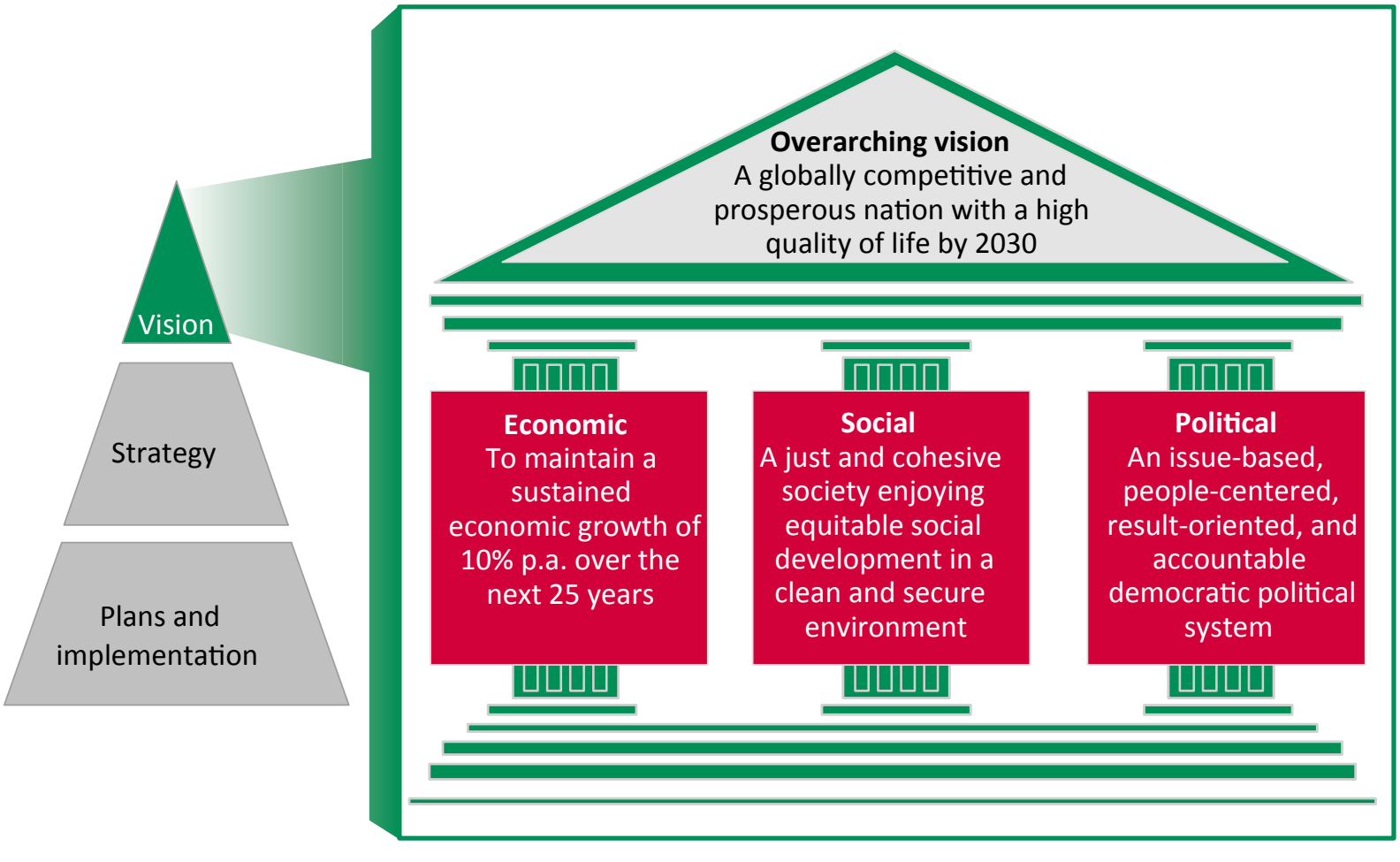
The natural environment refers to the entirety of all living and non-living things that occur naturally on earth (as distinguished from those that are human-made or artificial) and the context within which they exist and the various levels at which they interact. Kenya's environment comprises diffuse natural phenomena such as air and the climate as well as geographically identifiable ecological systems such as forests, woodlands, savannah, wetlands, mountains, lakes, rivers and oceans where the living and non-living components interact to form a stable system that provides a range of ecological services.

Although there is no universally accepted definition of economic development, it can be perceived as the long-term improvement of the standard of living of a country's citizens. As such, it comprises the policies, processes and activities by which a nation improves the economic, political and social welfare of her people. Kenya's long-term economic development aspirations are contained in Vision 2030 (GoK 2007) which was launched in 2007. Its overarching objective is to transform Kenya into a globally competitive and prosperous nation with a high standard of living for its citizens. This will be incrementally achieved through a series of five year medium-term rolling plans, the first of which covers 2008-2012. Kenya's development blueprint consists of several flagship projects and other priority programmes that are buttressed by the social, political and economic pillars. Figure 1.1 contains a thematic overview of Kenya Vision 2030.

The primary goal of the social pillar is to build a just and cohesive society that enjoys equitable social development in a clean and secure environment. This will be achieved by transforming six essential social sectors which are education and training; health; water and sanitation; the environment; housing and urbanization; as well as gender, youth, sports and culture. The social pillar also aims to cater for the specific needs of Kenyans with disabilities and the marginalized communities in its quest for social equity and poverty reduction. The main goal of the political pillar is to consolidate the gains made in building a democratic society that respects individual liberties, freedoms of speech, association and worship, as well as the rule of law. This will be achieved through enacting legislation to enhance national governance, improving public service delivery and revolutionizing the judiciary to make it both more efficient and effective. The economic pillar aspires to attain and maintain an annual GDP growth rate of 10 percent by improving efficiency in six priority sectors. These are agriculture and livestock; tourism; wholesale and retail trade; manufacturing; finance; and business processing outsourcing/offshoring (BPO).

Figure 1.1: Thematic overview of the Kenya Vision 2030

Source: GoK 2007



Nexus between environment and economic development

The World Commission on Environment and Development popularly referred to as the Brundtland Commission coined the term 'sustainable development' to draw the world's attention to the relationship between environmental factors and economic growth (WCED 1987). The upshot is that, in light of the intricate feedbacks that exist between the two arenas, charting Kenya's economic aspirations must be done in tandem with assessing the concomitant environmental impacts precisely because the production and consumption patterns that stimulate economic growth are dependent on use or extraction of natural resources and ecosystem services as well as waste disposal into landfills, water or the atmosphere. However, if these are left unbridled, there is a risk that excessive resources' extraction could lead to their depletion or outstrip their regenerative capacity while the accumulation of waste and concentration of pollutants could overwhelm the environment's carrying capacity, successively aggravating environmental degradation and eventually imperilling the citizens' wellbeing and the country's economic development. This is particularly worrisome given that, at the population growth rate of 2.9 percent per annum, Kenya's increasing ostentatious population of 38.6 million in 2009 (GoK 2010b) is projected to steeply rise to 70.3 million by 2030. Admittedly, Vision 2030 epitomizes the Kenya government's cognizance of the need to match economic development goals with ecological exigencies. The challenge therefore, is to translate these goals, first into actionable strategies and ultimately, into appreciable human welfare improvements and positive environmental outcomes.

Kenya's economy is linked to the environment in a myriad of ways. At the subsistence level, many rural households derive their livelihoods from the country's natural resources such as land, forests, woodlands, rivers, lakes, wetlands as well as coastal and marine resources. Business entities also depend on the environment for land which is one of factors of production, raw materials, energy and to dispose of their waste.

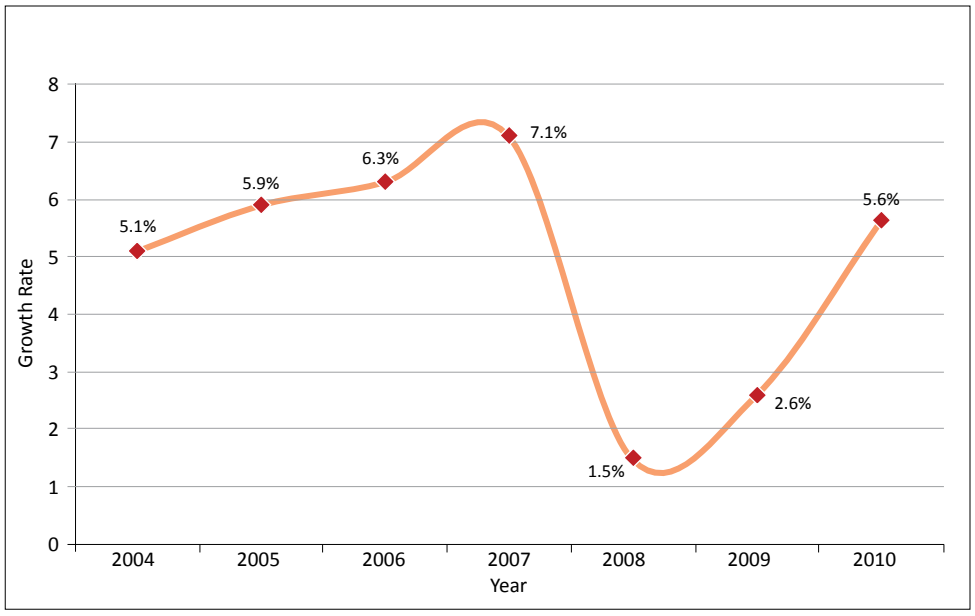
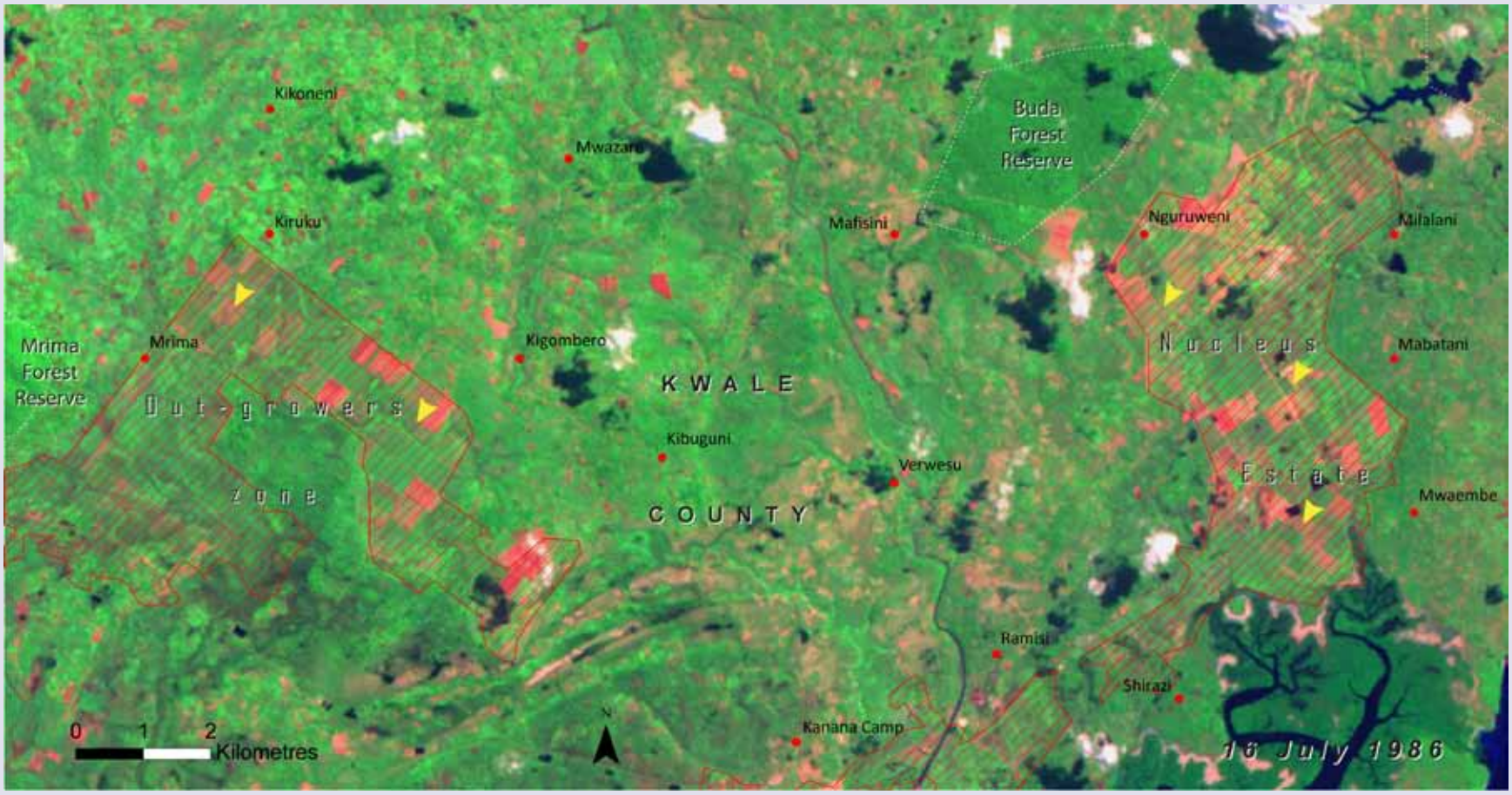
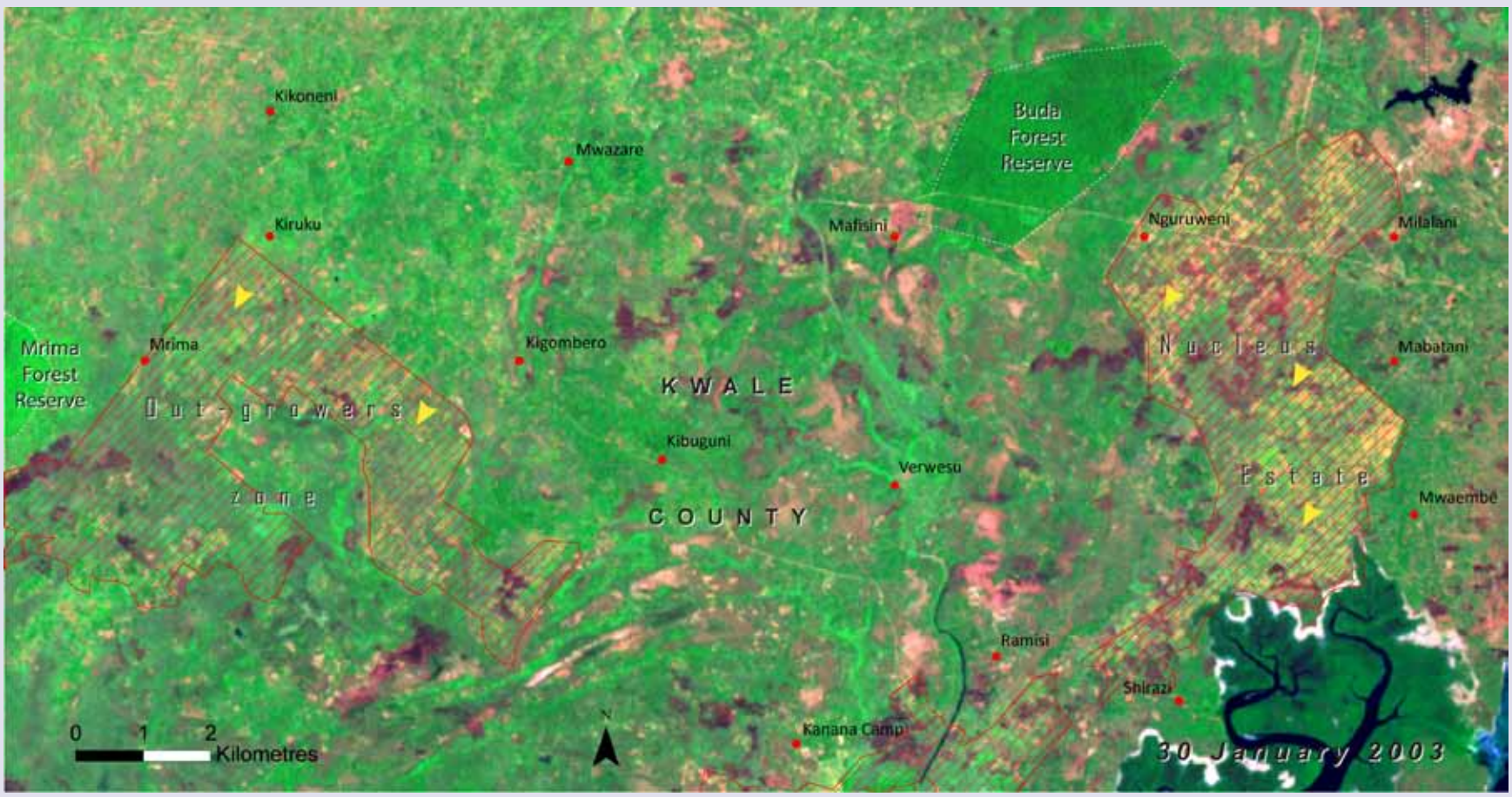


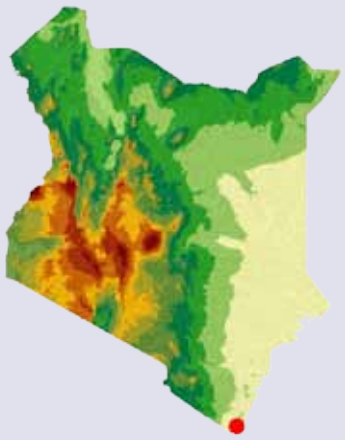
Figure 1.2: Kenya's economic growth rates, 2004-2010

Source: GoK 2010a and GoK 2011b

In 2010, Kenya's real GDP growth rate rose to 5.6 percent, up from 2.6 percent recorded in 2009. The improvement was attributed to a stable macroeconomic environment (such as low inflation), the implementation of the economic stimulus programme, increased credit to the private sector and favourable weather conditions (GoK 2011b). Figure 1.2 contains an illustration of the country's growth rates from 2004-2010. While the impressive 2010 growth rate is a testament to the buoyancy of the Kenyan economy, it is lower than the record 7.1 percent growth registered in 2007 before the effects of the spontaneous violence and reprisal attacks that rocked several regions of the country in the aftermath of the 2007 general elections and a severe global economic recession took their toll. Even more important for the purposes of this SoE report, the 5.6 percent growth rate is only a little over half of the 10 percent growth rate anticipated by Vision 2030 so giant strides need to be made in closing this gaping gap. As is evident from the discussion below, the country's economic growth continues to be weighed down by the sub-optimal performance of a number of important economic sectors and the volatility of several macroeconomic indicators.

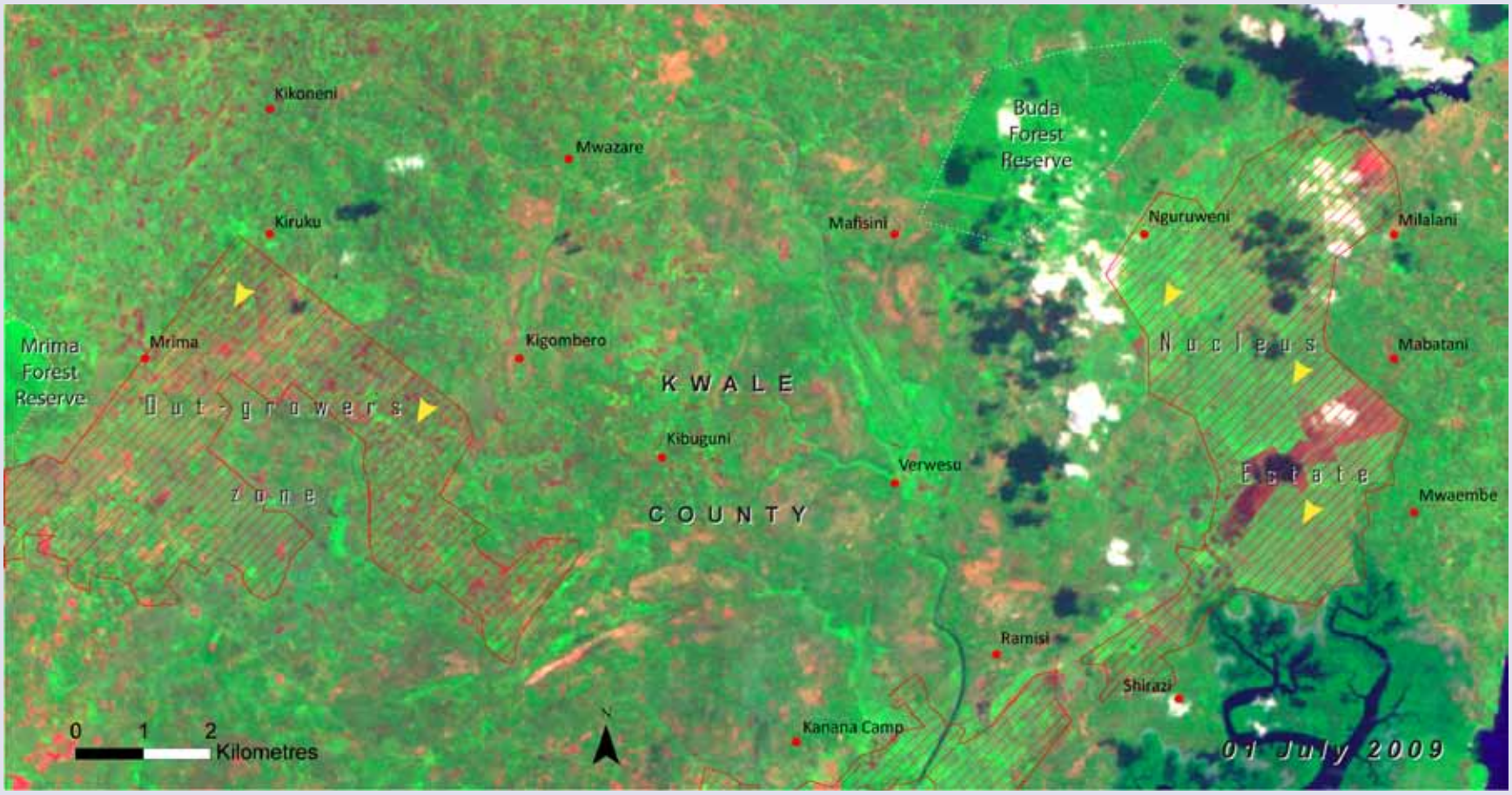


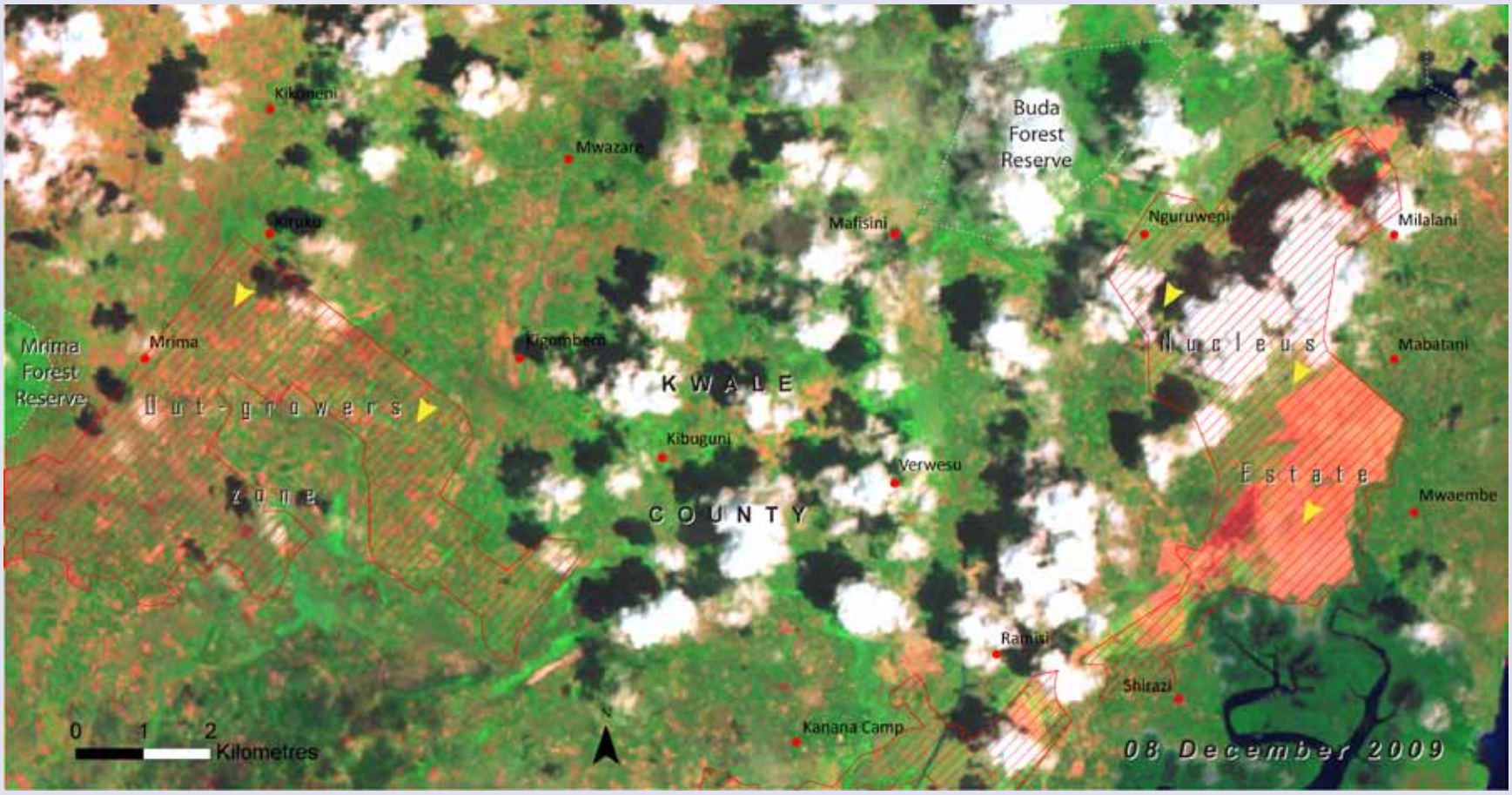




Ramisi Sugar Factory – Ramisi Sugar Factory was established in Ramisi, Kwale County, (south coast of Kenya) in 1927 but closed down its operations in 1989. During its operational days, sugarcane was grown in two major zones, the nucleus estate—owned and cropped by the company, and the out-growers zone operated by contracted small scale farmers (16 July 1986 image). After the collapse of the company, squatters occupied the nucleus estate and converted it to a patchwork of small scale farms while similarly, the out-growers zone reverted to other small scale agricultural activities (30 January 2003 image).

In a bid to shore up sugar production in the country, a new company, Kwale International Sugar Company Limited (KISCOL) was recently licensed by the Government to revive the stalled sugar cane farming in Kwale County.





The project nucleus covers 15 000 acres in Ramisi, Kigwede, Kidzumbani, Koromojo, Kitaruni, Shirazi and Fahamuni. The proposed project will have sugar cane grown under irrigation on a nucleus estate of approximately 8 000 acres, and out-grower farms covering 12 000 acres. Other project features will include a sugar mill, a co-generation power facility with a capacity of 17 MW and an ethanol plant, among others.

The clearing and preparation of the nucleus estate is visible very clearly in the 01 July 2009 and the 08 December 2009 satellite images.

Note:
The white patches in the images are clouds.
Sugar growing areas are marked by red hatches and yellow pointers.

A small scale farmer's mixed crop farm of bananas and sweet potatoes, grown under irrigation in the semi arid Mpeketoni area, Lamu County.

Key sectors of Kenya's economy, Vision 2030 and the environment

Agriculture

Like most of the sub-Saharan African countries, agriculture is the backbone of the Kenyan economy. The agriculture and forestry sector's contribution to the real GDP (at 2001 constant prices) grew by 6.3 percent from KSh 299.4 billion in 2009 to KSh 318.4 billion in 2010. The agriculture component alone increased by 6.5 percent from KSh 288.3 billion in 2009 to KSh 307.1 billion in 2010 compared to contractions of 2.7 percent in 2009 and of 4.3 percent in 2008 (GoK 2011b) The combined share of agriculture and forestry in the country's GDP dropped from 23.5 percent in 2009 to 21.5 percent in 2010. The agriculture component's proportion of the GDP was 22.7 percent in 2009 and 20.7 percent in 2010 and accounts for roughly one-fifth of the economic activity in the country.

The improvement in agricultural production was due to good weather, provision of low priced and quality seed and fertilizer by the government and the economic stimulus programme one of whose projects was to increase food (maize and rice) production by increasing the acreage under irrigation in Bura, Hola, Pekera, Tana Delta, Kibwezi, Ahero, Bunyala, Mwea and Kano in order to reduce poverty and hunger (GoK undated). Maize, wheat, rice, tea and sisal production increased while coffee, tea, sisal, pyrethrum and tobacco recorded favourable international prices which boosted earnings. Table 1.1 contains the estimated production of selected agricultural commodities, 2006-2010.

Reviving the collapsed irrigation schemes in the country's arid and semi arid lands (ASALs) notably Hola and Bura are in line with the Vision 2030 aspirations that are predicated on the realization that 9.2 million hectares in the ASALs have the potential for crop production if irrigated (GoK 2007). The increased agricultural production obviously went some way in assuring food security, improving household incomes and alleviating poverty in most of 2010. However these irrigation efforts need to be drastically scaled up if the country is to, in future, stave off famine on the devastating scale that is currently ravaging the greater Horn of Africa region.

Horticulture continued its declining trend that begun in 2008 primarily due to the continuing depressed demand in the main export markets given that these markets have not fully shaken off the effects of recession that dampened demand. Exports of cut flowers, fruits and vegetables all fell with cut flowers falling from 87 000 tonnes in 2009 to 67 700 tonnes in 2010. Exports of fruits reduced from 21 200 tonnes in 2009 to 19 300 in 2010 while those of vegetables decreased from 72 500 tonnes in 2009 to 60 100 tonnes in 2010 (GoK 2011b). Following a 33 700 tonne plunge in horticultural exports, earnings from the sector declined by a considerable KSh 9.2 billion in 2010 relative to 2009, forcing flower farms to lay off workers (Riungu 2009) which is contrary to Vision 2030's goal of stimulating employment creation.

Table 1.1: Estimated production of selected agricultural commodities, 2006-2010

Source: GoK 2011b

Crop	Unit	2006	2007	2008	2009	2010*
Maize	Million bags	36.1	32.5	26.3	27.1	35.8
Beans	Million bags	5.9	3.5	2.9	5.2	4.3
Potatoes+	Million tonnes	2.7	2.8	2.2	2.6	3.1
Sorghum	Million bags	1.6	1.8	0.6	1.1	1.8
Millet	Million bags	0.8	0.9	0.4	0.6	0.6

* Provisional + Revised

As the largest sector of Kenya's economy, it is reasonable to assume that the environmental impacts of agriculture are considerable and exceed those of the manufacturing sector. Indeed, increased water requirements compound the water scarcity and the attendant user conflicts that the country already has to grapple with. Further, increased fertilizer requirements imply burning of more fossil fuels from which they are derived and directly contribute to climate change and variability whose effects in Kenya are discussed in Chapter 3. Agricultural pesticide and chemical runoff often pollute the country's watercourses and bodies and the Indian Ocean, with adverse effects for freshwater (Odada et al 2004) as well as marine and coastal biodiversity. For instance, the Mombasa and Lamu inshore waters as well as the Malindi Bay and Sabaki Estuary which contain excessive loads of microbiological, metal and nutrient loads from agricultural runoff have been categorized as pollution hotspots in the western Indian Ocean region (UNEP/Nairobi Convention Secretariat et al 2009). Moreover, besides biodiversity threats, pollution is associated with a range of human health risks arising from contact or ingestion of contaminated fish and seafood. It also adversely affects the livelihoods of artisanal fishermen. Marine pollution also reduces the attractiveness of Kenya's leading coastal tourist destinations and could well cause the Vision 2030 goal to make Kenya one of the world's top ten long-haul tourist destinations to recede beyond reach. This would have ripple effects on the attainment of the other goals of Vision 2030's economic, social and political pillars principally because tourism is the country's biggest foreign exchange earner and its continued growth is vital to shielding the country against the rising prices of vital imports such as crude oil.

Manufacturing

The real GDP attributable to the manufacturing sector grew by 4.4 percent from KSh 137 billion in 2009 to KSh 143 billion in 2010. The sector consists of food manufacturing which is the single largest subsector but also beverages and tobacco and miscellaneous manufacturing activity. The considerable challenges faced by the sector such as high production costs, high taxes, poor infrastructure and cheap imports were more than cancelled out by favourable weather, which assured manufacturers of a steady supply of primary raw materials and hydroelectric power. Both the bulk of the manufacturing sector and energy sources are weather-dependent which highlights the magnitude of the effect environmental forces have over Kenya's economy. Indeed, the poor performance of the sector in 2009 was, in addition to cheap imports and high production costs, primarily attributed to drought.

Although the manufacturing sector's higher growth rate in 2010 is commendable, it continues to display a lacklustre performance. This probably accounts for the fact that even though it was the second largest economic sector after agriculture in 1990, by 2009 it had slipped to fourth place. And, even the sector's 2010 growth rate was 1.2 percent lower than the average growth rate and therefore continues to drag down the overall real GDP growth rate. Yet, because the sector is capital-intensive and creates many synergies and linkages with other industries such as agriculture, financing and wholesale (which are themselves some of the economic pillar's priority areas), it is an important job and wealth creator. Its growth is also crucial to shrinking Kenya's growing trade deficit as it would help bridge the gap between the low value exports and high value imports. The manufacturing sector will also be vital to transforming the country into a rapidly industrializing middle-income country by 2030 which is perhaps Vision 2030's most eloquent clarion call.

Given that the manufacturing sector's sustained double-digit growth rate is crucial to directly meeting the targets enumerated in the Vision 2030 economic pillar and to producing the resources for financing the identified social and political programmes, it is expected to come under pressure to reclaim its fast diminishing influence. It is therefore important to institute strong policy and legal mechanisms to ensure that the imminent increased manufacturing activity does not aggravate environmental degradation. This is partly because, due to intermittent power outages even at the best of times, a number of the country's industries increasingly rely on diesel-powered generators to meet production targets. Yet there is consensus among the scientific community that fossil fuel burning is responsible for emitting the largest proportion of greenhouse gases (GHGs) that are liable for climate change and variability (IPCC 2007). The suspended particulate matter from fossil fuel burning compromises air quality and causes diseases such as asthma and chronic bronchitis (Nel 2005). Although all the fuel that is sold in the country is unleaded, lead emissions from industrial processes (such as paint and battery manufacturing) contaminate crops and raise the risks of hypertension, heart attacks and strokes (Lovei 1998). In addition, a number of manufacturing entities pump untreated effluent into the country's rivers with this being largely responsible for the high pollution levels in the Nairobi and Ngong Rivers (UNEP 2007). These toxic and heavy metal-laden effluents alter the chemical composition of the rivers, giving off pungent smells which negatively affect human health. They also lead to loss of freshwater biodiversity and adversely affect the capacity of these watercourses to provide their traditional ecosystem services. The manufacturing sector should, under the auspices of its umbrella Kenya Association of Manufacturers (KAM) be encouraged to adopt lean production techniques that minimize waste and prevent pollution. These should complement command and control structures and other innovative measures such as targeted carbon emissions taxes that are already planned for implementation in developed countries such as Australia.

Over the last few decades, rising manufacturing activity has been associated with the increased use of plastic bags as the latter are often used to package manufactured goods but also to pack purchased groceries. Not only are plastic bags a source of aesthetic pollution—as these bags are dotted all over trees, parks and roadsides which negatively affects tourism—it is also a threat to biodiversity. Livestock and wildlife, for instance, get entangled or mistakenly ingest plastic bags while empty plastic bags that fill with rainwater are breeding grounds for malaria-carrying mosquitoes (UNEP 2005). Even though enforcement of the ban on the manufacture, importation and distribution of plastic carrier bags with gauges of less than 30 microns by both NEMA and the Kenya Bureau of Standards has helped to lessen the use of flimsy plastic bags, it has done little to encourage the recycling, reuse or proper disposal of the thicker plastic bags that are permitted by the law or even the use of the more readily biodegradable paper bags or conventional bags. The solution may therefore lie with imposing surcharges for consumers opting to use them (as is the case in Zimbabwe and Ireland) or imposing an outright ban on their use for packing goods in shopping outlets (as is the case in Rwanda).

	Unit	2006	2007	2008	2009	2010*
Freight:						
Tonnes	Thousand	1 891	2 304	1 628	1 532	1 572
Tonne-Km	Million	1 313	5 606	1 109	1 060	1 105
Revenue	KShs. Million	4 177	4 448	4 266	4 317	4 108
Revenue per tonne-Km	Cts	318	79	385	407	372
Passenger:						
Journeys	Thousand	4 348	4 500	3 226	8 861	6 049
Passenger-Km	Million	369	148	105	389	270
Revenue	KShs. Million	160	103	76	251	252
Revenue per passenger-Km	Cts	43	70	72	65	93

Table 1.2: Railway freight, 2006-2010

Source: GoK 2011b

Transport and communication

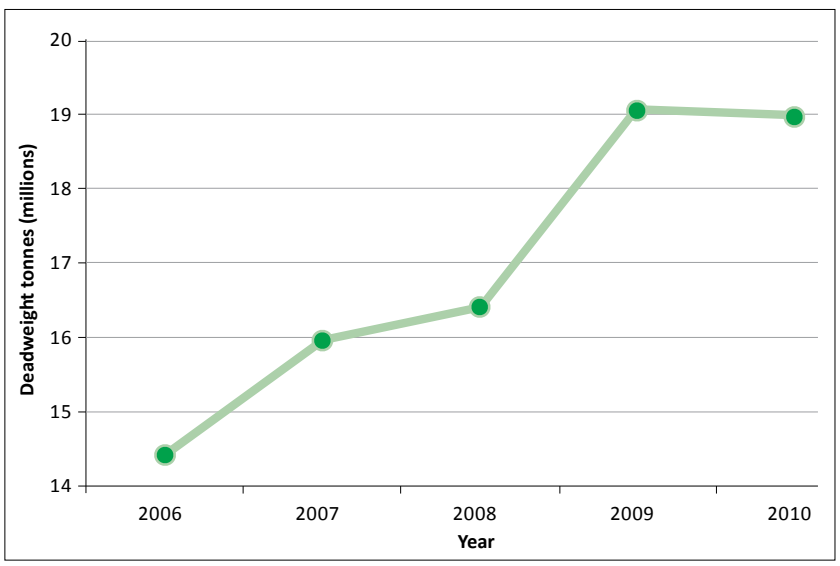
Transport

Growth in the country's transport and communications sector's contribution to the GDP slowed from 6.4 percent in 2009 to 5.9 percent in 2010 (GoK 2011b). The sector contributed KSh 172 billion to the real GDP in 2009 and KSh 182.5 billion in 2010. The sector comprises transport and storage, container handling at the port of Mombasa, air transport and the telecommunications subsectors which are fundamental to Kenya's economy and therefore to the attainment of Vision 2030. The century-old, 900km Kenya-Uganda railway line is recording falling or stagnant freight and passenger levels (see Table 1.2). This is because the railway line is dilapidated and is frequently vandalized, its rolling stock is obsolete and there is infighting among the shareholders of the Rift Valley Railways Consortium (RVR) which was awarded a 25-year concession to manage the railway in 2006. As a result, the burden of transporting bulk imports to the interior of the East African region is transferred to the country's road network. This causes heavy traffic congestion and frequent gridlocks on the roads leading into and out of the major cities, increased air pollution and exposure to traffic accidents. In addition, the roads wear out a lot faster and require more use of tar bitumen and cement concrete—whose manufacture is known to emit GHGs and other pollutants—because bulk goods are often transported in truckloads that exceed the legal axle loading limits.

The number of newly registered motor vehicles continued to grow. In 2010, 196 456 units were registered compared to 161 813 in 2009, which represented a considerable increase of 21.4 percent. From an environmental standpoint, this trend is worrying for a number of reasons. First, there is the likelihood of increased road accidents which in turn translate into higher family and state expenditure on injury-related medical care. In addition, the lives of many Kenyans are snuffed out at their prime, thrusting many of their families into poverty (and overreliance on natural resources) which is the very condition Vision 2030 seeks to stamp out. Second, the growing number of vehicles is likely to compound the already severe traffic congestions that the busier parts of the country experience. Completion of the construction of the Thika Superhighway and a number of by-passes should help to substantially ease this problem although it has been argued that by, for example bisecting the Nairobi National Park and the Ngong Forest, the southern bypass will irremediably disrupt the dynamics of the capital's biodiversity wonderlands. Third, more vehicles on roads obviously imply higher fuel consumption and the attendant air and noise pollution. This is especially important given that most of these newly registered cars are in fact second hand imports from Asia and are not as fuel-efficient as the car models that have recently rolled off the production line. So while the debate on motor vehicles in the developed countries is gravitating towards using alternative fuels such as biofuels, ethanol, liquefied petroleum gas (LPG), liquefied natural gas (LNG), compressed natural gas (CNG), and increased use of hybrid and electric vehicles, this is unlikely to be the case in Kenya in the foreseeable future. Measures by the City Council of Nairobi to lower the number of vehicles entering the capital's central business district by raising the daily parking fee from KSh 140 first to KSh 300 and then to KSh 250 have stalled over a pending legal suit that is challenging the justification for the new rate. Unfortunately for Kenya's environment, as long as Kenya's public transport network—primarily consisting of minibuses (*matatus*), buses and the railway line—remains inefficient and insecure, the number of newly registered vehicles is likely to continue its steep upward trend in the coming years.

The Port of Mombasa is primarily used to handle Kenya and the East African region's bulk import needs. Traffic throughput has been on the rise and grew by 16.1 percent from 16.4 million tonnes in 2008 to 19.06 million tonnes in 2009. In 2010 however, it registered a marginal 0.4 percent drop to 18.98 million tonnes (see Figure 1.3 and Table 1.3). Despite the generally strong growth recorded in the last couple of years, the port is operationally inefficient by international standards. For example, in 2009 the 618 816 containers handled by the port was equivalent to only 25 percent of those handled by Durban and 2.5 percent of those handled by Hong Kong and Singapore, which are the world's busiest ports (World Bank 2010). The corollary is that Kenya's

Figure 1.3: Trend of the amount of cargo handled by the Port of Mombasa



Source: Adapted from GoK 2011b

	Unit	2006	2007	2008	2009	2010
Container Traffic	TEUs	479 355	585 367	615 733	618 816	695 600
Ships Docking	No	1 857	1 811	1 686	1 748	1 579
Imports	000'DWT					
Dry General	"	4 099	4 866	4 979	5 435	5 987
Dry Bulk	"	2 344	2 722	2 891	4 641	3 871
Bulk Liquids	"	5 043	5 474	5 441	6 432	6 386
Total Imports	"	11 846	13 062	13 311	16 508	16 244
Of which Transit In	"	3 473	4 042	4 471	4 612	5 004
Motor Vehicles landed	No.	65 348	73 818	87 284	95 798	95 604
Exports	000'DWT					
Dry General	"	1 810	2 102	2 295	2 220	2 410
Dry Bulk	"	313	205	200	62	70
Bulk Liquids	"	132	167	190	167	95
Total Exports	"	2 255	2 474	2 685	2 449	2 575
Of which Transit Out	"	335	381	404	368	377
Total Imports and Exports	"	14 101	15 536	15 996	18 957	18 819
Transhipment	"	318	426	419	105	158
Grand Total	**"**	**14 419**	**15 962**	**16 415**	**19 062**	**18 977**

Table 1.3: Traffic handled at Mombasa Port, 2006-2010 Source: GoK 2011b

vital coastal and marine resource is not being put to optimal use. Moreover, nearly two-thirds of the containers imported full are exported empty (World Bank 2010), highlighting the enormous opportunities that exist for the country's manufacturing industries. Scaling up manufacturing activity would ensure that these containers are exported full, helping the struggling manufacturing sector to pull its weight in meeting the ambitious 10 percent annual economic growth rate anticipated by Vision 2030. Further, exporting manufactured goods rather than unprocessed or semi-processed raw materials would also help to bridge Kenya's worryingly widening trade deficit.

Air passenger traffic rose by 9.2 percent from 6.9 million in 2009 to 7.5 million in 2010, primarily due to an expanded route network for Kenya Airways and an economic upturn in some of the source markets. This air passenger growth boosted tourism and can be construed as a vote of confidence in the country's political situation as the devastating effects of the negative travel advisories imposed in 2008 in the wake of the post-election violence continued to ebb away. Both of these bode well for Vision 2030's economic and political pillars. These air passenger numbers are expected to soar when the new Unit 4 terminal at Jomo Kenyatta International Airport (JKIA) which is the country's busiest, is constructed. Upon completion, the new terminal is expected to offer 50 check-in counters, 8 air bridges for aircraft (including the gigantic double-deck, wide-body, four-engine Airbus A380 jet) to dock, 45 aircraft parking stands on the linked apron space, an additional runway and a multi-storey car park. The completion of the new terminal should help to cement Kenya's coveted position as the regional aviation and financial hub and accelerate delivery of the goals of Vision 2030's economic pillar.

However, aeroplanes are momentous polluters. Noise pollution both from the flying aircraft and the ground operations is an increasing problem for those who live, work and study around airports. The latter is a growing problem given that many university campuses are mushrooming around the Athi River area which is close to JKIA. Further, as aeroplanes traverse thousands of kilometres in a single flight and the aviation industry is rapidly growing, it is a significant emitter of CO_2 which accounts for the highest proportion of GHG emissions.

The Jomo Kenyatta International Airport, now under major expansion, is also home to one of Africa's largest airlines—Kenya Airways.

Mike Rosenberg/Flickr.com

Nairobi-Thika Superhighway – Nairobi-Thika Superhighway is part of the international trunk road that connects Kenya with Ethiopia to the north and is located in the Nairobi and Central Provinces of Kenya. It starts in Nairobi on Uhuru Highway at three points namely Haile Selassie Avenue, University Way and Museum Hill Roundabout and converges at Pangani Roundabout on Thika Road. It then proceeds to Thika via Muthaiga, the General Service Unit (GSU) headquarters, Kasarani and Githurai Roundabouts onto Kenyatta University, Ruiru Town, Juja Town and terminates at the bridge adjacent to Blue Post Hotel. The total project length is 50.4 km.

The traffic flow along the old Nairobi-Thika Road is characterized by heavy traffic snarl-ups, necessitating expansion of the road that will result in increasing the road's lanes from four to eight. In addition, there will be provision of cycle tracks and footpaths.

Below are photographs of sections of the superhighway, taken on 19th July 2011.

A completed section of the Thika Superhighway express lanes, close to Garden Estate.

On-going construction on a stretch of the Thika Superhighway approaching the GSU headquarters. The large roundabout that existed in front of the GSU headquarters has been done away with.

A panoramic view of a completed section of the Thika Superhighway.

An overpass by GSU headquarters connecting the Thika and Outer Ring roads.

Excavation works for bridge construction over the Pangani/ Muthaiga River.

Construction of an underpass at Pangani.

Construction of an underpass at Pangani.

Construction of a flyover at Pangani.

The Museum Hill/Uhuru Highway interchange.

Construction of the Superhighway and drainage works at the Utalii College/ National Youth Service (NYS) area.

A major sewerline under construction at Ngara.

A flyover above the Nairobi River at the Globe Cinema roundabout.

Moreover, emissions at high altitude are proven to have a 2-3 times greater effect on climate change (Williams et al 2002) than those at ground level yet there is still no viable alternative to the Jet A1 and avgas fuel used by aeroplanes. Kenya Airways, the flag carrier, launched a carbon offset programme which enables passengers to pay an amount over and above their airfare to pay for emissions contributed by them which are computed by an inbuilt IATA carbon calculator. The amount is arrived at based on actual fuel burn, travel class, weight of the passengers and cargo. The proceeds are used to fund environmentally sustainable projects (Kenya Airways 2011). While this innovative measure is commendable, its effectiveness is limited by the fact that this programme is limited to Kenya Airways yet at least 26 airlines operate international flights from JKIA alone, and it is entirely voluntary. As such, passengers are not obligated to actually offset their carbon emissions.

Communication

The telecommunications subsector exhibited a strong expansion thanks to the continued growth of the mobile telephony segment. To be sure, Kenya's mobile phone connections leapt by 50.4 percent from 12.9 million connections in 2008 to 19.4 million subscribers in 2009 and by 28.9 percent to 25 million connections at the end of 2010. This resulted in a market penetration of 63.2 percent which was a significant increase over the 49.7 percent mobile penetration recorded at the end of 2009 (CCK 2011). This growth is largely attributable to the entry into the mobile telephony market by Telkom Kenya and Essar, the increasingly cheaper handsets, stiffer competition in the segment characterized by bundling and promotions and entry by the Airtel, Orange and Yu brands into the mobile money transfer service which was developed and previously monopolized by Safaricom. The sector is expected to grow further in 2011 as the industry competition intensifies following the completion of Bharti Airtel's takeover of the Zain Africa Group and the introduction of mobile number portability that enables customers to seamlessly switch operators without losing their telephone numbers and prefixes.

In addition, cheaper and faster internet access following the granting of sea cable landing rights to The East African Marine System (TEAMS) and Sea Submarine Communications Limited (SEACOM), connecting all the country's district headquarters via a fibre optic link and attractive financing facilities by commercial banks are driving demand for computers, particularly laptops. However, left unchecked, the ICT revolution also has the potential to accentuate environmental degradation. When the mobile handsets, desktops, monitors, printers, photocopiers, facsimile machines and televisions breakdown or are deemed obsolete, typically within 5 years, they are discarded (Schluep et al 2008) as ordinary waste given that there is no functional regulatory mechanism for safe disposal of the country's burgeoning electronic and electrical equipment waste (e-waste). This problem is compounded by the fact that, while Kenya is a signatory to both the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal as well as the Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa, electronic waste generated in the developed countries is increasingly ending up in Kenya, along with other developing countries (Hileman 2006). This is because e-waste consignments are falsely labelled and declared as functioning goods (not waste), second-hand equipment or equipment for repair.

Moreover, this problem is likely to be compounded in the coming years given that although the Regional Radiocommunication Conference (RRC-06) set June 2015 as the deadline for all counties to migrate from analogue to digital terrestrial broadcasting technologies, Kenya plans to complete this migration by the end of 2012. While most of the current Kenyan households' analogue television sets will be able to receive digital broadcasting using a set-top box, many may be required to discard their analogue television sets and invest in those with an integrated set-top box (called idTVs). The challenge will be whether the relevant agencies will be able to safely dispose of the considerable electronic waste.

Tourism

The tourism sector witnessed a resurgence with earnings rising by 17.9 percent from KSh 62.5 billion in 2009 to KSh 73.7 billion in 2010 (GoK 2011b). The improved performance of the sector was thanks to an expanded international route network for Kenya Airways and successfully positioning Kenya as the destination of choice in the non-traditional markets of India, Russia, China and Middle East (GoK 2011a). However UK, USA, Italy, Germany and France remained the top five source markets in 2010. Kenya recorded 1.10 million holiday tourist arrivals in 2010. This represented a 3.7 percent growth over the 1.06 million arrivals registered in 2009 (GoK 2011b). The holiday tourist arrivals for 2005-2010 are illustrated in Figure 1.4. If this growth momentum is sustained, the country's unique and diverse wildlife and landscapes have the potential to become a major contributor to the 10 percent annual economic growth rate anticipated by Vision 2030.

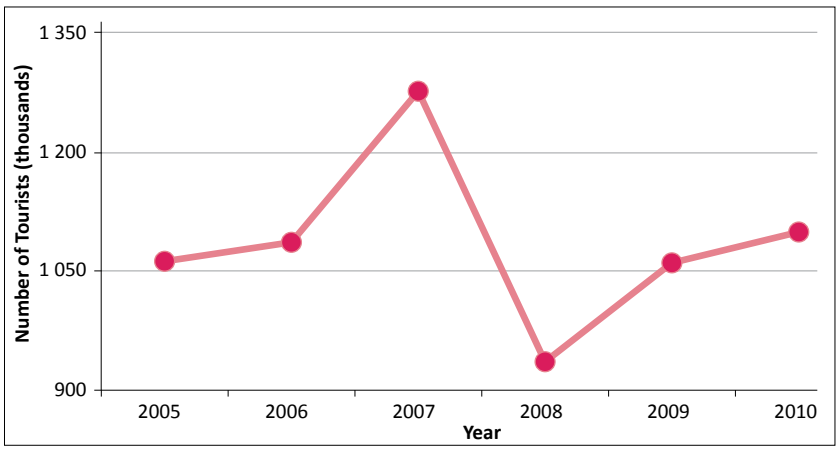


Figure 1.4: Trend in holiday tourist arrivals, 2005-2010 Source: GoK 2011b

Besides boosting government revenue through higher park entry fee collections, licences and taxes on the items consumed or rented by tourists, the tourism sector is an important source of employment (accounting for 9 percent of the formal employment in the country) and income for local communities. Tourism also has important interlinkages with Vision 2030's other priority growth areas such as manufacturing, agriculture and finance and its continued growth is bound to have positive knock on effects on these. The sector is also the leading foreign exchange earner for the country.

However, there is need to attenuate the relevant environmental pressures associated with rising tourist arrivals particularly during the critical breeding and migration seasons when off-road four wheel drive vehicles cause significant soil erosion, destroy tree roots, crush vegetation, animals, nests and burrows and cause physiological damage to fauna through noise pollution (Buckley 2004). Overuse of trails tramples soils and vegetation and occasions loss of biodiversity and other negative impacts that are tabulated in Table 1.4. Cigarette smoking by tourists heightens vulnerability to forest fires. The tents, lodges,

Alongside other abundant wildlife, birds—like these flamingos—are a major tourist attraction in Kenya.

hotels and resorts are also associated with a range of adverse environmental impacts. These accommodations aesthetically scar scenic landscapes and constrict wildlife dispersal areas. They also extract huge amounts of water from the environment for bathing, swimming pools and golf courses, compounding already severe water shortages in the country and degrading freshwater sources through saline intrusion into groundwater. In addition, the wood that is used for making fire to warm and prepare food for Mount Kenya's trekkers for example, is a major driver of deforestation (Mahaney 1986). Littering by tourists (Ikiara and Okech 2002) and improper waste disposal by tourist facilities also degrade the environment.

These are valid concerns, given that wildlife parks account for 75 percent of Kenya's total tourism earnings (GoK 2007) and visitors to the country's national parks and game reserves soared 46.6 percent from 1.63 million in 2008 to 2.39 million in 2009 and by 15.5 percent to 2.76 million in 2010 (GoK 2011b). Moreover, most of the wildlife tourism is concentrated in four parks namely the Maasai Mara National Reserve, Amboseli National Park, Samburu National Reserve and Lake Nakuru National Park. And it is reasonable to deduce that the Masaai Mara would record far higher tourist figures if the Narok-Sekenani stretch of the road to the national reserve was not in such an appalling state. To gradually ease pressure on these four wildlife parks which are already threatened by severe droughts and floods that have led to substantial wildlife population decreases, the government should implement the entry and accommodation fee increases mooted by Vision 2030. Given the incomparable role of wildlife to Kenya's economy and culture and the calibre of the governance structures that are in place in some of the national reserves, it would probably be appropriate to initiate a national debate on whether the Maasai Mara and Samburu National Reserves should continue to fall under the jurisdiction of the local authorities or whether their management should be transferred to the Kenya Wildlife Service (KWS) which has the overall mandate to conserve and manage the country's wildlife, and to enforce the relevant laws and regulations.

Trampling impacts on vegetation	Trampling impacts on soil
Breakage and bruising of stems	Loss of organic matter
Reduced plant vigour	Reduction in soil macro porosity
Reduced regeneration	Decrease in air and water permeability
Loss of ground cover	Increase in run off
Change in species composition	Accelerated erosion

Table 1.4: Impacts of trampling on vegetation and soil Source: Krumpe 1998

On a broader level, the thrust of the government's marketing campaign should be to reposition Kenya as a premium destination for ecotourism, high-spending tourists and as an ideal destination for the largely wildlife-neutral but lucrative conference and business tourism. This recommendation is predicated on the belief that if well thought through, tourism—particularly ecotourism—creates enormous opportunities for environmental protection and conservation. It can also be a vehicle for educating local and international tourists on the role of the environment, on environmental values and non-retrogressive cultural norms. Ecotourism is a more sustainable form of tourism because it attempts to prevent environmental degradation by recycling water, using renewable sources of energy such as solar in the national parks which are invariably off-grid, recycling organic waste in order to make fuel briquettes and composting green waste and using this in the tented camps' vegetable gardens (Ecotourism Kenya 2011). Ecotourism also often benefits local communities through improved infrastructure and better employment opportunities which in turn lead to less human-wildlife conflicts (Ogutu 2002). Segmenting the tourism product in line with the Vision 2030 aspirations (see Figure 1.5) will help to focus attention on the underutilized tourist destination categories.

Further, construction of hotels and other facilities in areas that are not on the sewerage line has deleterious environmental effects. In Mombasa for example, virtually all the beach resorts, along with public buildings and some households, have constructed onsite sewage management systems such as septic tanks and soakage pits. However, these often cause groundwater contamination because there are no

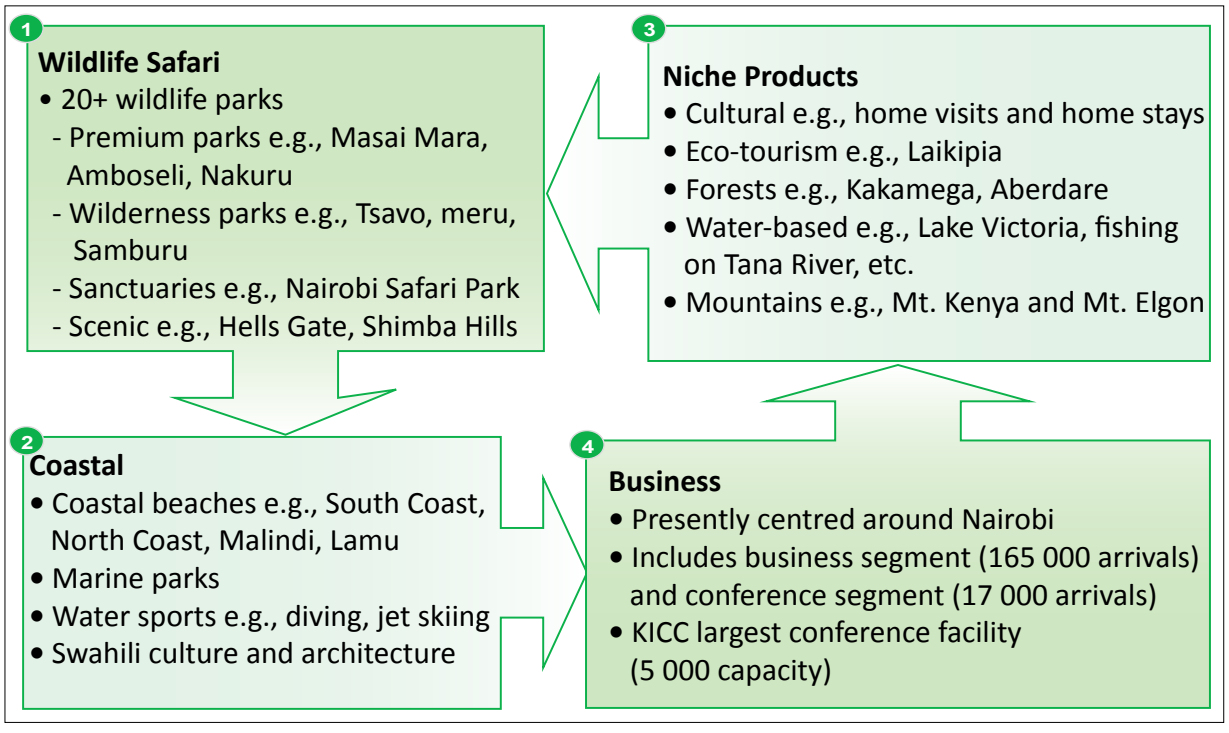


Figure 1.5: Anticipated segments of the country's tourism product

Source: GoK 2007

regulations to guide the construction of these systems (Munga et al 2006). Sewage runoff therefore causes considerable coral reef dieback, threatens the proliferation of marine life and can have serious consequences on human health.

Vision 2030 specifically highlights the need to develop a range of economic activities along the coast such as fishing and water sports, which are largely untapped. Indeed if well-regulated, these can appreciably boost tourism earnings as they would make the Kenyan coast an even more exciting tourist destination. From an environmental perspective however, there is need to exercise caution in developing anchoring, sport fishing, wind surfing, snorkelling, scuba diving and yachting because these activities often take place in and degrade fragile ecosystems such as coral reefs (Davenport and Switalski 2006). It is therefore important for KWS to as far as is practicable, ensure that the increased use of the country's coastal and marine resources is done in a manner that prioritizes environmental conservation.

Many of the above adverse environmental effects of tourism can be mitigated by formulating rigorous regulatory measures and ensuring their strict compliance. For instance, capping the number of visitors to the various wildlife parks to sustainable levels will obviously help to limit impacts that compromise these ecosystems' integrity.

Wholesale and retail trade

Vision 2030 identifies wholesale and retail trade as one of the sectors that can transform the economy by contributing to the delivery of the 10 percent annual economic growth rate. The long-term development blueprint envisages that this will be achieved through training, improving access to credit, eliminating inefficient intermediaries between producers and consumers and gradually formalizing the informal sector by creating formal market outlets for the sector's players.

Over the last five years, the wholesale and retail trade sector's contribution to Kenya's GDP has ranged from 9.3 percent in 2006 to 10.3 percent in 2010. In absolute terms, the sector's contribution to the real GDP grew from KSh 118.4 billion in 2006 to KSh 131.8 billion in 2007, KSh 138.1 billion in 2008, KSh 143.4 billion in 2009 and KSh 154.6 billion in 2010 (GoK 2011b). The potential of the sector is epitomized by the fact that it has been a key source of GDP growth since 2006 and at 14.4 percent in 2010, was the second highest source of growth after agriculture which contributed 24.5 percent to the growth realized. In 2008 however, it accounted for 30.8 percent of the source of growth, the highest by any economic sector that year.

Wholesale and retail trade is key to particularly achieving Vision 2030's poverty alleviation goals because it accounts for roughly 10 percent of formal employment in the country. It is also easy to engage in because it is not as capital-intensive as manufacturing or tourism, for example. Yet it is easy for the sector to have a transformative effect on the environment. Supplying agricultural produce through formal supply chains on the basis of negotiated contracts would eliminate destabilizing price oscillations and encourage farmers to produce commodities using environmentally sustainable practises because they will be virtually assured of a ready market and good return for their produce. Famers can themselves form producer groups and associations that would be better placed to act as internal watchdogs to ensure that set environmental standards in the production and processing of goods are met. Currently, due to wide price fluctuations, farmers are forced to hedge their bets by using wasteful production practises such as slash and burn agriculture which reduces soil fertility and cultivating economically unviable acreages due to market and price uncertainties.

Environmentally-conscious retail traders can also use their direct interaction with consumers to influence product choice by educating consumers about the relative environmental merits of the range of products on offer. In addition, the retail trade segment can be a focal point for effecting attitudinal change towards plastic bags by offering alternative packing materials such as paper bags and cardboard boxes. As big generators of waste (from spoilt food, expired products and discarded packaging materials), they can change ways in which their waste is handled by sorting it into recyclable and non-recyclable components and awarding waste collection contracts to firms that promote a range of environmental norms such as recycling and composting organic waste.

However, the wholesale and retail trade sector is associated with a range of daunting environmental challenges. As the sector is largely unregulated and consists of hundreds of thousands of disparate actors

A building under construction in Nairobi. Construction's contribution to the real GDP grew from 49.1 billion in 2009 to 51.4 billion in 2010.

who are dispersed all over the country, it is particularly difficult to enforce environmental laws and regulations. Transporting goods in small consignments using pick-ups, *matatus* or half-empty trucks due to lack of financial and logistical resources generates more air pollution and creates inefficiencies which unnecessarily push up retail prices and burden the final consumer. Government would therefore be well-advised to offer a range of fiscal incentives to encourage larger investments in the sector as these would reap the benefits of economies of scale. It would also be easier for agencies with an environmental mandate to regulate fewer but larger wholesale and retail traders.

Construction

Construction's contribution to the real GDP grew from 49.1 billion in 2009 to 51.4 billion in 2010 (GoK 2011b). Although the sector's growth fell from 12.4 percent in 2009 to 4.5 percent in 2010, the outlook remains bullish. For example, cement consumption increased by 16.2 percent from 2 671 million tonnes in 2009 to 3 104 million tonnes in 2010 and was attributed to the flourishing building and road construction sector. Indeed, the index of government's expenditure on roads rose substantially from 312.9 in 2009 to 394.8 in 2010. The number of private buildings under construction around the country also went up. The value of building plans approved by Nairobi and the other towns witnessed an upward trend in 2006-2010 as is illustrated in Figure 1.6. Construction is an important sector of Kenya's economy and development of modern physical infrastructure is indispensable to the delivery of Vision 2030. An efficient road network keeps production costs in check, opens up hitherto inaccessible markets and creates new employment opportunities. The number of wage earners employed by the sector rose by 8.5 percent to 101 300 in 2010 so the sector is a significant contributor to the employment creation and poverty alleviation initiatives set forth in Vision 2030.

Construction also has several positive ripple effects on other sectors of the economy such as manufacturing, wholesale and retail trade, and the financial sector. For example, the growth in the

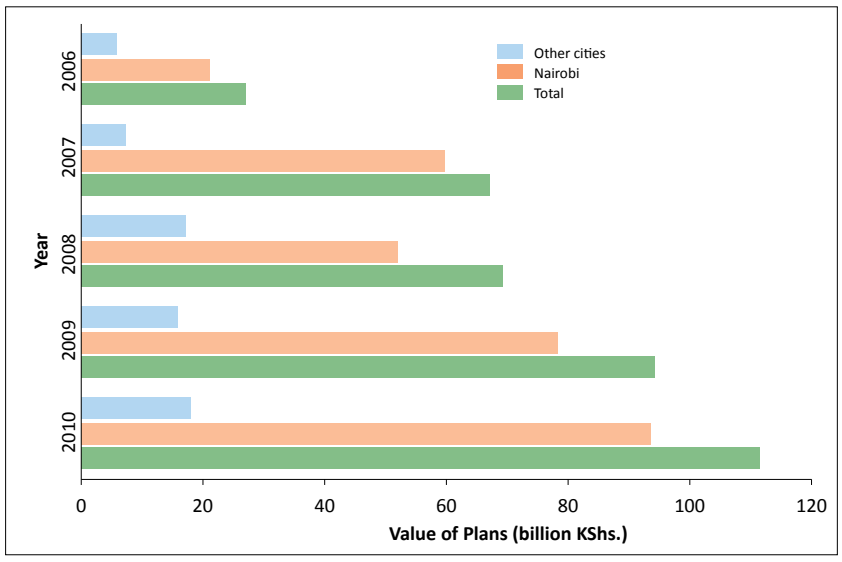


Figure 1.6: Value of building plans approved by Nairobi and the other towns, 2006-2010

Source: GoK 2011b

construction sector was accompanied by a 7.3 percent rise in the loans and mortgages from commercial banks and these grew from KSh 30.4 billion in 2009 to KSh 32.6 billion in 2010 (GoK 2011b).

Despite the construction sector's commendable contribution to the realization of the goals of Vision 2030's economic pillar, a number of environmental safeguards need to be instituted. In fact, owing to its sheer size, the construction industry isn't just one of the largest users of material, water and energy resources, it is also a momentous air, water and noise polluter (Horvath 2004). A range of adverse environmental effects have been catalogued to result from processes for obtaining local construction materials such as sand, limestone and stones from quarries. Abandoned quarries are not only aesthetically unappealing, they are safety hazards for human beings and wildlife and fill up with water which acts as breeding grounds for malaria-transmitting mosquitoes. As a result, the meagre household and government financial resources are used to treat the disease instead of being invested in productive activities. Severe malaria also keeps employees from work and results in loss of man hours that could have

	Quantity ('000 Tonnes)					Value (KSh Million)				
Year	**2006**	**2007**	**2008+**	**2009+**	**2010***	**2006**	**2007**	**2008+**	**2009+**	**2010***
IMPORTS										
Crude petroleum	1 643.2	1 598.7	1 773.3	1 627.9	1 551.5	55 015.6	49 240.8	81 452.9	54 495.4	72 598.0
Petroleum Fuels	1 402.7	1 999.9	1704.5	2 259.0	2 071.9	55 807.2	70 204.8	112 786.7	96 621.3	119 462.5
Lubricating Oils	2.6	0.0	12.4	17.0	3.0	73.1	10.8	614.1	588.2	123.4
Lubricating Greases	124.4	93.2	118.6	265.0	218.2	2 823.6	2 319.6	4945.5	8 487.6	8 596.1
TOTAL	**3 172.9**	**3 691.8**	**3 608.8**	**4 168.9**	**3 844.6**	**113 719.5**	**121 776.0**	**199 799.2**	**160 192.5**	**200 780.0**

* Provisional + Revised

Source: GoK 2011b

Table 1.5: Quantity and value of imports of petroleum products, 2006-2010

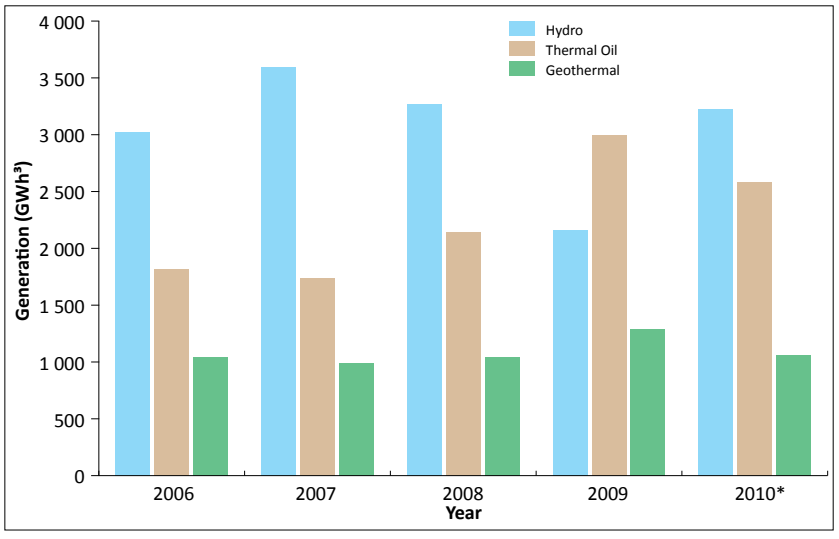
been used to fulfil the Vision 2030 promises. Further, modern roads and buildings often require the importation of large amounts of steel and finishing components which are often transported to Kenya by ships which can pollute the ocean and have devastating implications for marine biodiversity. These issues can hamper realization of the Vision 2030 underlying goal of growing the economy and improving the welfare of Kenyans without compromising environmental integrity. Road contractors and developers of commercial and residential buildings should therefore be encouraged to use local materials wherever possible and to adhere to internationally recognized green building certification processes. Some of these processes provide rigorous third-party verification that a building was designed and built using a suite of environmentally sustainable construction standards.

Construction activity also seems to be skewed to catering for the affluent segment of the population and little progress is being made in meeting the housing needs of the low income Kenyans. This implies that the recent real estate boom masks systemic inequities as decent housing remains an elusive dream for many Kenyan households given that there is an annual demand for 150 000 housing units in Kenya against an annual supply of less than 35 000 units (OECD et al 2011). The poor Kenyans therefore have to make do with sub-standard housing. Yet squalid living conditions lower the dignity of the affected and due to the associated inhospitable environment, make the inhabitants more susceptible to waterborne, water-related and sanitation-related diseases. The government should therefore formulate a range of incentives to encourage development of affordable housing and also ensure that the lower income cohort of the population has access to reasonably priced mortgage facilities.

Energy

The quantity of petroleum products imported into the country declined by 7.8 percent from 4.2 million tonnes in 2009 to 3.8 million tonnes in 2010 (see Table 1.5). Nevertheless, the total import bill of the petroleum products rose by a considerable 25.5 percent from KSh 160.2 billion in 2009 to 200.8 billion in 2010 (GoK 2011b) principally due to the increased oil prices on the international market. Petroleum products are an important source of government revenue because they attract excise duty, petroleum development duty and road maintenance levy which are vital to funding government activities and to consequently meeting a number of Vision 2030 goals. Most of the petroleum products imported into the country are used as fuel for the growing number of vehicles and in the production processes. As such, their rising prices have fuelled inflation and put many basic commodities out of the reach of many Kenyans, pushing them into—rather than out of—the poverty bracket, contrary to the Vision 2030 promises. As discussed in Chapter 2, the poor cohort tends to overexploit natural resources with this exacerbating environmental degradation. In addition, due to poverty and squalor, natural catastrophes disproportionately affect the poor and compound their marginalization.

The pervasive use of petroleum products in the country results in a range of negative health and environmental consequences. Human health consequences include respiratory diseases such as asthma, lung cancer and eye diseases such as conjunctivitis which particularly affects the young and elderly (Mulaku and Kariuki 2001). Environmental effects of petroleum fuel use include smog, acid rain and the aggravation of climate change and variability (IPCC 2007) which is discussed in more detail in Chapter 3. More localized problems include the toxic sludge from the petroleum refineries at Changamwe that is considerably degrading the country's coastal and marine environment.



* Provisional

Source: GoK 2011b

Figure 1.7: Generation of electricity by source, 2006-2010

Hydroelectric power represented 56.8 percent and 50.6 percent of all the power generated in 2007 and 2008 respectively. However, due to acute drought which lowered the dam water levels, hydropower production plummeted from 3 267.0 GWh in 2008 to 2 160.0 GWh in 2009, when it constituted only 33.2 percent of the country's energy portfolio and was displaced by thermal oil power, which accounted for 46.3 percent of the power generated, as the leading source of energy. In 2010 however, hydropower reclaimed its position with a total of 3 224 GWh and accounted for 46.2 percent of the power generated while the comparable figure for thermal oil was 2 586 GWh

which accounted for 37.1 percent (GoK 2011b). The generation of electricity over the last five years is displayed in Figure 1.7. The bulk of Kenya's hydroelectric power is generated by five power plants namely; Gitaru, Kiambere, Turkwell, Kindaruma and Masinga which have a combined installed capacity of 555MW. Figure 1.8 contains the geographic distribution of Kenya's power plants by category. Energy is one of the foundations on which Vision 2030's economic, social and political pillars are anchored so it is a major driver of Kenya's long term economic development.

Large and medium commercial and industrial establishments are collectively the largest consumer of electricity and in 2010 accounted for 55.7 percent of the electricity consumption with domestic and small commercial consumption accounting for 37.7 percent of the consumption. Demand for electricity under the rural electrification programme (REP) grew by 14.3 percent from 254.4 million KWh in 2009 to 290.8 million KWh in 2010 and is in keeping with Vision 2030's plans to scale up the number of rural households that are connected to the national grid or the off grid installations. To be sure, REP is one of the key projects under the energy segment that are earmarked for implementation in 2008-2012. Ensuring that a critical mass of rural households in the country has access to electricity would lessen the pressure on the country's forests and woodlands and allow them to regenerate. There is therefore need to radically scale up implementation

Figure 1.8: Geographic distribution of Kenya's power plants by category

Source: KenGen 2011

of the REP. This would concomitantly reduce the incidence of acute respiratory infections caused by indoor air pollution that is associated with using biomass fuels (Ezzati and Kammen 2001) which the majority of the rural and urban households in Kenya rely on.

However, even though hydroelectric power is considered to be a cleaner source of energy than its thermal oil counterpart, its reliance on the vagaries of weather has often led to domestic and industrial power rationing as well as rising electricity bills. These put electricity out of the reach of many Kenyans by stymieing implementation of REP and threatening to undermine Kenya's coveted position as the regional economic giant. Manufacturing companies are extremely sensitive to energy costs and unless remedial measures are urgently instituted, they could relocate to neighbouring countries which are better endowed with water resources as they would be assured of cheaper and more reliable hydroelectric power. This will obviously force many Kenyans out of work and make it harder for the government to deliver the economic and social pillar goals and the higher standards of living promised by Vision 2030.

Nonetheless, dams that have conventionally been constructed to create water reservoirs for hydroelectric power plants have been associated with a number of adverse environmental impacts which range from slowed river flows, loss of biodiversity to destruction of upstream riparian habitats (Maingi and Marsh 2002). In an attempt to address this problem, the 60 MW Sondu Miriu hydropower plant is a run-of-the-river plant that does not rely on damming but the natural flow of the Sondu Miriu River into Lake Victoria (KenGen 2004). Nevertheless critics have argued that even without damming, the construction of the hydropower plant polluted the river's waters, led to the disappearance of streams and springs and the extinction of endemic fish species like Okoko (*Synodontis sp.*) (International Rivers Network 2000).

Other adverse environmental impacts relate to the thermal oil power plants operated by the Kenya Electricity Generating Company Limited (KenGen), the Independent Power Producers (IPPs) and Emergency Power Producers (EPPs). As these generate electricity by burning large amounts of fossil fuels, they are major emitters of carbon dioxide (CO_2), nitrous oxide (NO_x), sulfur oxide (SO_x) and chlorofluorocarbons (CFCs)—which are some of the GHGs that are responsible for the climate change and variability that the world is grappling with—and particulates which, in addition to causing a range of pulmonary diseases, are carcinogenic. Going forward, it will be important for Kenya to reduce her reliance on both hydroelectric and thermal power by developing untapped potentials in geothermal and wind energy. In addition, it is important for the government to offer attractive fiscal and non-fiscal incentives in order to encourage rural and urban households to reduce their reliance on the national grid by investing in cleaner, renewable sources of energy such as solar, wind and biogas.

Larger electricity generators such as KenGen and wholly private sector actors should also harness the country's considerable geothermal potential. They could do this by scaling up their access to resources under a series of climate change mitigation initiatives such as the Clean Development Mechanism (CDM) which is provided for by Article 12 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC). Admittedly, all the three CDM projects that have been registered in Kenya relate to energy. These are the Ol Karia II Geothermal Expansion project; the Ol Karia III Phase II Geothermal Expansion project; and Lake Turkana 310 MW Wind Power project (UNFCCC 2011). The challenge is for players in the power industry to tap the enormous CDM financial resources before the Kyoto Protocol's first commitment period expires in 2012 as the future of this legal regime is uncertain.

In 2010, Kenya announced plans to venture into nuclear energy. As such, the country intends to commission her first 1 000 MW nuclear power plant by 2017 in order to diversify energy sources and rein in rising energy costs. The magnitude of the recent Fukushima nuclear disaster—which is evocative of the Chernobyl catastrophe—and its immense environmental fallout appear to demonstrate that conventional safeguards cannot adequately proof atomic plants against natural disasters such as earthquakes and tsunamis. In this regard, Japan plans to gradually phase out its nuclear reactors which account for 30 percent of its energy portfolio. Germany also plans to phase out nuclear energy, which accounts for 40 percent of that country's energy needs by 2022. Kenya's Nuclear Electricity Project committee will therefore need to carry out thorough due diligence on the viability of this form of energy in Kenya. Should it recommend that the country embark on the path to the cheap but extremely risky atomic energy, it will need to ensure that these nuclear plants can operate safely, conform to the standards set by the International Atomic Energy Agency (IAEA) and can withstand even the severest of natural disasters. It would follow that the country would need to quickly secure the requisite technology transfers that would sufficiently mitigate the attendant risks.

Fishing

The quantity of fish landed rose by 8.2 percent from 133 600 in 2009 to 144 505 in 2010. However, earnings from fishing, largely from the country's freshwater bodies rose by 36.2 percent from KSh13 billion in 2009 to KSh 17.7 billion in 2010. The jump in earnings was both because of higher catches and better domestic and export prices (GoK 2011b). As is evident from Table 1.6, Lake Victoria accounted for the largest quantity (78.7 percent) and highest value of fish landed by freshwater body. Admittedly, Vision 2030 does not specifically identify fishing as one of the priority sectors. However, it is an important subsector because it is a major source of livelihood for communities which live on the shores of Lake Victoria, Lake Turkana and Lake Naivasha, and those who live near the Tana River and Indian Ocean. It also meets the protein needs of the country's poor and can significantly contribute to the growth of the tourism and manufacturing sectors. Indeed, fishing in Lake Victoria, River Tana and the Indian Ocean have the potential to become important components of the water-based tourism niche which is grossly under-utilized. Setting up fish processing facilities in Kisumu and at the coast in line with the Vision 2030 targets will also contribute to the growth of the manufacturing sector, with positive outcomes for Vision 2030. This is because it will increase the value added component of the sector and also stimulate the growth of offshore fishing, which is largely untapped.

Nevertheless, a number of environmental challenges need to be addressed. Agrochemical runoff, lakeshore leaching by mining tailings, disposal of industrial, medical and chemical waste as well as expired pesticides (some of which are highly carcinogenic) and sludge result in eutrophication of the country's freshwater bodies such as Lake

A mature fish (tilapia) captured in Ramisi River, Kwale County.

Victoria (Odada et al 2004). In addition, abusive fishing practises, such as using pesticides to catch fish (Canter and Ndegwa 2002, Henry and Kishimba 2006) have raised questions over the sanitary condition of the country's fish and whether it is fit for human consumption and resulted in the EU imposing a ban on the import of chilled freshwater fish from East Africa in 1999. Moreover, freshwater fishing is, of course, directly dependent on the availability of freshwater and the water scarcity that Kenya is experiencing and which is projected to worsen as detailed in Chapter 7 is likely to pose further threats to the sustainability of the subsector. In addition, the Kenya-Uganda standoff over the jurisdiction of Migingo and Ugingo Islands of Lake Victoria whose waters abound with Nile perch and tilapia does not augur well for the subsector which is dominated by fishing from the lake or indeed for achievement of the political pillar targets of Vision 2030. Because of the clear relationship between the environment and political stability, efforts to amicably resolve this turf dispute should be intensified.

Financial services

The financial sector in Kenya consists of banking and quasi-banking institutions such as savings and credit cooperative organizations (SACCOs), microfinance institutions (MFIs)

Table 1.6: Quantity and value of fish landed by freshwater body, 2006-2010 Source: GoK 2011b

Quantities – Tonnes	2006	2007	2008	2009	2010*
Freshwater fish					
Lake Victoria	143 908	117 231	111 369	108 934	113 041
Lake Turkana	4 559	5 122	8 070	9 445	8 123
Lake Naivasha	189	203	225	688	693
Lake Baringo	68	173	262	191	198
Lake Jipe	109	96	109	109	111
Tana River	1 024	1 112	1 302	584	596
Fish Farming	1 012	4 245	4 452	4 895	12 153
Other areas	842	706	883	828	869
TOTAL	**151 711**	**128 888**	**126 672**	**125 674**	**135 784**
Marine fish	6 023	6 355	7 561	7 024	7 600
Crustaceans	436	618	578	407	549
Other marine products	500	494	597	495	572
GRAND TOTAL	**158 670**	**136 355**	**135 408**	**133 600**	**144 505**
Value – KShs. Million					
Freshwater fish	8 071	8 029	10 718	12 274	16 905
Marine fish	335	422	541	557	614
Crustaceans	123	145	147	127	173
Other marine products	38	43	49	44	50
TOTAL	**8 567**	**8 640**	**11 455**	**13 002**	**17 742**

and development finance institutions (DFIs), insurance, capital markets and pension funds. Financial services are also one of the six priority areas of the economic pillar. Vision 2030 seeks to create a vibrant and globally competitive financial sector that encourages a high ratio of savings to income that will then be used to finance Vision 2030 and other projects. It proposes to achieve this through carrying out legal and institutional reforms, consolidation of small banks, streamlining informal finance organizations and strengthening capital markets to play a critical role in the mobilization of resources for equity finance, for issuance of long-term bonds including those for funding infrastructure as well as for tapping international debt capital markets.

The financial intermediation sector contributed 5.5 percent to the GDP in 2009 and 5.6 percent of the GDP in 2010, which was considerably higher than its 4.0 percent contribution in 2006. The sector posted an 8.8 percent growth rate in 2010 compared to a 4.6 percent growth rate in 2009. Its contribution to the GDP rose from KSh 64.1 billion in 2006 to KSh 88 billion in 2007; KSh 97.8 billion in 2008, KSh 129.9 billion in 2009 and KSh 143.6 billion in 2010 (see Figure 1.9). Although Kenya has 40 banks, the industry is dominated by 5 banks. Short term interest rates witnessed a downward trend in line with the falling Central Bank rate. For example, the interbank rate and the 91-day treasury bill interest rate declined by 1.77 percent from 2.95 percent in December 2009 to 1.18 percent in December 2010. However, high commercial lending rates (in double digits) and insistence on fixed asset collateral imply that the majority of Kenyan businesses are unable to obtain credit.

As is the case with other service industries, the emission of toxic chemicals, energy consumption and generation of hazardous wastes is substantially lower for the financial services sector than it is for the manufacturing sector (Rosenblum et al 2000), for example. In addition, many of the country's commercial banks are encouraging customers to withdraw money at the automated teller machines (ATMs) rather than at the counter by imposing punitive surcharges for the latter. Further, some of the banks no longer mail paper statements to their customers but email e-statements instead. Both of these developments have reduced the use of paper (which in turn slows the rate of deforestation) and the energy previously used to print, post and transport these statements. Most of the banks have also introduced e-banking and mobile banking and customers don't have to drive to banks in order to obtain their balances, saving both fuel and the country's ambient environment that is already under pressure from the rising vehicle numbers.

While all these innovative practises are commendable, banks can play a more significant role in saving Kenya's environment. Their due diligence on potential projects should entail rigorous review of environmental impact assessments (EIAs) while the credit approval processes should subject the proposed project's design and operations to meticulous assessment on whether these will adhere to accepted environmental norms. In addition, fiscal incentives should be instituted to encourage banks to embrace the concept of green financing which could for example, target developers of environmentally sustainable buildings, wind, solar, biofuel and other emerging energy options as well as responsible waste handling and energy-efficient technologies. With skyrocketing fossil fuel prices and dwindling world oil reserves,

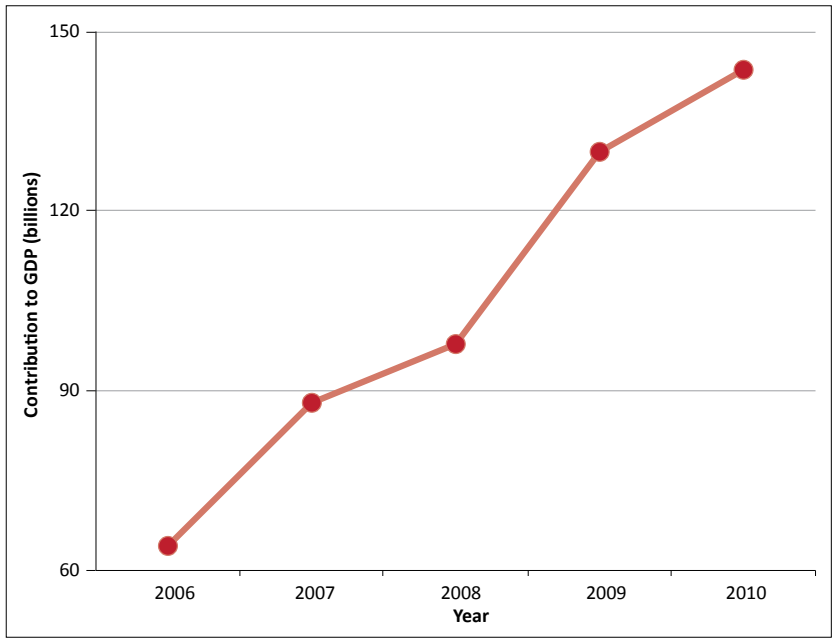


Figure 1.9: Financial intermediation sector's contribution to the GDP, 2006-2010

Source: GoK 2011b

and growing interest by citizens and policymakers in tackling climate change and variability, the business case for green financing has never been stronger and it is in the sector's own long-term interest to kindle corporate interest in green financing.

Macroeconomic indicators

Macroeconomic stability is obviously indispensable to attainment of the goals enumerated under the economic, social and political pillars of Vision 2030. This is because the assumptions made for growths of the priority sectors outlined above are predicated on stable economic fundamentals otherwise inflationary pressure would, for example, more than cancel out any gains made. This section interrogates the consumer price indices and inflation, exchange rates, interest rates, capital market, and foreign exchange reserve macroeconomic indicators and their implications for the delivery of the Vision 2030 goals from an environmental standpoint.

Consumer price indices and inflation

The consumer price indices (CPI), which were based on the new CPI basket formulated in February 2009 (see Table 1.7), were 76.25 in 2006, 79.50 in 2007, 92.36 in 2008, 102.10 in 2009 and 106.26 in 2010 (GoK 2011b). The basket's top five heavily weighted items are food and non-alcoholic beverages (36.03 percent), housing, water, electricity, gas and other fuels (18.3 percent), transport (8.67 percent), clothing and footwear (7.43 percent) and household maintenance (6.16 percent). Each of these has striking interlinkages with the environment for example, road and building construction is often attended by heavy water and other resources use as already discussed. The food and non-alcoholic beverages portion of the index rose by 5.9 percent in 2010 relative to 2009. The availability and cost of food is dependent on environmental factors such weather, water availability, pest and diseases as well as land degradation. Scaling up efforts to protect Kenya's environment will therefore help to rein in adverse changes in the most heavily weighted component of the CPI. The availability of water and hydro power generation—which is the dominant source of electricity use in Kenya—are also positively related. On the other hand, the 10.3 percent drop in the communication index for 2010 relative to its 2009 counterpart highlights the fact that consumers are beginning

Broad Item Group	Weights (%)	Annual Average Index 2009	Annual Average Index 2010	% Change
Food and Non-Alcoholic Beverages	36.03	103.28	109.35	5.9
Alcoholic Beverages, tobacco, and Narcotics	2.06	103.72	111.48	7.5
Clothing and Footwear	7.43	101.54	104.97	3.4
Housing, Water, Electricity, Gas, and other Fuels	18.30	101.8	105.09	3.2
Furnishings, Household Equipment, and Routine Household Maintenance	6.16	100.81	104.07	3.2
Health	3.13	101.73	106.16	4.4
Transport	8.67	102.52	107.92	5.3
Communication	3.83	99.62	89.32	-10.3
Recreation and Culture	2.25	100.62	101.85	1.2
Education	3.14	100.03	101.38	1.4
Restaurant and Hotels	4.49	102.53	106.68	4.0
Miscellaneous Goods and Services	4.52	101.45	103.70	2.2
Weighted Average of all Items	100	102.10	106.26	4.1

Table 1.7: CPI and inflation by commodities, 2009 and 2010

Source: GoK 2011b

to reap the benefits of the stiff competition in the mobile telephony subsector. However, as discussed earlier in this chapter, while lower telephone tariffs and internet charges are important to increasing the mobile telephone penetration, to transforming Kenya into the knowledge economy and to tapping the potentially lucrative business process outsourcing (BPO) opportunities that Vision 2030 envisages, this has several environmental downsides. Increasing numbers of obsolete handsets and IT equipment are likely to compound the growing e-waste problem in the country as already discussed and a legal and policy framework needs to be urgently instituted.

Inflation decreased from 10.5 percent in 2009 to 4.1 percent in 2010, which was even better than the government target of keeping this macroeconomic indicator below the five percent mark. A low inflation rate is essential to creating a stable economic climate as it improves the purchasing power of the poor. This in turn reduces the dependence of this cohort on the environment, allowing natural resources such as forests and fish stocks to recover. Low inflationary pressure also encourages the private sector to make long-term investments that create employment opportunities which reduce poverty and improve the people's wellbeing, accelerating attainment of the poverty alleviation goals of Vision 2030. In addition, resources become available for investment in environmental conservation resulting in a better environment.

However, a number of internal and external shocks are threatening to reverse the gains made in taming inflation which stood at 6.0 percent in 2006, 4.3 percent in 2007, 16.2 percent in 2008, 10.5 percent in 2009 and 4.1 percent in 2010 (GoK 2011b). The annual inflation rates for 2006-2010 are illustrated in Figure 1.10. The projected inflation rate of 10 percent for 2011 could turn out to be a gross underestimate due to a range of domestic and external shocks. While the domestic shocks emanate from the persistent drought that has led to scarcer and pricier agricultural commodities, the external shocks relate to increases in international crude oil prices (CBK 2011) in the wake of the Arab Spring. These issues highlight the interlinkages between inflation and the environment, including natural resources.

Exchange rates

The Kenyan Shilling depreciated against two of the world's major currencies. The shilling depreciated against the US dollar by 6.5 percent from KSh 75.82 as at December 31, 2009 to KSh 80.75 at the end of 2010. The shilling depreciated against the Sterling pound by 2.4 percent from KSh 121.89 in 2009 to KSh 124.77 at the end of 2010. The shilling however appreciated against the Euro by 1.2 percent from KSh 108.94 in 2009 to KSh 107.63 in 2010 (CBK 2010).

A depreciating shilling improves export earnings but makes imports more expensive. So while a weakening shilling will likely improve the welfare of the country's exporters of tea, coffee and horticultural produce, this may encourage farmers in this sector to increase production using environmentally unsustainable practises such as excessive use of pesticides which have a range of adverse effects on human health and also degrade the country's soil and water resources unless proper regulatory and enforcement mechanisms are in place. On the other hand, because Kenya does not have proven fossil fuel reserves, all her fossil fuel needs are met by imports and a depreciating shilling will make these more expensive. Fuel, notably kerosene which is used by the country's poor for lighting and cooking, is then priced out of reach. In order to meet its cooking and energy needs, this segment of society consequently exerts more pressure on the country's diminishing forests and woodlands for wood fuel, fuelling their deforestation.

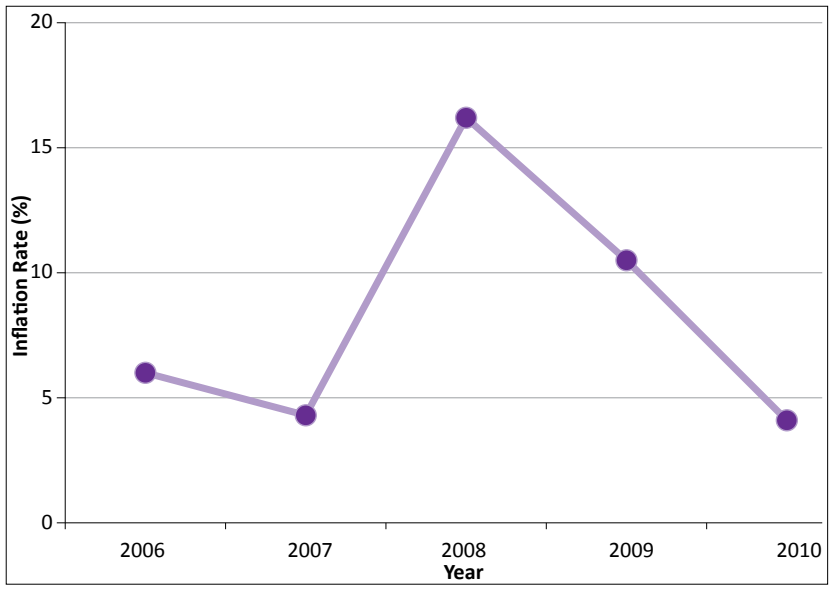


Figure 1.10: Annual inflation rates, 2006-2010

Source: GoK 2011b

Interest rates

The average yield rate for the 91-day treasury bills, which is a benchmark for the general trend of interest rates, has recorded a mixed performance over the last 7 years. As illustrated in Figure 1.11, this stood at 8.29 percent in 2004, 8.14 percent in 2005, 5.73 percent in 2006, 6.87 percent in 2007, 8.59 percent in 2008, 6.82 percent in 2009 (GoK 2010c) and 2.3 percent in 2010 (GoK 2011b). The interest rates commercial banks

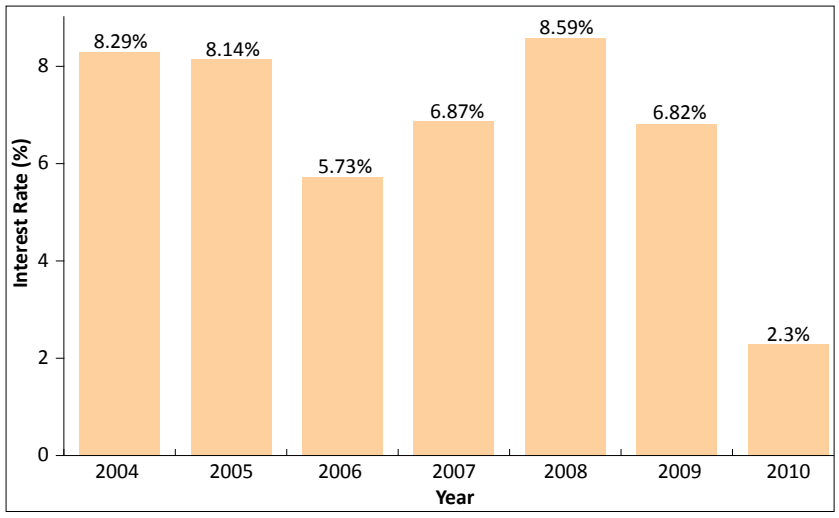


Figure 1.11: Trend in interest rates, 2004-2010

Source: Adapted from GoK 2010c and GoK 2011b

pay on savings is dismally low and has ranged from 1.4 percent to 1.7 percent over the last five years (GoK 2011b).

Yet despite the low cost of money to the country's financial intermediaries, commercial bank base lending rates—which are invariably marked up by several percentage points—have ranged from 13.3 percent to 14.8 percent in the last five years which is quite high. In the period of high interest rates—which is exacerbated by onerous fixed asset collateral requirements—Kenyans cannot, for instance, afford to borrow in order to make investments required for environmentally sound mechanised agriculture and are instead more likely to engage in slash and burn agriculture that depletes soil fertility. Equally, due to the pertaining high interest regime, manufacturing entities are unlikely to borrow in order to invest in cleaner production technology or energy-efficient vehicles, with adverse consequences on Kenya's environment.

Capital markets

The Nairobi Stock Exchange share index (NSE 20) increased by 36.5 percent from 3 247 in 2009 to 4 433 points in December 2010. As seen in Figure 1.12, although the index was the highest in three years in 2010, it is still considerably lower than the indices of 5 646 and 5 445 recorded in 2006 and 2007 respectively. The total value of shares traded surpassed the KSh 100 billion mark and stood at KSh 110 billion, which reflected a 189.5 percent increase over the KSh 38 billion total value of shares in 2009. The total number of shares traded hit an all time high of 7.5 billion, more than double the 3.2 billion shares traded in 2009. Market capitalization also exceeded the trillion shilling mark and closed the year at KSh 1.17 trillion. In comparison, market capitalization was KSh 792 billion at the end of 2006, KSh 851 billion in 2007, KSh 854 billion in 2008 and KSh 834 billion at the end of 2009.

Share price movements continue to be largely driven by profitability earnings or projections to the exclusion of environmental imperatives. In order to root environmental considerations more firmly, the Capital Markets Authority (CMA) should consider developing an environmental stock market index by drawing on the expertise of the country's environmental economists. This would aim to provide a quantitative measure of the environmental damage caused by the companies in an index and in turn subject the environment-friendliness of the listed companies' operations to public scrutiny.

Bonds worth KSh 479 billion were traded in 2010, which was a 331.5 percent increase over the bonds worth KSh 111 billion traded in 2009. Implementation of bond reforms, automation of bond trading and settlement, and issuance of large infrastructure bonds by government are credited with the phenomenal growth. However, Kenya's environment would be much better off if potential investors were provided with sufficient information on the environmental friendliness of the projects for which the bonds are issued to enable them to make informed, eco-friendly decisions. This is particularly important for the large infrastructure bonds that have the potential to irredeemably degrade the environment by ensuring that rigorous, third party-verified environmental impact assessments are carried out. In addition, conducting integrated environmental assessments of all plans, policies and programmes (GoK 2009) of which these projects are part, in accordance with the National Environment Action Plan (NEAP) 2009-2013, would enhance rather than vitiate sustainable development that is crucial to the delivery of the goals of the economic, social and political pillars of Vision 2030.

Broad money supply (M3), a key indicator for monetary policy formulation, expanded from KSh 653.0 billion in December 2006, KSh 777.6 billion in 2007, KSh 901.1 billion in 2008, KSh 1.05 trillion in 2009 and by 21 percent to KSh 1.27 trillion in December 2010. Money and quasi-money (M2) grew from KSh 553.9 billion in 2006 to KSh 666.9 billion in 2007, KSh 766.4 billion in 2008, KSh 898.1 billion in 2009 and by 22.4 percent to KSh 1.1 trillion in 2010. As broad money supply is well correlated with the strength of the economy, it is evident that from the 2010 figures, the economy's underlying fundamentals are strong. Given the interconnectedness of the economy and the environment, future economic growth at the ambitious levels envisaged by Vision 2030 should be assured by paying due regard to environmental imperatives.

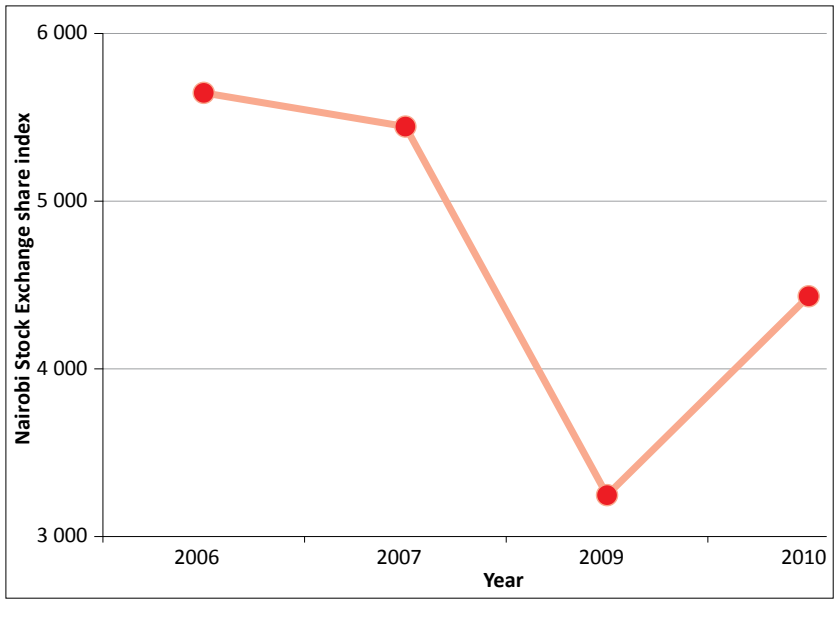
Foreign exchange reserves

The total central government reserves increased only marginally from KSh 1.52 billion in 2009 to KSh 1.56 billion in 2010. However the net foreign assets of the Central Bank rose by 20.3 percent from 220.8 billion in 2009 to 275.5 billion in 2010. To the extent that the level of foreign exchange reserves is an important indicator of government's ability to repay foreign debt, stabilize the volatile exchange rate and tame imported inflation, these levels do not appear to be able to adequately cushion Kenya against the rising fuel prices, for example. As the effects of this macroeconomic indicator are far reaching, this threatens to derail the attainment of the goals of all the three pillars of Vision 2030.

An unstable macroeconomic milieu encourages short-termism rather than long term sustainability. As such, with the comparatively

Figure 1.12: Nairobi Stock Exchange share index, 2006-2010

Source: GoK 2011b



low level of foreign reserves, government commitments on the environment which involve expending money are likely to be postponed. In addition, should public expenditure need to be cut, it is likely that the budgetary allocation to the Ministry of Environment and Mineral Resources, which is already only a tiny fraction that of other ministries such as Education and Defence will be cut more than others. This would obviously have negative outcomes for the delivery of Vision 2030 and beyond because the strides made in the economic sphere would not be sustainable as the departments and agencies with an environment mandate would be inadequately resourced.

Conclusion and recommendations

Vision 2030 recognizes the role of the environment in attaining the targets not just of the social pillar, where it falls, but of the economic and political pillars as well. In a sense therefore, the country's long-term development blueprint is underpinned by the principle of sustainable development and the recommendations set forth below should ensure the actualization of this principle.

- **Mainstream environmental concerns into the economy by:**
  - o Formulating a national environment policy which would provide the policy framework for the numerous sectoral environmental policies and laws.
  - o Integrating environmental objectives into the plans, policies and programmes of government, government agencies as well as the activities of the private sector (Dalal-Clayton and Bass 2009). To be successful, this would need to be matched with higher budgetary allocations to NEMA and the Ministry of Environment and Mineral Resources whose funding should compare favourably with the country's well-resourced ministries, such as that of Education.
- **Institute a range of fiscal measures to reward environment-friendly initiatives** such as green technology and green financing and deter activities that are notorious for degrading the environment by meticulously meting out penalties based on the 'polluter pays' principle.
- **Ensure that the national accounting system embraces environmental accounting** because traditional financial accounting methods typically underestimate the country's natural capital and therefore the environmental costs of economic activity (Burnett and Hansen 2008). Environmental accounting would enable Kenyan businesses to better internalize their externalities, incrementally leading to less water and air pollution, deforestation and land degradation.
- **Encourage consumers to make lifestyle choices and purchasing decisions that are eco-responsible.** This will increase public scrutiny on the environmental friendliness of production processes and the ecological impacts of products and will encourage businesses to adopt environmentally sound norms.

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CHAPTER 2
SOCIOECONOMIC STATUS, POVERTY, GENDER AND ENVIRONMENT

Introduction

The nexuses between socioeconomic status, poverty and gender on the one hand and environment on the other are emerging research and policy fields as the relationship between these mutually reinforcing sets of variables becomes increasingly clear. In this paradigm, because women, the poor and those who occupy the bottom rung of the socioeconomic hierarchy have limited resources, they are more likely to over rely on the natural environment for sustenance. Equally, because they enjoy an intimate relationship with nature, they are disproportionately affected by environmental degradation and natural disasters. In this sense then, addressing the plight of socioeconomically deprived sections of society, instituting poverty alleviation measures, attaining gender parity and ensuring sustainable environmental management are perceived as complementary goals. Tackling these exclusions is vital to the attainment of Vision 2030 because ultimately, improving Kenyans' welfare without compromising the country's environment must be buttressed by targeted pro-poor, pro-marginalized, gender equity and equality and environmentally sustainable initiatives. Although these are not discrete categories as many Kenyans simultaneously face multiple exclusions, because each of these categories elicits specific interactions with the environment, they are as far as possible, discussed separately below. An additional section discusses the multiple exclusions many Kenyans have to continually confront because they live at the intersection of these identity markers.

Socioeconomic status and the environment

Socioeconomic status is an individual's relative social and economic standing in society based on an amalgamation of three variables namely; educational attainment, economic activity (which encompasses business pursuits and occupational prestige) and income. There is a strong correlation between socioeconomic status and the environment because Kenyans with high and medium socioeconomic statuses have little interaction with the natural environment and they have the wherewithal to withstand ecological crises while those with a low socioeconomic status are disproportionately affected by these crises because they have to live and work in close contact with nature and they have a low coping capacity.

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Education

State of education in Kenya

The Kenyan government introduced the Free Primary Education (FPE) and the Free Tuition Secondary Education (FTSE) programmes in 2003 and 2008 respectively. As the names of the programmes suggest, government pays all the tuition fees for all the pupils enrolled under the FPE programme while it pays part of the tuition for students under the FTSE programme. The costs for uniforms, school meals, transport to and from school, healthcare and boarding facilities and national examination costs are borne by the parents.

Some remarkable successes have been recorded under both programmes. Primary school enrolment has been rising since inception and leapt from 7.7 million in 2006 to 8.3 million in 2007, 8.6 million in 2008, 8.8 million in 2009 to 9.4 million in 2010 (GoK 2011). Because of this progress, the country is likely to achieve Millennium Development Goal 2 (MDG 2) which seeks to ensure that by 2015, all children (girls and boys) can complete a full course of primary schooling. Table 2.1 contains the primary school enrolment by standard and sex for 2006-2010.

On the introduction of FTSE, secondary school enrolment increased from 1.2 million in 2007 to 1.4 million in 2008, 1.5 million in 2009 and 1.7 million in 2010 (GoK 2011) as illustrated in Figure 2.1. As

Table 2.1: Primary school enrolment by standard and sex, 2006-2010 Source: GoK 2011

Province	2004	2005	2006	2007	2008	2009*
Coast	556 013	585 543	600 041	643 355	658 860	689 798
Central	910 806	903 638	882 429	888 236	911 340	975 561
Eastern	1 371 680	1 379 909	1 378 210	1 480 629	1 538 785	1 565 188
Nairobi	229 252	237 858	234 819	319 000	320 102	345 939
Rift Valley	1 697 619	1 695 359	1 724 052	1 871 397	1 876 777	1 977 115
Western	1 101 162	1 143 972	1 122 557	1 273 510	1 333 640	1 365 127
Nyanza	1 321 901	1 324 239	1 334 597	1 441 735	1 508 264	1 576 779
North Eastern	69 958	70 891	81 182	98 629	115 287	138 172
TOTAL	**7 394 762**	**7 597 285**	**7 632 113**	**8 330 148**	**8 577 619**	**8 827 535**

* Provisional

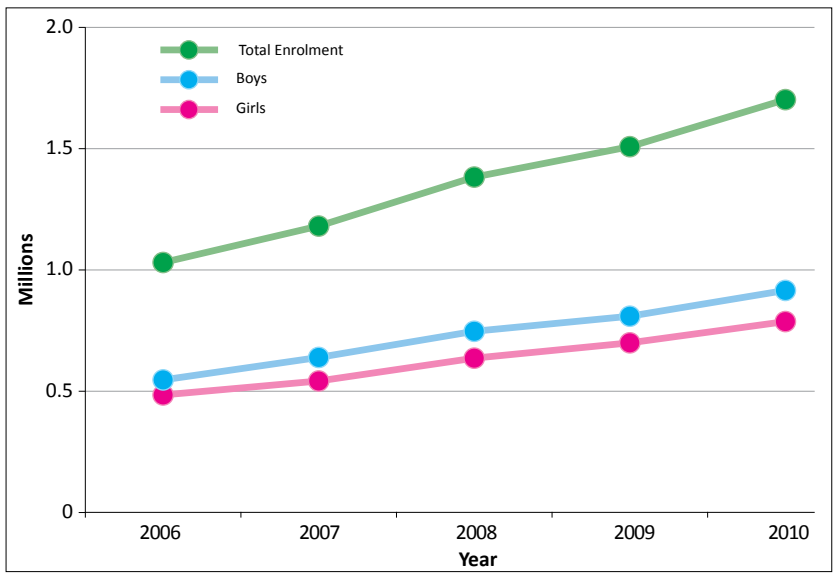

Figure 2.1: Secondary school enrolment by sex, 2006-2010 Source: GoK 2011

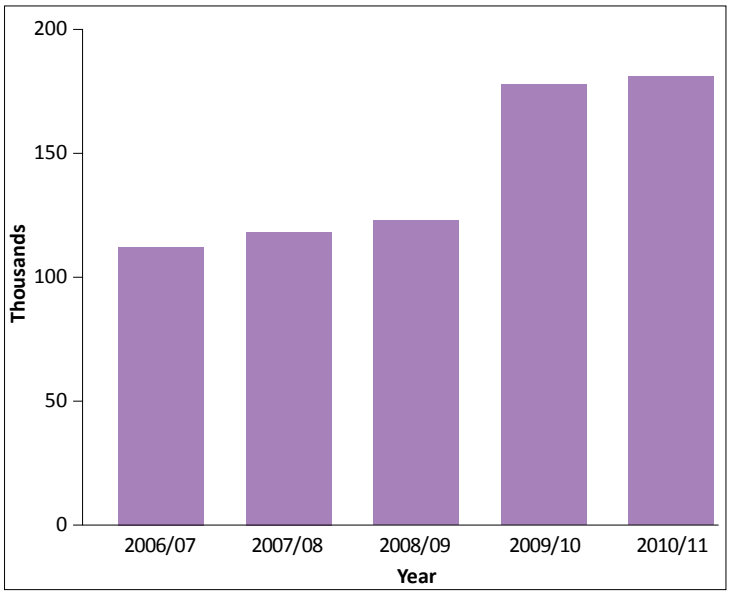

Figure 2.2: University education enrolment, 2006/07-2010/11 Source: GoK 2011

Table 2.2 demonstrates, the number of education institutions has also increased. University education has also recorded higher student enrolments. These rose from 112 229 in the 2006/07 academic year to 118 239 in 2007/08, 122 847 in 2008/09, 177 735 in 2009/10 and 180 078 in the 2010/11 academic year (see Figure 2.2). It is arguable that the 1.3 percent growth in the 2010/11 academic year could have been higher but was limited by university infrastructural constraints and the need to keep student-teacher ratios low particularly following the introduction of module II (parallel) programmes (KIM 2010).

However, although laudable strides have been made in improving primary and secondary school enrolment and retention rates, these figures mask striking gender differences as males still outnumber females in primary, secondary and university education attendance. The female attendance rate only exceeds that of their male counterparts at the tertiary institution level. For example in 2010, 4 751 900 boys were enrolled in primary school compared to 4 629 300 girls (GoK 2011). The gender disparity is more pronounced at the secondary and university levels and is attributable to the fact that girls carry a heavier work burden than the boys and often have to skip school in order to ensure that all the important domestic chores are completed. Although there are no precise data on this, it is reasonable to expect that girls constitute the majority of the 9.6 percent of the 6-13 year old children who are out of school (GoK 2011).

One of the other reasons that adversely impacts education is poor sanitary facilities. This constraint particularly affects girls and forces them to skip school due to waterborne and sanitary-related diseases, and during their menstrual cycles. Despite the 74 percent level of awareness among pupils and students on the importance of hand washing in preventing diseases, it is not regularly practised in schools due to lack of soap and water (GoK 2010e). However, various institutions have been created to undertake policy, supervision, regulatory and delivery functions in the water sector in line with the Water Act 2002 and these are gradually having a positive impact although these need to be scaled up. These factors highlight the pervasive influence of environmental factors on the level and quality of education attained.

Table 2.2: Number of education institutions by type, 2006-2010 Source: GoK 2011

Category	2006	2007	2008	2009	2010*
Schools					
Pre-Primary	36 121	37 263	37 954	38 247	38 523
Primary	25 929	26 104	26 206	26 667	27 489
Secondary	5 659	6 485	6 566	6 971	7 308
Teacher Training Colleges					
Pre-Primary	30	33	34	71	125
Primary	30	33	96	105	110
Secondary	3	3	2	3	3
TIVET Institutions					
Youth Polytechnics	563	574	654	754	765
Institutes of Technology	22	22	23	24	24
Technical Training Institutes	23	23	24	22	22
National Polytechnics	3	3	3	5	5
Polytechnic University Colleges	-	-	-	2	2
Universities	24	28	28	31	32
TOTAL	68 377	70 538	71 556	72 831	74 533

* Provisional

Interlinkages between socioeconomic status, education and environment

There is a correlation between socioeconomic status, the state of the environment and education. Kenyan households which occupy the base of the socioeconomic hierarchy are less likely to employ someone to help with the domestic chores. Children, particularly girls, therefore have to frequently skip school in order to perform these duties. Moreover, the harsher the physical environment, the longer girls have to walk in search of scarce wood fuel and water resources, leaving little or no time to attend school. In Wajir County for example, at least 61 percent of the population has to walk for more than a day in search of water during the dry season (Ibrahim and Jenner 1996). This may explain why the school enrolment rates are quite low in the arid and semi arid North Eastern Province. In 2009 for instance, only 138 172 primary school pupils were enrolled in the province, which was well below the comparable figures for the other provinces (GoK 2010f) and cannot be attributed merely to the fact that the province is sparsely populated. Table 2.3 contains the primary school enrolment by province, 2004-2009. Anecdotal evidence corroborates claims that the school attendance rate is far lower for the girls in the province.

Province	2004	2005	2006	2007	2008	2009*
Coast	556 013	585 543	600 041	643 355	658 860	689 798
Central	910 806	903 638	882 429	888 236	911 340	975 561
Eastern	1 371 680	1 379 909	1 378 210	1 480 629	1 538 785	1 565 188
Nairobi	229 252	237 858	234 819	319 000	320 102	345 939
Rift Valley	1 697 619	1 695 359	1 724 052	1 871 397	1 876 777	1 977 115
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TOTAL	**7 394 762**	**7 597 285**	**7 632 113**	**8 330 148**	**8 577 619**	**8 827 535**

* Provisional

Source: GoK 2010f

Table 2.3: Primary school enrolment by province, 2004-2009

In addition, a number of harmful cultural practises such as early marriage and female genital mutilation conspire to keep the girl child out of school as she approaches adolescence (Mareng 2010 and Ondiek 2010) although these are expressly proscribed by the Children's Act 2001. Fewer girls are therefore able to reach the apex of the education pyramid. As such, as is displayed in Figure 2.3, females only accounted for 39.1 percent of the university student enrolment in the 2006/07, 40.1 percent in the 2007/08 and 2008/09, 37.9 percent in the 2009/10 and 38.6 percent in the 2010/11 academic years (GoK 2011).

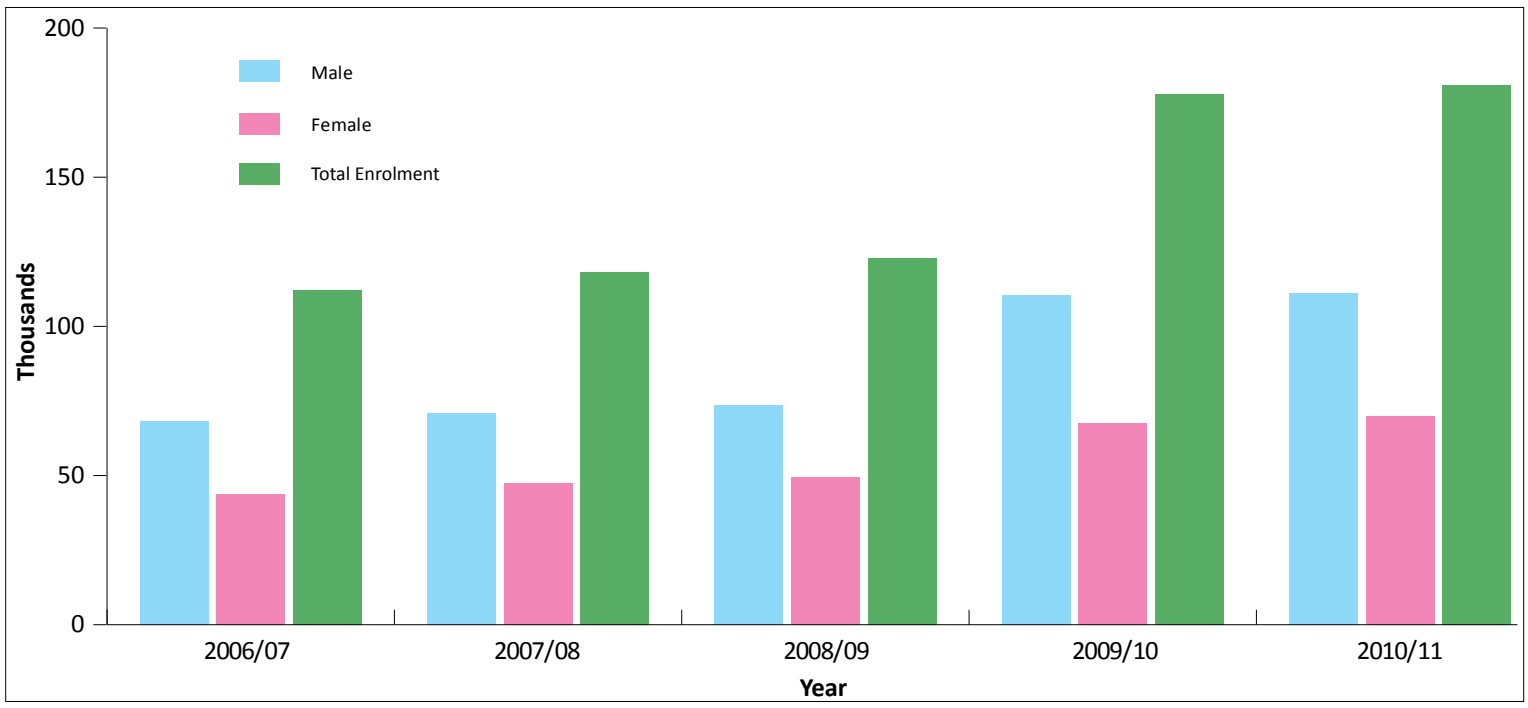
In addition, 6.1 million Kenyans, representing 17 percent of the country's population in 2009, have never been to school (GoK 2010c). The latter is an especially disturbing statistic because education isn't just crucial to fostering economic development and improving the life prospects of the marginalized segments of society, there are important interlinkages between education, socioeconomic status and the state of the environment. Education, for example, provides appropriate manpower training in environmental management and elicits positive mindsets towards environmental conservation and family planning. Environmental conservation has been identified as crucial to the attainment of Vision 2030 while family planning ensures less future population pressure on the environment. The linkages between education and the other social sectors of Vision 2030 are illustrated in Figure 2.4.

In addition, education improves the recipients' employment and business prospects and concomitantly makes them less directly reliant on the environment and thereby prevents its overexploitation. The educated are also better able to appreciate contemporary environmental problems such as climate change, to internalize and apply environmental ethics and to be more attuned to environmental considerations when weighing the pros and cons of operational options. However, the state of the environment also affects education. Indeed, a barren and harsh environment implies that children, particularly girls have to walk long distances in search of scarce natural resources, leaving little or no time to attend school. Samburu girls, for instance, have to walk for more than 15 km a day in search of drinking water (MNSF 2011). And, without a decent education, these girls are unable to improve their socioeconomic status.

Moreover, while Kenya has made tremendous strides in the education field, it is becoming increasingly clear that the country's education-related challenges go beyond just providing a pool of literate

Figure 2.3: University education enrolment by sex, 2006-2010

Source: GoK 2011



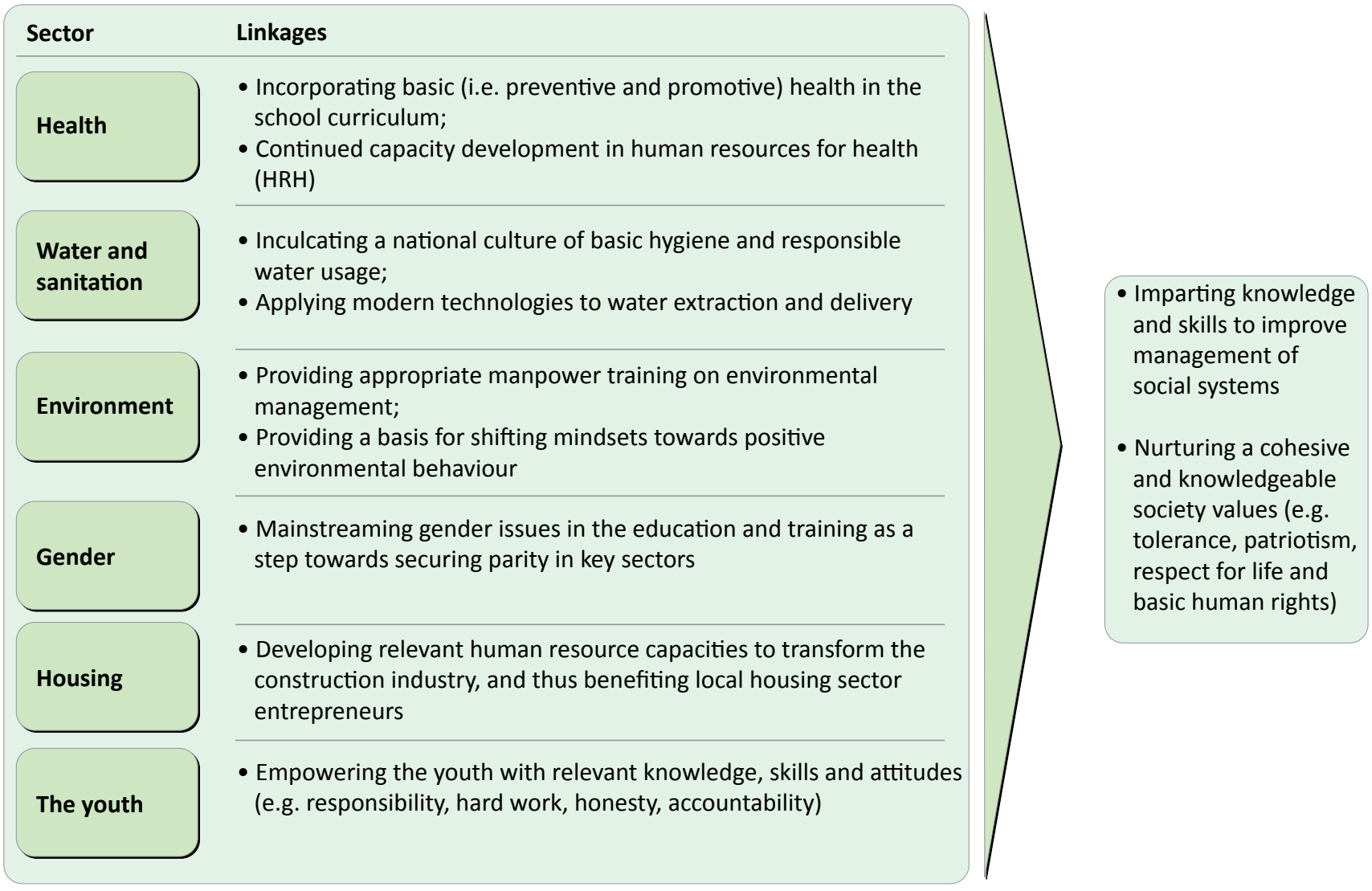


Figure 2.4: Linkages between education and other social sectors

Source: GoK 2007

individuals. Indeed, in today's fiercely competitive world, the need for employers and employees to frequently undertake retraining in the fast-evolving information technology as well as in state-of-the-art and best practises in product and service delivery cannot be underestimated. The challenge, however, will be to infuse these refresher courses' curricula with a range of environmental norms so that the economic transformation that results from the cutting-edge knowledge and from re-aligning Kenya's education system to the supply and demand dynamics for human resources as envisaged by Vision 2030 is not achieved at the expense of the environment.

Economic activity

State of economic activity in Kenya

In 2009, the percentage of the economically active population aged 5 and above was 58 percent compared to 66 percent a decade earlier. Males accounted for 53 percent of the economically active population (GoK 2010c). If the drop in the percentage of the economically active is not due to increased enrolment of children in school following the introduction of the Free Primary Education (FPE) programme in 2003, the statistics are worrying for two reasons. First, the declining percentage of the population engaged in gainful employment or business implies that the growing number of persons without reliable sources of income overexploit the country's environmental assets as this is the only livelihood means they have access to. Second, because the category of females without a steady source of income exceeds that of males, the former are more likely to eke a living out of the country's open access natural resources because these have little or no effective regulation. The pressure that a rising population exerts on a dwindling absolute and per capita resource base chains off a vicious cycle where the worsening environmental degradation gradually erodes the economic base of the formal and informal sectors of the economy. This in turn forces a sizeable proportion of the economically active population out of work and business, effectively coercing them to join the multitudes that are solely dependent on, and overexploit the natural environment. These are likely to reverse the gains made in poverty alleviation and economic development rather than contribute to the attainment of the Vision 2030 goals.

Fifty seven (57) percent of Kenya's women and 86 percent of men aged 15 to 49 years are currently employed (GoK 2010d). Women from Central and Nyanza provinces stand the highest chance of finding jobs with an employment chance of 66 percent while their counterparts from North Eastern province are least likely to be employed with an employment probability of 19 percent. This skewed pattern probably reflects the uneven development of the country but also the societal attitudes towards women's employment and involvement in the public arena. Another underlying factor for these employment opportunity disparities could be the fact that the country's arid and semi-arid lands (ASALs)—which encompass North Eastern Province—present entrepreneurs with much more austere physical and operating environments with only a few businesses opening and even fewer operating profitably. This is a demonstration of the positive correlation that exists between the state of the environment and economic opportunities for women. Reversing environmental degradation will therefore be crucial to attaining gender equity in the economic sphere which is often a precondition to achieving gender parity in the social and political spheres as well.

Interlinkages between socioeconomic status, economic activity and environment

Because low socioeconomic status Kenyans are generally not well-educated and they are not the beneficiaries of patronage, they are less likely to be engaged in economic activity as either employees or entrepreneurs. When they are engaged in economic activity, it tends to be in the *jua kali* (informal sector) where jobs are characterized by low earnings and poor working conditions (Fashoyin 2001). As such, those who are not engaged in any economic activity or are employed in the *jua kali* sector are likely to rely on the natural environment for food, water, wood fuel and medicinal herbs with the likelihood that they will overexploit the few natural resources they have access to and bear the brunt of environmental catastrophes. Kenyan women fare particularly badly because they wield little socio-economic power, have much fewer economic opportunities than their male counterparts and are largely excluded from even the *jua kali* sector because men are perceived as being better able to carry out the associated manual tasks.

Thirty nine (39) percent of working women and men in the 15-49 age bracket are engaged in agricultural occupations although 10 percent less women and 3 percent less men are dependent on the sector than they were in 2003 (GoK 2010d). Nevertheless, the fact that the sector provided the largest proportion of employment opportunities highlights its importance in the Kenyan economy and with it, the potential to influence both economic growth and the state of the environment. With respect to the former, halting land degradation by instituting measures to increase crop and livestock yields, overhauling the regulatory and institutional framework, expanding the irrigable land, encouraging value addition and improving market access—as outlined in Vision 2030—would certainly edge the country's annual economic growth towards the desired 10 percent mark. Equally, painstakingly mainstreaming ecological concerns into each of the above measures would ensure that the desired growth rate is achieved without sacrificing environmental imperatives.

Employee performance appraisal systems provide a unique opportunity to mainstream the environment within business operations and to improve the environmental performance of enterprises' products and operations. Individual and departmental targets for reducing energy consumption, emissions of greenhouse gases (GHGs) and other air pollutants, effluent discharge and waste generation while increasing recycling rates would help to ensure that the increased economic activity that is expected to undergird Vision 2030's economic pillar delivers positive environmental externalities. For this initiative to be effective however, there would be need for the departmental and individual performance targets to cascade from wider organizational goals that commit to continual environmental improvement and place these goals on the same pedestal as improving the bottom line and shareholder value which are often regarded as commercial enterprises' foremost objectives.

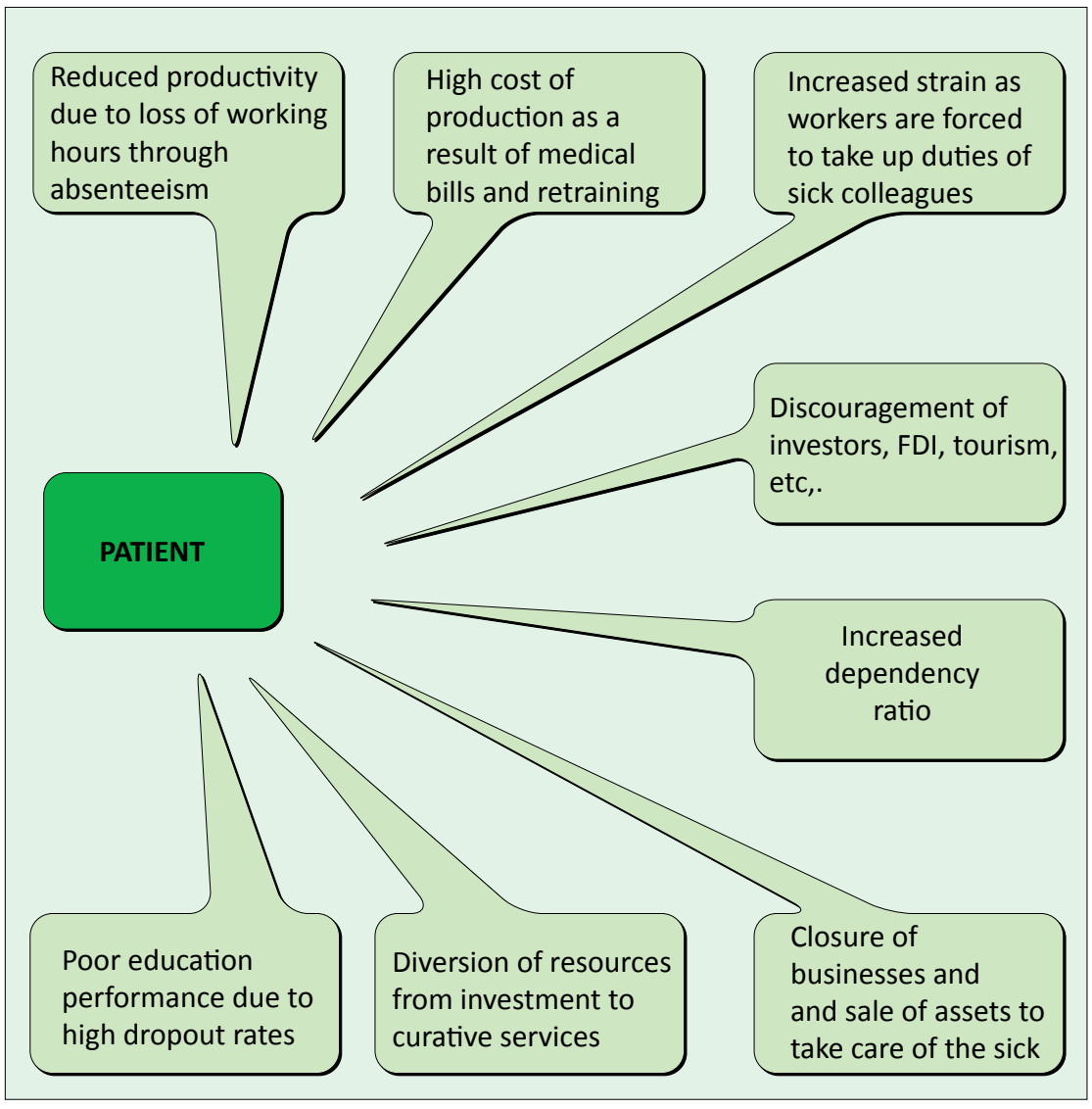
Health

Role of health in the attainment of Vision 2030 and key health determinants in Kenya

Good health is expected to play an important role in boosting economic growth, poverty reduction and the realization of social and economic goals of Vision 2030. The burden of ill-health continues to be a threat to the overall economic and social development of Kenya and undermines the physical, emotional and psychological well-being of individuals as illustrated in Figure 2.5.

Figure 2.5: The burden of ill-health on the nation

Source: GoK 2007



The array of health determinants in Kenya include fertility levels, marriage, sexual activity, fertility preferences, awareness and use of family planning methods, breastfeeding practises, nutritional status of women and young children, childhood and maternal mortality, maternal and child health, malaria, domestic violence, HIV prevalence among adults, awareness and behaviour regarding HIV/AIDS and other sexually transmitted infections (STIs) (GoK 2010d). This information influences the planning, implementation, monitoring, and evaluation of population and health programmes in Kenya. Vision 2030 envisages equitable and affordable healthcare at the highest affordable standard for citizens. Environmental risk factors that adversely affect Kenyans' health include unsafe water, sanitation and hygiene, urban air pollution, indoor smoke from solid fuels, lead exposure (Najam et al 2006). Selected determinants of health are discussed below.

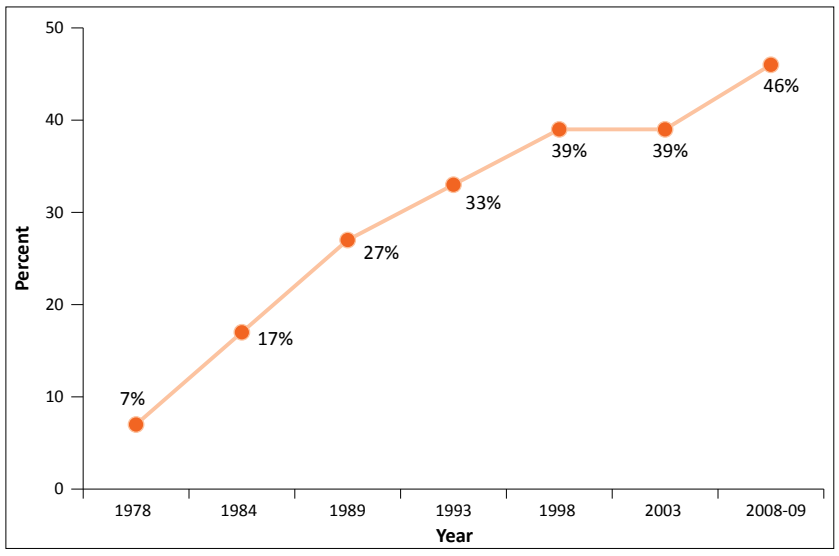


Figure 2.6: Trend in contraceptive use by married women, 1978-2008 Source: GoK 2010d

Family planning and the environment

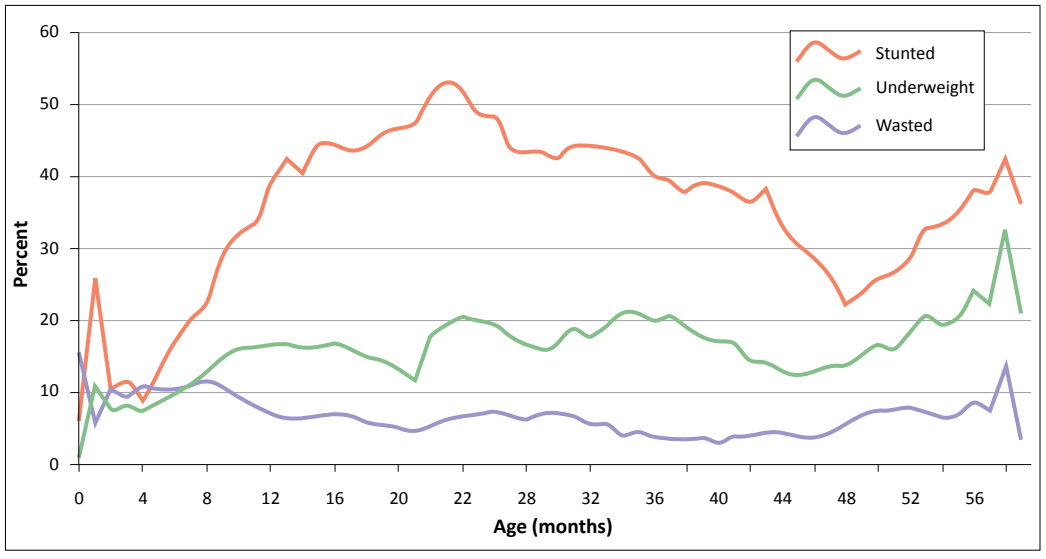
Government has prioritized reduction in fertility rates as one of the key interventions to attain a balance between available resources and the population. To this end, the country's population policies promote family planning as an entitlement that is based on informed and voluntary choice. The proportion of women using a family planning method is increasing and as is depicted in Figure 2.6, contraception use rose from 7 percent in 1978 to 46 percent in 2008. The sustained increase in the use of family planning services was a major factor in fertility transition, providing women and couples with the means to plan pregnancies and the size of their families. As a result, the fertility rate declined from 8.1 children per woman in 1977 to 6.7 in 1989, 4.7 in 1998 and 4.6 in 2008 (GoK 2009c). However, although the fertility rate has drastically declined since the 1970s, it is still high and the country's 2.9 percent annual population growth (GoK 2010c) is exerting tremendous pressure on the country's natural resources and in many instances, outstripping their renewal rates.

Maternal and child health and the environment

Another key indicator is maternal and child health in Kenya. Women's nutritional status has important implications for them and their children. Malnutrition in women results in reduced productivity, increased susceptibility to infections, slow recovery from illness, and heightened risks of adverse pregnancy outcomes (GoK 2010d). Food security and nutritional status are closely linked to socioeconomic status, education, incomes and diets which are in turn related to food production and distribution practises in the country. Environmental disturbances and degradation negatively affect crop and livestock production, which in turn impacts the nutritional status of communities, leading to ill-health, stunting, wasting and underweight conditions in children (GoK 2010d). In particular, the reliance of the majority of Kenyans on a narrow range of foods such as maize and rice which are extremely climate-sensitive exacerbates food insecurity. The country would be well-advised to diversify the main staples from maize to drought-resistant crops such as millet and sorghum. If children are well nourished and cared for, the first five MDGs that include eradication of extreme poverty and hunger will be met. However, if current levels of stunting which are illustrated in Figure 2.7 remain unchanged, the present value of productivity losses in the country for 2007-2015 is estimated at KSh 80 billion (UNICEF 2009). Moreover, when children are undernourished, they fail to achieve their full academic potential, and are thus unable to climb the socioeconomic ladder. Further, without a proper education, they cannot attain optimum productivity at the workplace and the goals under the Vision 2030 economic pillar will prove more elusive.

On the other hand, environmental degradation, particularly of water resources, affects availability and accessibility of clean water and good sanitary conditions leading to a high incidence of diarrhoea and outbreaks of cholera and other waterborne diseases. This is a major concern given that only 57 percent of households in Kenya derive water from sources that are considered safe (GoK 2007). Dehydration caused by severe diarrhoea is a major cause of morbidity and mortality among young children (GoK (2010d) particularly those whose mothers occupy the bottom rung of the socioeconomic ladder with the result that they don't even have the confidence or the financial means to seek medical help before the medical condition deteriorates irreversibly.

Figure 2.7: Nutritional status of children by age Source: GoK 2010d



Malaria and the environment

Malaria remains the leading cause of morbidity and mortality in Kenya (GoK 2010d) and is a major challenge to attainment of the goals enunciated under the economic, social and political pillars of Vision 2030. The incidence of malaria is closely linked to poor environmental management that encourages the formation of large pools of stagnant water. It has been found that changes in local temperature partly attributable to climate change and land use changes contribute to the expansion of the malaria zone into hitherto malaria-free areas such as

Box 2.1 Malaria prevention and control measures

The National Malaria Strategy (NMS) aims to achieve national and international malaria control targets through a set of core interventions including:

- Vector control using insecticide-treated nets (ITNs) and indoor residual spraying (IRS)
- Case management (using Artemisinin-based combination therapies (ACTs) and improved laboratory diagnosis)
- Management of malaria in pregnancy
- Epidemic preparedness and response
- Cross-cutting strategies including information, education, and communication for behaviour change, as well as effective monitoring and evaluation.

Adapted from the National Malaria Strategy and the National Health Sector Strategic Plan 2005-2010

the country's highlands (Minakawa et al 2006). Malaria is however more than just a health issue as it is also a major driver of poverty. Box 2.1 contains the malaria prevention and control measures recommended by the National Malaria Strategy (NMS) and the National Health Sector Strategic Plan 2005-2010. Kenyans with a low socioeconomic status live in unsanitary conditions where stagnant pools are more likely to occur. They are also less likely to sleep under insecticide treated mosquito nets (ITNs), to seek early medical care or to afford complete doses of medicine (Zucker et al 1996) and are therefore disproportionately affected by the disease.

HIV/AIDS and the environment

Another health condition with far reaching impacts on the social and economic development in Kenya is HIV/AIDS. HIV/ AIDS shows regional heterogeneity in the country with Nyanza province being the worst affected with an overall prevalence rate of 14 percent. The prevalence rates for Nairobi and Western provinces stand at 7 percent each. All the other provinces have prevalence levels of 3-5 percent except North Eastern province where the prevalence rate is about 1 percent, the lowest in the country. While individuals of low and high socioeconomic standing are equally susceptible to HIV infection, the richer ones are better able to stave off full blown AIDS because they can afford the costly anti retroviral drugs (ARVs) and to take the balanced diet that is vital for maintaining the body's immunity to opportunistic diseases. There is also a gender dimension to HIV/AIDS as prevalence of the condition is highest among women who are widowed (43 percent), with divorced or separated women and men also having relatively high HIV prevalence rates of 17 percent and 10 percent respectively. Figure 2.8 depicts the HIV/AIDs prevalence rates by age group and sex.

There are a number of interlinkages between HIV/AIDS and the environment. Although the disease is primarily spread through sexual intercourse, poor management of healthcare waste—such as pathological waste and contaminated needles—and its careless disposal into the environment exposes garbage salvagers to HIV infection. In addition, because AIDS-related illnesses often cause the death of both spouses who are often a family's bread winners, it is associated with immense social stigma and consigns affected families to poverty and the bottom of the socio-economic hierarchy where

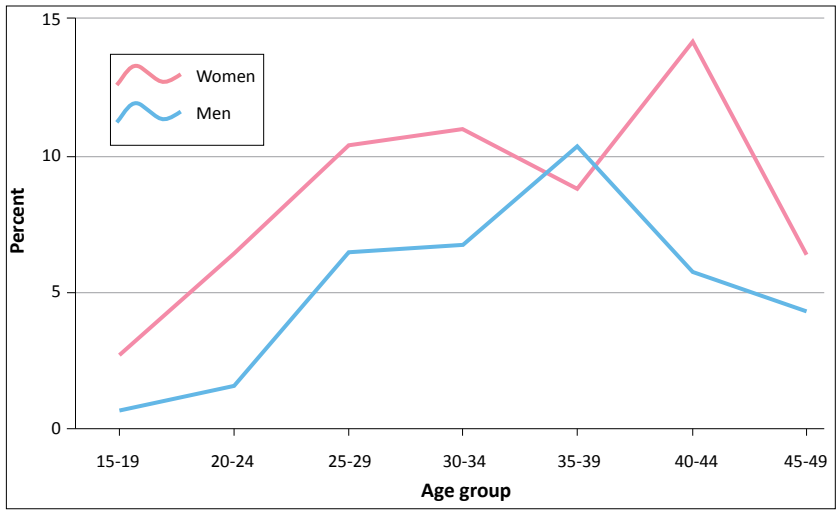


Figure 2.8: HIV/AIDs prevalence rates for men and women by age group Source: GoK 2010d

they live on marginal lands or in unsanitary informal settlements and are disproportionately impacted by ecological crises such as floods and drought.

Gender based violence and environment

Gender based violence, a proximate determinant of health, is also a common feature in Kenyan society. 39 percent of women have experienced some form of gender based violence since they were 15 years old (GoK 2010d). The main perpetrators are husbands, teachers, mothers, fathers, and brothers. Marital violence is considerable, with 30 percent of the women who have ever been married reporting emotional violence by husbands while 37 percent reported physical violence, and 17 percent reported sexual violence. The prolonged treatment for physical and emotional trauma imposes additional demands on the already limited women's resources or those of the national healthcare system. Less personal and public finances are channelled to the productive sectors of the economy and to instituting measures to stem environmental catastrophes. On the other hand, environmental crises such as floods that result in the displacement of people aggravate gender violence because the inadequate resources and limited access to basic services create despondency, predisposing the displaced women to higher than-average levels of violence as their spouses use this as a form of catharsis. The fact that victims are often in uncharted territories means that they do not know where to turn for help and often have to endure months or years of gender based violence before they can get help.

Vision 2030 undertakes to revitalize health infrastructure, strengthen health service delivery and develop equitable healthcare financing mechanisms (GoK 2007). The Kenya Health Policy Framework seeks to ensure equitable allocation of resources in order to reduce disparities in healthcare, increase cost-effectiveness and resource use efficiency and manage population growth. The framework also seeks to enhance government's regulatory role in healthcare provision and to create an enabling environment for increased private sector and community involvement in service provision and financing (GoK 2010d). It is envisaged that these initiatives will more than pay for themselves by leading to a healthier and more productive population that will better contribute to the delivery of Vision 2030. Because of the correlation between health and the environment, these initiatives will also have positive impacts on the country's environment.

		Percent		
Housing Component	Material type	1989	1999	2009
Roofing	Corrugated iron sheet	52	63	73
	Grass	*	23	14
Wall	Stone		12	17
	Brick/block	12	14	17
	Mud/wood	57	47	37
	Mud/cement		7	8
	Wood	10	11	11
Floor	Cement	27	35	41
	Earth	70	63	57
Number of households		4 352 751	6 371 370	8 738 097

Table 2.4: Percentage of households by housing materials

Source: GoK 2007

House construction materials

House construction materials are considered to be a good indication of a household's wellbeing and this was one of the socioeconomic indicators surveyed in past population and housing censuses. Use of corrugated iron sheets stood at 73 percent in 2009, up from 63 percent in 1999 and 52 percent in 1989. Use of stone walls rose 5 percent from 12 percent in 1999 to 17 percent in 2009 while the use of brick walls rose slightly from 12 percent in 1989 to 14 percent in 1999 and 17 percent in 2009. Table 2.4 contains the percentage of the households enumerated by housing material.

Houses constructed with permanent materials are a sign of affluence and rising percentages of these are an indication that many Kenyans are becoming wealthier and correlate with the gradual drops in poverty rates. However, mud huts are increasingly seen as more environmentally sustainable because they blend with the surroundings. In contrast, disused and unfilled stone, sand and limestone quarries which provide construction materials for the modern houses scar landscapes, are a human and animal safety hazard, a breeding ground for waterborne disease vectors such as mosquitoes and snails and are used to illegally dump domestic and industrial waste (Oloo 2010). However, because of their inherently porous nature, mud houses are also more susceptible to rodent burrowing and tick infestations (Nordstrandet al 2007) which are themselves associated with a range of ailments such as relapsing fever and plague. Because it is difficult to diagnose and treat these diseases, this affects the health of the manpower and puts a strain on the country's health facilities, negatively impacting Vision 2030. Mud huts are also less able to withstand environmental catastrophes such as landslides and severe flooding. Because these mud huts are invariably occupied by the poor and the socioeconomically vulnerable segments of society, they help to highlight the relationship between socioeconomic status and vulnerability to environmental crises.

Typical wood and wattle house on the plain, Village 2,Solio Settlement, Central Kenya.

Moving Mountains Trust/Flickr.com

Poverty and the environment

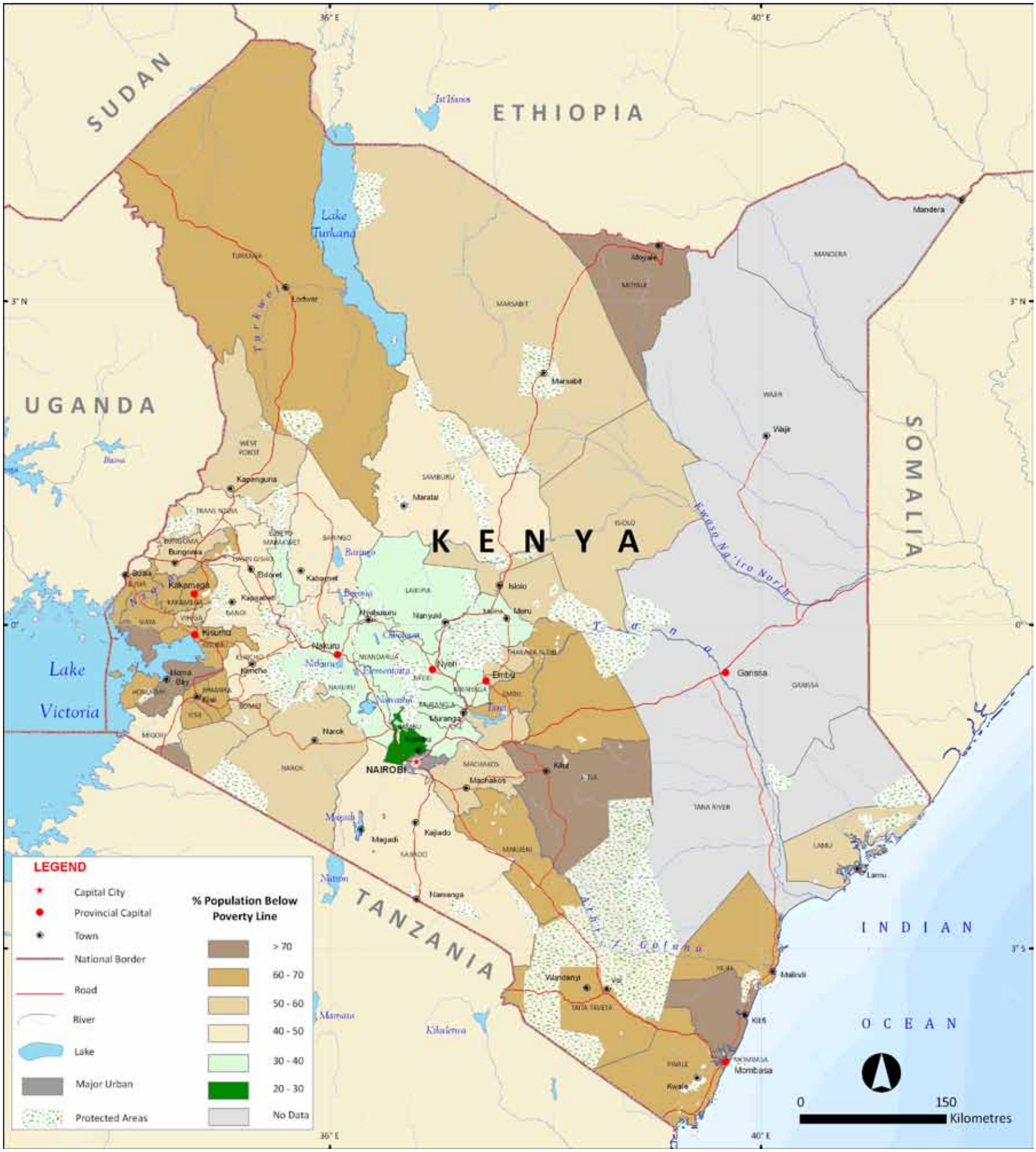
Definition, statistics and causes/manifestations of poverty in Kenya

Income, consumption and human welfare indicators are largely used to define poverty (Wagle 2002) although in its broader definition, poverty transcends nonmonetary aspects and encompasses ill health, illiteracy, social exclusion, insecurity, powerlessness, lack of access to information and governance failures (WRI et al 2005). Chronic poverty typically persists for years or lifetimes and may beget intergenerational transmission that makes it difficult for subsequent generations to escape the poverty trap. Transitory poverty, on the other hand, is temporary and largely arises from transient shocks to individual assets (Barrett and McPeak 2004). Figure 2.9 maps out the percentage of the population living below the national poverty line.

Because 46.6 percent of Kenya's population lives below the national poverty line (UNDP 2010), poverty in the country remains widespread and poses a range of development challenges. The poverty incidence however, displays extremely skewed distribution in the country. Poverty is more prevalent in rural than urban Kenya and in

Figure 2.9: Percentage of population living below the national poverty line

Source: World Bank not dated



Box 2.2 Determinants of poverty in Kenya

The Poverty Reduction Strategy Paper 2001 catalogues the following determinants of poverty in Kenya:

- *National income:* Slow per capita income growth in the agricultural sector on which many poor people depend.
- *Income distribution:* A high level of inequality—both income and regional inequality—has a negative relationship on growth and poverty reduction. There is considerable heterogeneity in poverty levels between and within the country's regions. Rural households are more deprived than urban households and are less able to earn a decent income, and to access productive resources such as land and credit.
- *Unemployment:* Few jobs have been created and unemployment (including underemployment) continues to act as a major determinant and characteristic of poverty. This is compounded by low wages and earnings especially in the informal sector.
- *Other socioeconomic factors:* Poverty has many facets and can manifest itself as the inability to meet basic needs such as food and proper housing and limited social, economic, cultural and human rights.
- *HIV/AIDS:* HIV/AIDS contributes to poverty by reducing the productive capacity of ill persons, loss of income through the illness and death of productive household members.
- *Environment and poverty:* Poor people depend more on natural resources for their livelihoods and they are more likely to engage in destructive extractive activities.
- *Insecurity and poverty:* Poverty leads to inadequate consumption, education and health. The poor lack resources and services which manifests itself in illness, crime, domestic violence, harvest failure, malnutrition and lack of social security in old age.
- *Corruption and poverty:* Corruption increases poverty because it results in unfair distribution of income and inefficient use of resources. Corruption deepens poverty, exacerbates inequalities and skews the structure of the economy, breeds impunity, undermines vital governance institutions and undermines the principles of honesty and hard-work (ACEG 2000).
- *Governance and poverty:* Poor governance that promotes exclusion, isolation and lack of trust in public agencies causes poverty. On the contrary, governance that promotes the collective public good creates impetus for poverty alleviation initiatives through enforcement of law and order, revenue collection, equitable allocation of resources, provision of infrastructure and promotion of human rights. Good governance also enhances public participation, accountability, citizenship rights (both political and economic) and political inclusion (Nyong'o 2001).
- *Women and poverty:* Gender equity is essential for eradication of poverty because there are gender gaps in all the core dimensions of wealth—opportunities, capabilities, empowerment and security (Mukui 2005) which are often enhanced through education. However, the education dynamics are such that girls are less likely to make the transition from primary school to secondary school compared to boys and more girls fall out of secondary school prior to completion.

Source: Poverty Reduction Strategy Paper 2001

some regions, poverty rates are lower than 30 percent while they are particularly high in the ASALs where they average 80-90 percent. The interrelated causes and effects of poverty are an exponential population growth rate, insecure land tenure, poorly planned urbanization, political marginalization, high levels of illiteracy, unemployment and under-employment as well as income inequality. The non-economic aspects of deprivation include lack of access to basic services such as primary healthcare, education, clean and potable water as well as adequate housing and sanitation (GoK 2007). These have recently been compounded by the post election that followed the 2007 general elections, the global financial meltdown and skyrocketing fuel and food prices in the wake of the political upheavals in the Arab world that have raised the cost of living well beyond the means of the average Kenyan. The Poverty Reduction Strategy Paper 2001 catalogues the determinants of poverty in the country and these are summarized in Box 2.2.

Interlinkages between poverty and environmental degradation

How poverty exacerbates environmental degradation

Poverty in Kenya exacerbates environmental degradation in a number of ways. It forces poor people to overexploit open access or under-regulated natural resources such as forests because to them, "nature is a daily lifeline" (WRI et al 2005). For example, the country's growing households predominantly rely on the dwindling forests for their wood fuel as well as wood carving, homestead fencing and construction timber, honey and herbal medicine needs. Encroachment into all of Kenya's five 'water towers' namely the Mau Forest Complex, Aberdare range, Mount Kenya, Mount Elgon and the Cherengani Hills has aggravated their degradation. This has lent credence to the assertion that in Kenya as elsewhere in Africa, felled trees are valued far more than standing ones. In addition, the overreliance by the burgeoning curio industry on the country's granite and soap stone quarries for sculpting and on the wetlands' clay for pottery and reeds for basket, mat and furniture making have despoiled these important ecosystems.

Forests and rangelands are also important sources of traditional herbal medicine for the poor. The rich biodiversity in these ecosystems has maintained traditional healers' services for generations. However, some of the herbal medicine species such as the *Asystasia schimperi, Carissa edulis* and *Toddalia asiatica* species which occur in South Nandi district are threatened with extinction due to overharvesting (Jeruto et al 2010). Similarly, the rate of wood fuel harvesting from the Marsabit forest in northern Kenya stands at an unsustainable 56 000 tonnes per year which is primarily responsible for the annual deforestation of approximately 1.6 ha per year (Kirubi et al 2000).

An open air handicraft market in Nairobi.

In addition, continued use of rudimentary technology due to poverty contributes to environmental degradation. For example, use of fire as a tool for lighting, honey harvesting, game hunting, defence against wildlife predation and clearing agricultural land for subsistence farming has largely been responsible for accidental fires that lead to loss of biodiversity in the country's forests and rangelands. Frequent occurrences of fires lead to loss of ground cover and make the land more prone to desertification and soil erosion. In the ASALs, environmental degradation takes the form of sheet and gully soil erosion due to the fragile ecosystems and livestock overstocking although it also occurs in the arable lands where inappropriate agricultural techniques are used. This degradation reduces soil fertility and has negative implications on land productivity, livestock carrying capacity, water quantity and quality and wood fuel availability. The related national economic costs are estimated at US$ 390 million annually which amounts to about 3 percent of GDP (GoK 2008).

Because poor Kenyans don't enjoy secure land rights, they are forced to cultivate ecologically fragile landscapes such as forests, wetlands, lakeshores and hillsides with catastrophic consequences for themselves, biodiversity, ecosystems and the general environment. Large-scale encroachment into the Mau Forest Complex for agriculture, settlement, charcoal production and illegal logging is, along with forest excisions, primarily responsible for destruction of 25 percent of its forest cover in a span of only 15 years (GoK 2009). In addition, Yala Swamp—Kenya's third largest wetland—is densely populated and the rising human population continues to exert tremendous pressure on its fish, floral and faunal resources and to reclaim portions of the wetland for agriculture (Schuyt 2005). It is therefore hardly surprising that poverty indices have tended to confirm the contention that some of the Victoria lakeshore districts have the highest incidences of poverty in the country. In addition, because they lack security of tenure, the poor often risk predation to occupy wildlife dispersal areas and migration corridors consequently degrading and constricting the wildlife's potential breeding and feeding grounds and rendering threatened species extinct (Okello et al 2011) with negative impacts on the country's tourism sector and indeed Vision 2030.

Poverty-driven environmental degradation has been exacerbated by the erosion of traditional knowledge caused by Westernization. Traditionally, cultural norms and practises regarding respect of taboos and totems, reverence of sacred sites, ritual regulation of resource harvests and buffer zone maintenance were used to ensure sustainable use of valuable plant and animal species for the common good of entire communities (CBK 2008). Some of the forests considered sacred in Kenya include the Kaya forest in Coast Province, the Njuri Njeke site in Meru, and the Mukurwe wa Nyagathanga in Murang'a. In addition, herd diversity practised by the pastoralist Rendille and Maasai communities ensured affordable and sustainable livestock production. The Maasai also traditionally relied on the emurua (*Cynodondactylon*) and orpalakai (*Panicum maximum*) grass species for fodder as these were known to boost milk production. Other species such as oltarakwai (*Juniperus procera*), oloirien (*Olea europea ssp. africana*), olkiroriti (*Acacia nilotica*) and ololiondoi (*Olea capensis*) were used for fencing due to their resistance to termite infestation (Barrow et al 2007). The Rendille also regularly used indigenous knowledge on the suitability of tree species for livestock kraal construction (Warui and Kshatriya 2009). Further, farmers in western Kenya used indigenous knowledge on gauging crop yields, poor crop growth vigour, the presence of specific weeds and soil colour as evidence of declining soil fertility (Odendo et al 2010). Traditional knowledge should therefore be preserved by creating viable linkages between this knowledge and biodiversity management in line with the provisions of the Convention for Biological Diversity (CBD) which Kenya ratified in 1994. As the principal reference centre for biodiversity research and heritage conservation in the country, the National Museums of Kenya (NMK) is in a unique position to ensure that this indigenous knowledge that is vital to maintaining the country's rich biodiversity is not lost. Moreover, showcasing Kenyan cultures that are environment-friendly could be one of the ways of reviving the threatened cultures and positioning cultural tourism as a niche product in line with Vision 2030's aspirations on the sector.

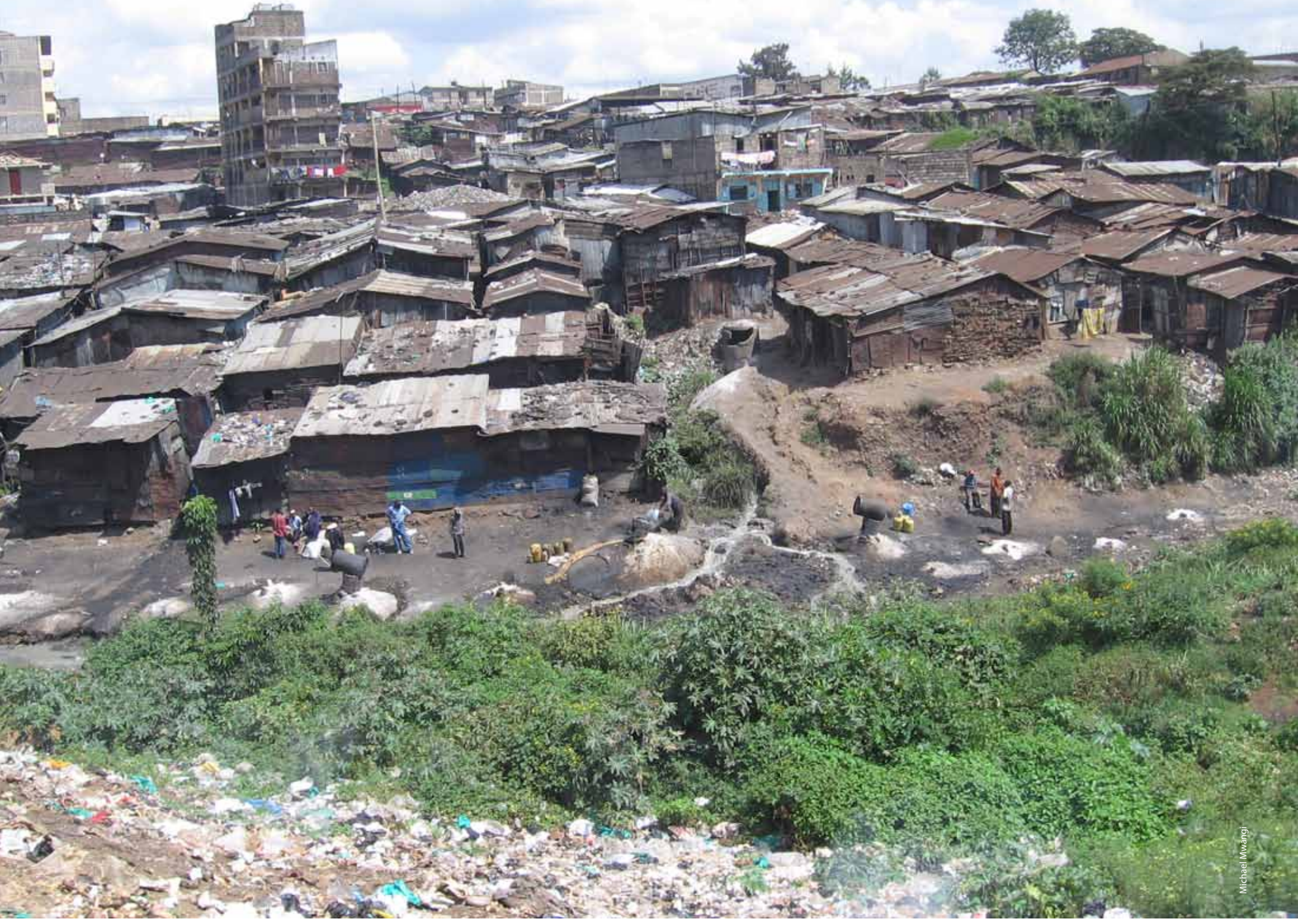
Poverty also constrains developing country governments such as Kenya to favour short-term economic growth over long-term environmental concerns. This is often coupled with fears that formulating and enforcing stringent environmental standards will render Kenyan products uncompetitive in the global market place and that Kenya will lose her comparative advantage to her regional neighbours.

The Dandora dumpsite as viewed from space: the surrounding estates are mainly inhabited by poor people. Source: SPOT

How environmental degradation exacerbates poverty

Environmental degradation aggravates poverty in a number of ways. Disadvantaged sections of society are forced to occupy marginal lands or hazardous urban neighbourhoods such as those adjacent to the Dandora waste dump in Nairobi and are exposed to much higher levels of pollution than the average 42µg/m^3 (GoK 2010e) that pertains in Nairobi. For example, blood samples taken from children who live near the open Dandora waste dump exhibited unusually high levels of heavy metals (such as lead, mercury and cadmium) and persistent organic pollutants which are toxic in minuscule doses and whose negative health effects include renal failure, gastro-intestinal disorders and respiratory tract irritations such as asthma and bronchitis (Kimani 2007). These are in addition to established health effects associated with living near landfills such as leukaemia and organ cancers and negative pregnancy outcomes such as terminated pregnancies, stillbirths and low birth weights (Vrijheid 2000).

In addition, environmental degradation disproportionately impacts the health and general well-being of the poor and exacerbates their vulnerability to natural disasters because they already live in extreme deprivation and only possess a limited gamut of coping mechanisms. For example in 2010, El Niño-induced floods ravaged Narok, Moyale and Magarini. Further, mudslides buried 14 people alive in Marakwet district in 2010 and wrecked havoc in Icanjeru near Murang'a (Ng'etich 2010, Ngunjiri and Njagi 2010). In addition, in



The Mathare informal settlement in Nairobi.

October 2009, nearly 20,000 people who live in the Nairobi's Mukuru-Magarini informal settlement had to be temporarily relocated to higher, safer ground ahead of the El Nino rains. The low income cohorts in urban areas of course live in congested and low quality dwellings, typified by poor sanitary conditions (GoK 2010e) and infrastructure and are particularly affected by natural disasters as these cement their poverty.

Opportunities and challenges for tackling poverty in Vision 2030

In order to tackle poverty and inequality in the medium term (2008-12), key targets to be achieved include raising the average annual incomes per person from an estimated US$ 650 in 2006 to above US$ 992 by 2012; reducing poverty levels by around 18 percent to 28 percent by 2012; reducing rural and urban inequality from the current levels of 0.38 and 0.45 to 0.34 and 0.41 respectively by 2012; and raising the level of Human Development Index (HDI) for Kenya from 0.53 in 2007 to between 0.6 and 0.7 by 2012. The HDI is a composite index that measures average achievement in three basic dimensions of human development namely; life expectancy, education and per capita GDP (UNDP 2010). The government also aims to accelerate the achievement of the MDGs during this medium term period by redirecting spending to high priority areas (GoK 2007). The opportunities and challenges for environmental management within Vision 2030 are detailed in Box 2.3

In order to achieve these targets, there are a number of flagship projects proposed for implementation. These include profiling the poor and their needs, comprehensively studying and analyzing poverty reduction initiatives and promoting pro-poor growth through targeted poverty programmes and projects. These include the Social Protection Policy which encompasses the cash transfer programme; free primary education; subsidized secondary education, food subsidies, subsidized agricultural inputs, disability fund and free healthcare for the under-fives, public works programmes (Kazi Kwa Vijana), waivers and exemptions, price subsidies, school-feeding programmes and free food distribution. In addition, micro-finance programmes such as the Women Enterprise Development Fund and the Youth Fund seek to empower some of the most marginalized segments of the population.

Box 2.3 Opportunities and challenges for environmental management within Vision 2030

The core sectors of socio-economic change as outlined in the Vision 2030 provide both challenges and opportunities for environmental management:

- The first National Spatial Plan intended to guide physical development activities over the next 50 years provides opportunities for mainstreaming environmental planning in national development. Similarly, the 50-year integrated national transport master plan, aimed at developing a light rail for Nairobi and its suburbs will help to decongest the city and reduce emissions from fossil fuels-run motor vehicles. However, the implementation of the project to increase energy security including coal supply for both domestic and industrial use will likely have negative environmental consequences including loss of biodiversity at the supply points and increased carbon emissions.
- Modernization of Kenya's meteorological systems and information and wider use of communication technologies will improve disaster preparedness and promote public education and awareness on the environment issues among vulnerable communities and decision makers.
- The planned land reforms, including the sustainable land use reforms, provide an opportunity for the government to engage in sustainable ecological management.
- Plans to transform Kenya into a knowledge economy will increase use of science and technology related environmental management practises.
- The envisioned improvement of the security situation in the country will discourage environmental crime such as dumping of raw sewage into water systems or dumping of hazardous wastes.
- Reforming the public service to strengthen linkages between planning, budgeting, programme implementation and coordination will ensure results-based management of resources (including environmental resources).
- Differentiating the tourism product (the coast, safari, niche, and conference and business tourism products) will increase boost international tourist arrivals. This process will in turn grow demand for accommodation and other services, with positive or negative impacts on the environment.
- Increased agricultural activities will increase demand for fertilizer and chemicals and could eventually have a negative impact on the environment if not well managed.
- Creating a globally competitive and adaptive human resource base through education and training will create a community that is better able to ensure sustainable management of the environment.
- Improvements to the health sector will support the economy by reducing health expenditure and the burden of disease (UNEP 2007) and the time saved will be expended on productive activities.
- Increasing opportunities for empowerment of the youth, women and the disabled will reduce their vulnerabilities and serve to bridge the existing gender and income inequalities.

Source: Kenya Vision 2030

The government has also increased allocation of resources directly to the districts and constituencies through the Constituency Development Fund (CDF), District Roads Fund, Constituency AIDS Fund, the Local Authorities Transfer Fund (LATF) and the Constituency Bursary Fund.

Further, the Kenya Slum Upgrading Programme (KENSUP) seeks to provide better housing and sanitation for those who live in the country's informal settlements. Table 2.5 contains the proportion of the urban population that lives in the informal settlements. The overarching aim of KENSUP is to improve the overall livelihoods of the people who live and work in informal settlements through targeted interventions to address shelter, infrastructural, land tenure and employment issues as well as the impact of HIV/AIDS. The programme has yielded positive environmental gains by improving access to safe water and in providing adequate sanitation to thousands of low-income urban dwellers.

	Years					
	1999	**2001**	**2005**	**2006**	**2007**	**2008**
National population (m)	29.5	31.3	35.1	36.1	37.2	38.3
Urban population (m)	10	11	13	15	15	14
Slum population (m)	7	8	9	9	10	10
Percent urban population	34	34	36	36.1	38	35
Share of slum population in total urban population	70	71	71	60	67	71
Urban population with access to water	75	87	59		37	
Urban population with access to improved sanitation	32	53	42	45	30	50
Urban population with access to durable housing	88	80	80	80	80	81

Table 2.5: Percentage of Kenya's urban population that lives in slums Source: GoK 2010e

KENSUP has also improved the awareness of the urban stakeholders and of the informal settlement dwellers themselves, on their role in environmental management.

Gender and the environment

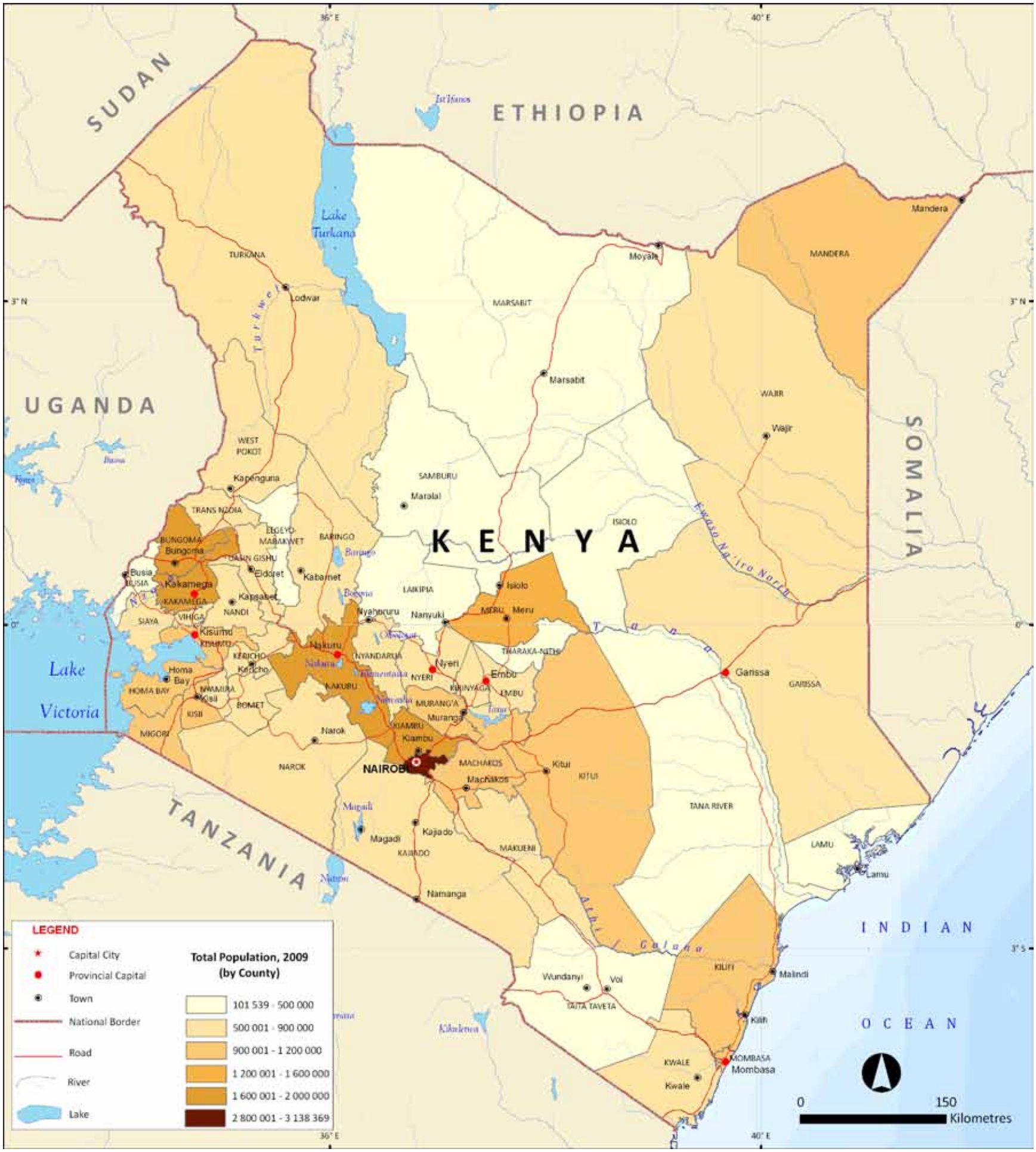
Gender definition, and gender roles in Kenya

While sex refers to those roles and relationships that are biologically determined, gender denotes the range of socially constructed roles of men and women as well as the relationships between them. As is evident from Table 2.6 detailing Kenya's 2009 population by province and gender, women comprise 50.3 percent of Kenya's population. Figure 2.10 details Kenya's population distribution by County in 2009.

Domestic roles and responsibilities as well as access to and control of natural resources are inseparably linked to the positioning of people not only by race, ethnicity and class but by gender as well (Thomas-Slayter and Rocheleau 1995). Traditionally, women are the gatherers of food, fuel, fodder and medicinal herbs and collectors of water. Because of different pre-defined gender roles, men and women often undertake different productive and reproductive roles in the natural resources' realm. Thus the term 'feminization of agriculture' was coined to reflect African women's increasingly dominant role in subsistence

Figure 2.10: Kenya's population distribution by County, 2009

Source: Adapted from GoK 2010b



Province	Total	Female	Female %	Male	Male %
Nairobi	3 138 369	1 533 139	48.85	1 605 230	51.15
Central	4 383 743	2 230 760	50.89	2 152 983	49.11
Coast	3 325 307	1 668 628	50.18	1 656 679	49.82
Eastern	5 668 123	2 884 776	50.89	2 783 347	49.11
North Eastern	2 310 757	1 052 109	45.53	1 258 648	54.47
Nyanza	5 442 711	2 824 977	51.90	2 617 734	48.10
Rift Valley	10 006 805	4 980 343	49.77	5 026 462	50.23
Western	4 334 282	2 242 907	51.75	2 091 375	48.25
TOTAL	**38 610 097**	**19 417 639**	**50.29**	**19 192 458**	**49.71**

Table 2.6: Population of Kenya by province and sex

Source: GoK 2010a

agricultural production as they comprise a growing proportion of households heads in light of the rising levels of rural-urban migration of men in search of more lucrative economic opportunities (FAO 1998). The remaining men who derive their livelihood from the sector tend to dominate commercial agriculture. Women and men also articulate different relationships with forest resources. While women typically gather wild foods, wood fuel and medicinal herbs and possess intimate knowledge of these resources and their ecological processes, men outnumber women in harvesting timber and other forest products for commercial purposes.

Relationship between gender and access to and control of natural resources

Despite their important role in ensuring food security, women paradoxically have little access to and control over land and own a paltry 5 percent of the registered land in Kenya (KLA 2004). Although women enjoy some customary usufruct rights on communal and male relatives' land, these are often limited to less valued resources such as leaves and twigs as opposed to the treasured timber, for example (Dankelman and Davidson 1988). This sorry state of affairs is partly attributable to the fact that customary inheritance law—which in practise supersedes the Succession Act (Cap. 160) which grants a married woman the right to inherit her husband's property and accords female and male, married or unmarried children equal property sharing rights where their father dies intestate—bestows land inheritance rights only on the male progeny. This serves to highlight the contradiction between women as producers and non-owners and men as non-producers and owners (Thomas-Slayter and Rocheleau 1995). These oppressive cultural norms transcend the inheritance sphere and also play out in the education, employment and health sectors which are also replete with gross gender disparities and also ensure that women are stuck on the bottom rung of each of these.

Interlinkages between gender inequities and the environment

There are a number of intricate relationships between gender and the environment. On the causal front, lack of legal land tenure and other income streams often forces Kenyan women to engage in harmful environmental practises such as slash and burn agriculture in the country's water towers and to cook illegally poached game meat from the country's national parks. From the effect perspective, because of their biological reproductive role, women's bodies are able to exhibit signs of environmental trauma, such as miscarriages and stillbirths, in ways that men's bodies cannot. For example, soon after a yellow liquid chemical with noxious fumes was dumped in Kipevu, Mombasa in 2008, several women unexpectedly experienced miscarriages (BBC 2008). In addition, felling trees for tobacco curing in Mbeere led to soil erosion that washed away minerals such as iron and iodine which are vital to women's health, occasioning several miscarriages, stillbirths and the birth of babies with congenital defects (Wangari et al 2010). The degradation of land, forests, wetlands, lakeshores and riverbanks also has a profound and disproportionate effect on women because they are highly dependent on these natural resources. Television footage of emaciated women, together with their children is the ubiquitous face of the recurrent, prolonged drought in northern Kenya. Women and girls are also particularly affected by deforestation because it is they who have to walk farther in search of wood fuel, wild foods and medicinal herbs. Searching for increasingly scarce resources also squeezes out the time for other pursuits such as education, business and leisure by women and girls, cementing their position at the bottom of the societal hierarchy.

Opportunities for gender to enhance environmental sustainability

Kenyan women are not just victims of environmental degradation as they can effect an attitudinal change in environmental management. As the experiences of the Green Belt Movement demonstrate, women can be at the forefront of preventing and reversing environmental degradation. Founded by Nobel Peace laureate Prof. Wangari Maathai, the Green Belt Movement is credited with thwarting then influential politicians' attempts to grab Uhuru Park in order to construct a 62-storey building, and the Nairobi city's Karura Forest (Maathai 2004). The Green Belt Movement has also planted more than 40 million trees since its formation in 1977.

Another example where gender roles have been harnessed to contribute to conservation is the Kiunga Marine National Reserve Conservation and Development Project in the Lamu Archipelago which combines health programmes with livelihood efforts in order to meet its twin goals of improving the local community's welfare and conserving the marine environment. By creating and selling handicrafts from slippers washed ashore, the women's eco-friendly handicraft project is both a source of income and ensures better survival rates for the endangered Green Sea turtles as slippers hamper the emergent turtle hatchlings' movement to the Indian Ocean waters. In addition, the Kiunga men are also taught sustainable fishing practises that reduce turtle bycatch and ensure that the fishing rate does not outstrip the regeneration rate (WWF undated). Further, Kenya Water for Health Organization (KWAHO) which provides sustainable water and sanitation for disadvantaged communities in the Nairobi, Coast, Nyanza and Western Provinces encourages women to get actively involved in the management and operational activities of community projects.

It appears evident that environmental degradation in Kenya is partly due to the pressure exerted by the unsustainably high annual population growth rate of 2.9 percent (GoK 2010a). It has, for example, been argued that the high population growth rate results in high demand for wood fuel, which in turn causes deforestation (Sunny 1992). Table 2.7 shows the trends of selected demographic indicators. The pressures of an increasing population on the environment are exacerbated by the high percentage of a young population as shown

in Figure 2.11. Therefore, the demand for resources is expected to continue to rise in the foreseable future.

The rapid population growth is reinforced by the cultural practise of having a large family. This cultural norm is driven by the desire for male descendants, for the gild child who is regarded as a source of bridal wealth, old age security and the desire to have many children as a kind of insurance against the pertaining high infant mortality rates. Therefore, addressing the latter through providing basic healthcare facilities (including national and targeted immunization programmes) would be an important first step. Given their biological role as child bearers, women can play a role in reversing this degradation by bearing fewer children that they are able to adequately care for. This would gradually bring the fertility rate down from the current 4.6 as already seen. North Eastern province which has an actual and wanted fertility rate of 5.9 (GoK 2010d) would require special interventions aimed at reducing both child mortality and fertility rates. This would entail educating women about the advantages of family planning and the range of contraception options available to them, "enabling them" to make informed reproductive choices. Of course, society would also need to be disabused of the perception that virility is measured by the number of children a man has. Therefore, taking a holistic, gender approach would be important if Kenya is to sufficiently rein in the high population growth rate and ensure that the goals of the Vision 2030 social pillar do not recede beyond reach.

Basic demographic indicators					
Indicator	1969	1979	1989	1999	2009
Population (millions)	10.9	16.2	23.2	28.7	39.4
Density (pop./km^2)	190	27.0	27.0	49.0	67.7
Percent urban	9.9	15.1	18.1	19.4	21.0
Crude birth rate	50.0	54.0	48.0	41.3	34.8
Crude death rate	17.0	14.0	11.0	11.7	-
Inter-censal growth rate	3.3	3.8	3.4	2.9	2.8
Total fertility rate	7.6	7.8	6.7	5.0	4.6
Infant mortality rate (per 1,000 births)	119.0	88.0	66.0	77.3	52.0
Life expectancy at birth	50.0	54.0	60.0	56.6	58.9

Table 2.7: Selected demographic indicators for Kenya in the censual years Source: GoK 2010d

Intersectionality of low socioeconomic status, poverty and gender; and environmental degradation

Intersectionality and multiple exclusions in Kenya

The concept of intersectionality seeks to examine the ways multiple marginalized identities of an individual consisting of socially constructed categories such as gender and class interact on several and simultaneous levels to produce systemic oppression and social prejudice. In the specific context of this SoE report, intersectionality denotes the different ways in which low socioeconomic class, poverty and a weak gender position interact to shape Kenyan women's environmental experiences. The section is borne out of the realization that treating these categories as if they were mutually exclusive fails to sufficiently interrogate the complex interplay among the identity markers and masks the cumulative effects of multiple inequalities and the impact of these on Kenya's environment.

Women and men in Kenya are ostensibly juridically equal with the concept of legal equality being entrenched in Article 27 of the Constitution. However, owing to the prevailing patriarchal norms, poverty and a low socioeconomic status are more prevalent among Kenyan women than men. Indeed, 60.2 percent of Kenya's women fall within the lowest and second lowest wealth quintile (GoK 2010d). And, because poverty and the stratification of domestic chores along gender lines bring women into close contact with the environment, it is reasonable to expect them to exert considerable pressure on the country's natural resources, fuelling their degradation. This degradation is aggravated despite the fact that women possess a wealth of indigenous knowledge and experience.

Figure 2.11: Kenya's population pyramid, 2008-2009

Source: GoK 2010c

This is because, owing to the multiple exclusions they are subjected to, this knowledge remains largely unacknowledged and excluded from decision making (Aguilar and Blanco 2004) and is not reflected in relevant environmental laws and policies. Therefore, the multiple exclusions these Kenyan women are subjected to amplify environmental degradation which, in turn, reinforces these exclusions. Because pastoralist Samburu women and Nubian women of the Kibera informal settlement are some of the Kenyans who face multiple exclusions and live at the intersection of low socio-economic class, poverty and gender inequality, they are disproportionately impacted by environmental degradation. Each of their situations is discussed below.

Samburu women

Although the sparsely populated ASALs, which are predominantly occupied by the country's pastoral communities, host the overwhelming majority of the country's livestock and wildlife, pastoralist women such as the Samburu are socially, economically and politically marginalized. Samburu women face two-pronged discrimination. First, they suffer marginalization inflicted on their communities primarily because they are a numeric minority and because pastoralism is generally perceived as incompatible with modernity as it is regarded as the cause of overgrazing, drought and desertification (Kipuri and Ridgewell 2008). Second, due to the deeply entrenched gender-based division of labour, Samburu women suffer further marginalization as they bear an inordinately heavier workload than their male counterparts. Besides nurturing the children, women are responsible for tending the livestock, gathering wood fuels, collecting water and constructing houses.

These pastoralist women are considerably poorer than their male counterparts because they are commoditized and primarily valued as a potential source of bride price. And, the increasing economization of items such as milk, ghee, gum resins and beeswax which were entirely the women's domain has eroded their access to these items and resulted in more malnutrition for women and their children and eroded the little power women hitherto wielded.

These women's acute poverty implies that first, they are pushed to overexploit communal natural resources which are their lifeline. Second, due to poverty and powerlessness, these women have a diminished capacity to withstand environmental shocks such as climate change and variability. Third, because environmental degradation leads to scarcer natural resources, Samburu women are forced to walk farther from home in search of these resources. As a result, they are exposed to wildlife predation and sexual crimes by British soldiers carrying out military exercises in the area as detailed in Box 2.3.

The scarcer natural resources in Samburu District also foment human-wildlife conflicts which often manifest themselves in the form of encroachment, poaching, excessive use of the protected areas' resources (Eriksen et al 1996) and outright sabotage such as spearing and poisoning of elephants (Okello 2005). Thus most of the local communities view wildlife as an inordinate burden placed on them by the state and from which they reap no benefits (Kameri-Mbote 2002). The animal component of wildlife 'retaliates' through crop-raiding, killing humans and domestic animals, transmitting diseases and competing for scarce pasture and water with livestock which in turn increases the women's work burden. The dwindling resources also instigate inter-clan resource conflicts which women are sucked into and exposed to risks of violent crimes such as abduction, rape and murder, which are often committed with impunity. In addition, efforts to stem the rapid desertification of Northern Kenya led to the introduction of Prosopis juliflora (mesquite) in the rangelands in the 1980s (Mwangi and Brent 2005), an invasive alien species which is a threat to biodiversity and whose thorns pose health risks to human beings, particularly women, and livestock.

Box 2.3 Alleged abuses encountered by Samburu women at the hands of British soldiers

In 2004, over 600 Samburu women who were allegedly raped by British soldiers carrying out military exercises in Northern Kenya brought a class action lawsuit against the British government in the UK. These women were allegedly raped while fetching water, collecting wood fuel or herding livestock far away from home around Archer's Post in Samburu District. Medical and police records, mixed race children and confirmation by the local chief corroborate these women's claims.

The petition is the latest in a string of claims against the British government. In 2002 and 2003, in an out of court settlement, Britain paid US$ 7 844 155 to Samburu herdsmen who lost limbs and to those whose relatives were killed by live munitions and explosives left behind by the British troops.

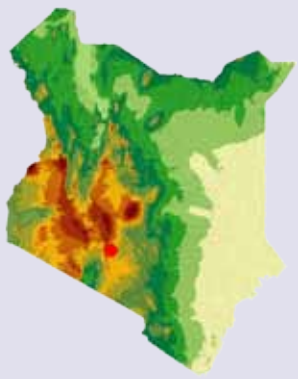
The British army has a longstanding military pact with the Kenya government which allows it to use Archer's Post in Samburu and Dol Dol in Laikipia districts as military training grounds. Nearly 3 000 British soldiers go to these training grounds each year.

This case illustrates the adverse effects scarcity of environmental resources can have on enjoyment of other fundamental human rights such as the right to bodily integrity. Because the Samburu have only a few water points, they have to walk all day, often up to 32 km away from home in search of water. It is therefore clear that if appropriate technologies are used to harness the groundwater sources of the Ewaso Ng'iro River basin (that encompasses the Samburu area) which are vastly untapped as detailed in Chapter 7, these Samburu women will not be exposed to gross human rights violations.

Adapted from Day and Patterson (2003), Muylwijk (2008) and The Samburu Water Project (2010)

The Nubian women of Kibera

The Nubians of the Kibera informal settlement are considered stateless and are treated as foreigners in a country they have occupied for more than a century. Their ancestors were enlisted in the British Empire's colonial army in the 1800s and many helped to open up the East African hinterland to British colonial occupation. Many Nubians were recruited into the King's African Rifles when it was formed in the early 1900s and they fought alongside the British in the First and Second World Wars. In Kenya, these soldiers were settled in a number of locations including Kibera. Unlike the Ugandan Nubians who have been recognized as a citizen tribe, in Kenya, they are discriminated against as foreigners and largely live in squalor although a few of them have benefited from better housing under the Kenya Slum Upgrading Programme (KENSUP) which is a joint initiative by the government and UN-Habitat. As such, Nubian women who have not yet benefitted from KENSUP continue



Nairobi River Clean Up – The Nairobi River Basin comprises a complex of streams that flow eastwards. The Nairobi River, which flows through the Central Business District, is the basin's main river while the Ngong and Mathare Rivers are its main tributaries. This river basin is faced with a myriad of environmental problems which include rapid urbanization, industrialization, poor urban planning and weak enforcement of environmental laws. As such, untreated effluent, raw sewage and solid waste from industrial and domestic sources drain into the river, causing serious environmental degradation.

In a bid to reverse the above environmental problems, the Government of Kenya created the Nairobi River Basin Programme that aims to enhance the ecological integrity and socio-economic value of the

river basin. The Programme interventions focus on four key themes namely: environmental education, awareness creation and public communication; conservation of the riparian reserve; integrated waste management; and the restoration of the Nairobi Dam.

These two images show the section of the Nairobi River between Kijabe Street and the Globe Cinema roundabout. Waste has been physically removed from the area marked with yellow arrows and the section converted to a public recreation park. It is envisaged that such success stories will be gradually replicated throughout the river basin.

to grapple with poverty, polluted water and deplorable sanitary conditions. This is because they are the providers of water for their families and are responsible for keeping their houses clean. The latter has forced Nubian women and other Kibera residents to find alternative means of faecal disposal such as plastic bags (Omambia 2010) which are then disposed of into drains or flung as far as possible, a practise which is euphemistically referred to as 'flying toilets.' These contaminate surface and groundwater and are a health hazard to the Kibera residents, leading to frequent outbreaks of waterborne diseases. Nubian women are disproportionately affected because owing to their political and other exclusions, they can neither vote nor influence enactment of environment-conscious laws. Yet despite their political exclusion, many of them ironically bore the brunt of the 2008 post-election violence. In addition, as a disenfranchised segment of society, their voices are muted in the community and national environmental discourses. And, as women they are the traditional caregivers for sick family members so a degraded environment appreciably increases their workload.

Conclusion and recommendations

There are intricate relationships between socioeconomic status, poverty and gender on the one hand and environment on the other. The multiple exclusions many Kenyans suffer on account of these variables compound their marginalization and their propensity to degrade the environment. The following recommendations should be instituted in order to address these exclusions and to thwart degradation of the country's environment:

- **Gender mainstream plans, policies, laws and activities.** Gender mainstreaming is the holistic process of institutionalizing gender analysis and equity principles in problem identification, planning and implementation of development plans and laws for the benefit of girls, boys, women and men and other disadvantaged groups with a view to attaining gender equality and equity (GoK et al 2005). Gender mainstreaming would help to alleviate the harmful environmental and health conditions under which women live and work and would increase their capacity to fight environmental degradation. For example, the Agriculture Act should be reviewed to address the users (women) rather than the owners (men) of land.

- **Mainstream poverty-environment interlinkages into national and county development planning, policymaking, budgeting, programme implementation and monitoring** through financial and technical assistance (Drakenberg et al 2009) and step up the capacity of public institutions to address detrimental manifestations of the nexus between the two variables. An important vehicle for this would be to finalize the formulation of a national environment policy on which all sectoral environmental laws would be anchored.

- **Education of the poor, socio-economically disadvantaged girl child.** It is important to provide equitable education opportunities for Kenya's socio-economically disadvantaged, the poor and the girl child. The Free Primary Education programme (FPE) and the Free Tuition Secondary Education (FTSE) are important first steps although other issues, such as onerous domestic chores and cultural practises such as FGM and early child marriages continue to conspire to keep girls out of school. In promoting the education of the girl child, particular emphasis should be placed on drafting in minority communities such as the Samburu, Nubian and forest-dependent communities such as the Ogiek. However, because the socio-cultural impediments continue to militate against girls' education, affirmative action should be introduced to remedy these injustices.

- **Increase marginalized sections' access to resources**. It has been seen that women continue to be marginalized partly because they do not own the conventional factors of production. There is need to support policies and laws that increase women's economic opportunities, including credit so that women can acquire land (Kane 2005) and harness appropriate technology such as ploughs, rain-harvesting water tanks, boreholes and solar power. Several microfinance institutions (MFIs) specifically targeting women such as Kenya Women Finance Trust have recorded high success rates and present a unique opportunity for women to utilize the facilities offered to drastically lessen their work burden and then progressively better their lot. This can lead to reduced dependency on practises that degrade the environment out of desperation as all other potential livelihood sources are cut off.

- **Upscale implementation of innovative poverty-alleviation mechanisms.** Upscale implementation of innovative poverty alleviation schemes. Some of the initiatives that can be upscaled are Women Enterprise Development Fund, Youth Fund, Constituency Development Fund (CDF), District Roads Fund, Constituency Aids Fund, the Local Authorities Transfer Fund (LATF) and the Constituency Bursary Fund. There is also need to accelerate the KENSUP upgrade of Kibera and to upscale it to other informal settlements as it can lead to provision of safe water and adequate sanitation to low-income urban dwellers. This will in turn make them less susceptible to environmentally-mediated diseases and natural disasters.

- **Sensitize men and women on gender and environmental issues.** The oppression of women is so deeply embedded in our societies and psyches that it continues to be invisible. Gender stereotypical roles are enforced through familial, religious, economic and educational institutions. There is therefore need to raise the consciousness of both men and women on the need to promote a more egalitarian society as true development suffers where half the population is shut out of the formal economy. Carrying out environment- and gender-sensitivity training for women and men particularly policymakers, politicians and institutional leaders (Thrupp and Green 1995) will help them discard their stereotypical perceptions of the environment and women as well as retrogressive cultural practises that are implicated in the degradation of the environment and in consigning sections of society which suffer multiple exclusions to the poverty trap.

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CHAPTER 3
CLIMATE CHANGE AND VARIABILITY

Introduction

Climate change is possibly the most significant environmental challenge of our time and it poses serious threats to sustainable development in Kenya. It impacts ecosystems, water resources, food, health, coastal zones, industrial activity and human settlements. However, addressing these impacts presents opportunities for innovation, business and improved livelihoods.

Many future impacts of climate change or variability can be reduced, delayed or avoided if the necessary mitigation, adaptation and coping strategies are implemented. Kenya will need about US $500 million per year to address current and future climate change effects by 2012. It is predicted that this figure will rise to US $1-2 billion per year by 2030. Unless effective mitigation and adaptation mechanisms are urgently instituted, the combined effect of the climate change-induced impacts will slow or even hinder achievement of the targets detailed in Vision 2030. It is therefore important to formulate a range of policy instruments to address climate change. While the National Climate Change Response Strategy (NCCRS) was finalized in 2010, there is need to go further and formulate a national policy on climate change and enact a climate change law.

Box 3.1: Key definitions

Climate change refers to a change in the state of climate that can be identified (for example using statistical tests) by changes in the mean and/or the variability of its properties. It persists for an extended period, typically decades or longer.

Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. It may be due to natural internal processes within the climate system, or variations in natural or anthropogenic external forcings.

Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change. It is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity. Vulnerability is thus the relationship between the degree of climate stress on the population (exposure), the degree of responsiveness to stress (sensitivity) and the ability of the population to adjust to climate changes (adaptive capacity).

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The threat of climate change

Climate change and variability are considered to be major threats to sustainable development. The major areas likely to feel the greatest impacts include the economy, water, ecosystems, food security, coastal zones, health and the distribution of populations and settlements. Africa is considered to be particularly vulnerable to climate change-induced effects largely due to lack of financial, institutional and technological capacity (Eriksen et al 2008, IPCC 2007a).

Climate change effects are already being felt in Kenya. Moreover, widespread poverty, recurrent droughts and floods, inequitable land distribution, overdependence on rain-fed agriculture, and few coping mechanisms all combine to increase people's vulnerability to climate change. For instance, poor people have little protection against extreme climatic events. They have few resource reserves, poor housing and depend on natural resources for their livelihoods. Extreme weather events have serious economic implications. Floods and droughts cause damage to property and loss of life, reduce business opportunities and increase the cost of doing business. Vulnerability to climate change is not uniform across Kenya. Box 3.1 gives a definition of the key terms used in this chapter.

Evidence of climate change

Global Level

Owing to mounting scientific evidence, there is growing consensus that the world has to grapple with increasingly severer climatic events. Some of the manifestations of climate change are rising average temperatures with the last three decades having got successively warmer (Arndt et al 2010), increasing sea levels which have been rising at an average 1.8 mm/year between 1961 and 1992 and about 3.1 mm/year since 1993 (IPCC 2007) and the thinning snow cover in the Northern Hemisphere. These manifestations of climate change are diagrammatically depicted in Figures 3.1a-c. Climate change and variability have also led to more frequent extreme weather events such as hurricanes, erratic rainfall, flooding, more intense and prolonged droughts and devastation of some coastal areas, species' extinction, a

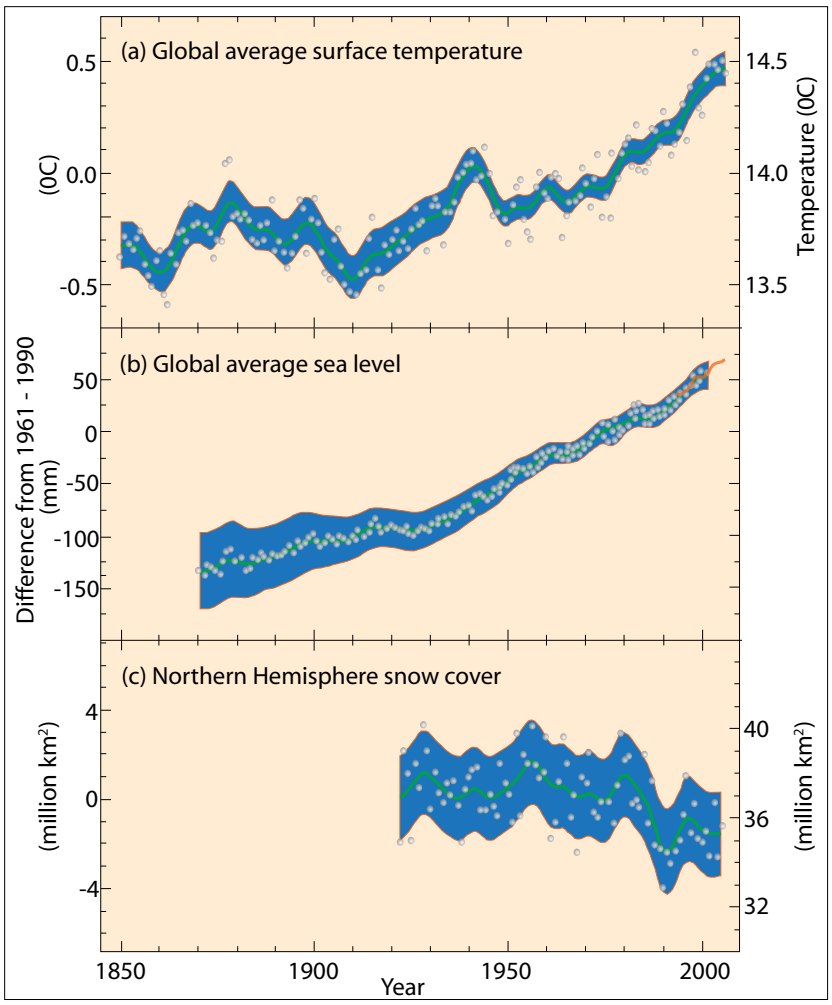


Figure 3.1: Observed changes in (a) global average surface temperature; (b) global average sea level from tide gauge (blue) and satellite (red) data and (c) Northern Hemisphere snow cover for March-April

Source IPCC 2007

reduction in ecosystems' diversity and negative impacts on human health (IPCC 2007). Future IPCC projection scenarios indicate an expected range of global warming of between 0.3°C for a scenario of

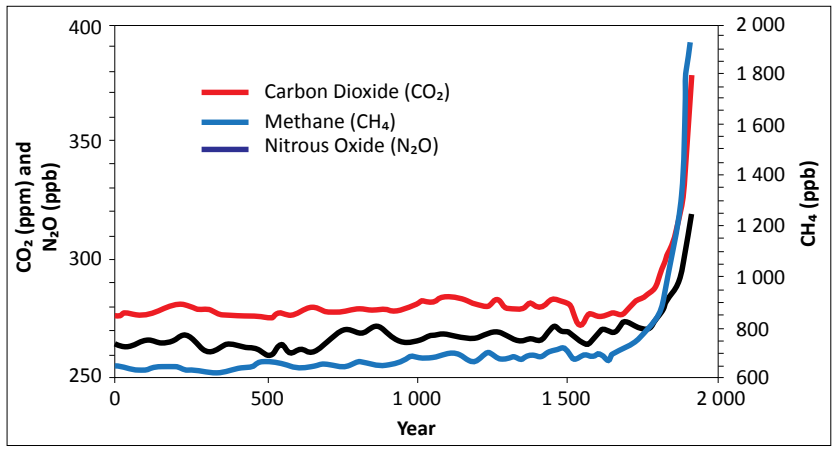


Figure 3.2: Trends in greenhouse gas emissions over the last 2000 years

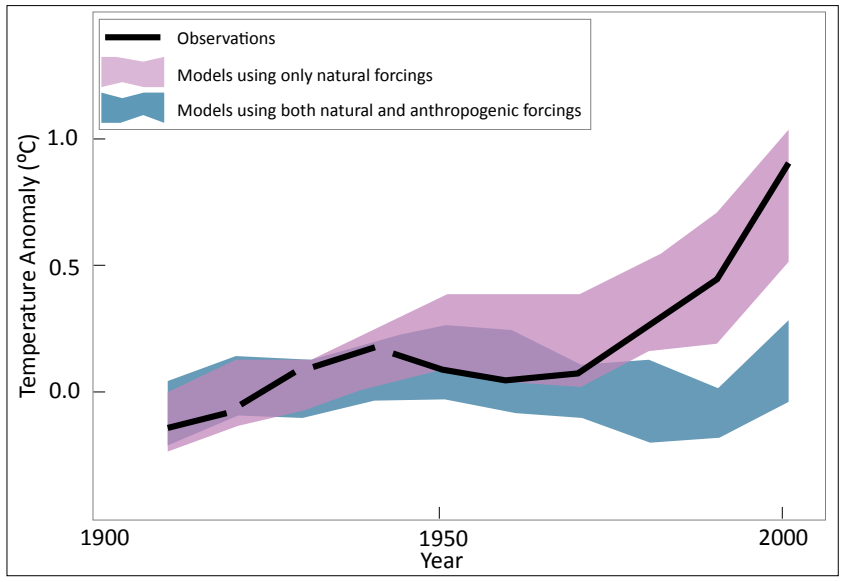
Source IPCC 2007

constant levels of greenhouse gas (GHG) emissions to 6.4°C for the highest case emissions scenario. The assessment of regional climatology requires more study, including research on climate-model projections and associated down-scaling of climate outlooks from regional to local scales (Hulme et al 2005, Vogel and O'Brien 2006).

Anthropogenic factors are thought to be the main drivers of global warming. Human activities have led to changes in the chemical composition of the atmosphere by adding more greenhouse gases (GHGs) to it. Between 1970 and 2004, global GHG emissions increased by 70 percent (IPCC 2007). The energy sector was the largest contributor of global GHG emissions, increasing by about 145 percent. Over the same period, direct emissions from transport grew by 120 percent; industry 65 percent; and land use, land use change and forestry 40 percent (IPCC 2007). Trends in the concentrations of the main GHGs—carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)—are shown in Figure 3.2.

Climate change-induced drought has devastating impacts on the livestock sector as this photo of emaciated livestock and carcasses in Dambas, Arbajahan, demonstrates.

Brendan Cox / Oxfam



Source: IPCC 2007

Figure 3.3: Comparison of observed continental- scale changes in surface temperature with results simulated by climate models using either natural or both natural and anthropogenic forcings. Decadal averages of observations are shown for the "period 1906-2005 (black line) plotted against the centre of the decade and relative to the corresponding average for the 1901-1950. Lines are dashed where spatial coverage is less than 50 per cent. Blue shaded bands show the 5- 95 per cent range for 19 simulations from five climate models using only the natural forcings due to solar activity and volcanoes. Purple shaded bands show the 5- 95 per cent range for 58 simulations from 14 climate models using both natural and anthropogenic forcings.

Africa

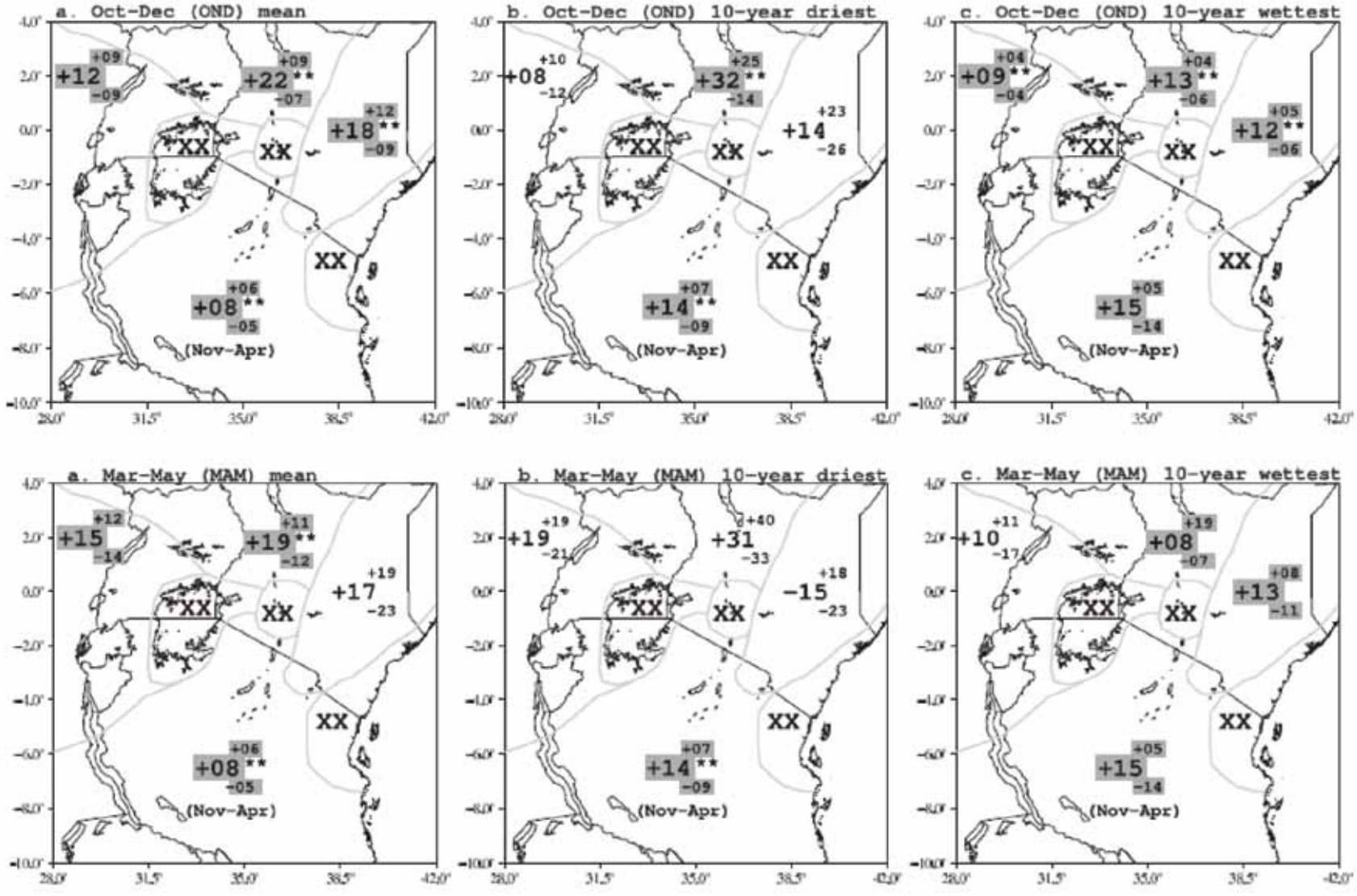
Climate change and variability are being felt on the African continent with different parts of the continent experiencing climate change differently. The evidence shows warming of about 0.7°C on average over most of Africa during the twentieth century (IPCC 2007). This is shown in Figure 3.3.

There has also been a 25 percent decrease in rainfall across large portions of the Sahel over the past 30 years (Desanker undated). Southern and eastern Africa also had more intense and widespread droughts, while central Africa experienced increased rainfall and less severe droughts (Desanker undated, Shongwe et al, 2010, IPCC 2007). The trends for the East African region are shown in Figures 3.4 and 3.5. Although increased precipitation generally has beneficial implications for agricultural production, it may also have negative impacts caused by the increased frequencies and intensities of extreme events like floods.

The top panel of Figure 3.4 illustrates the projected changes (percent) in October –December (OND) short rains in East Africa along the following trajectories: a) mean precipitation rates, b) 10-year driest events, and c) 10-year wettest events in each climatic zone. The middle number gives the mean projected change preceded by the relevant sign (+ve for increase and -ve for decrease). The number above or below the mean change, preceded by a +ve or -ve sign gives the distance to the upper or lower critical value as the case may be, at the 5 percent level of significance. Projected changes at the 5 percent significance level are shaded while those at the 1 percent level are indicated by xx. Figure 3.5's bottom panel displays identical

Figure 3.4: Projected changes (percent) in October - December (OND) short rains and the March, April, May (MAM) long rains in East Africa.

Source: Shongwe et al 2010



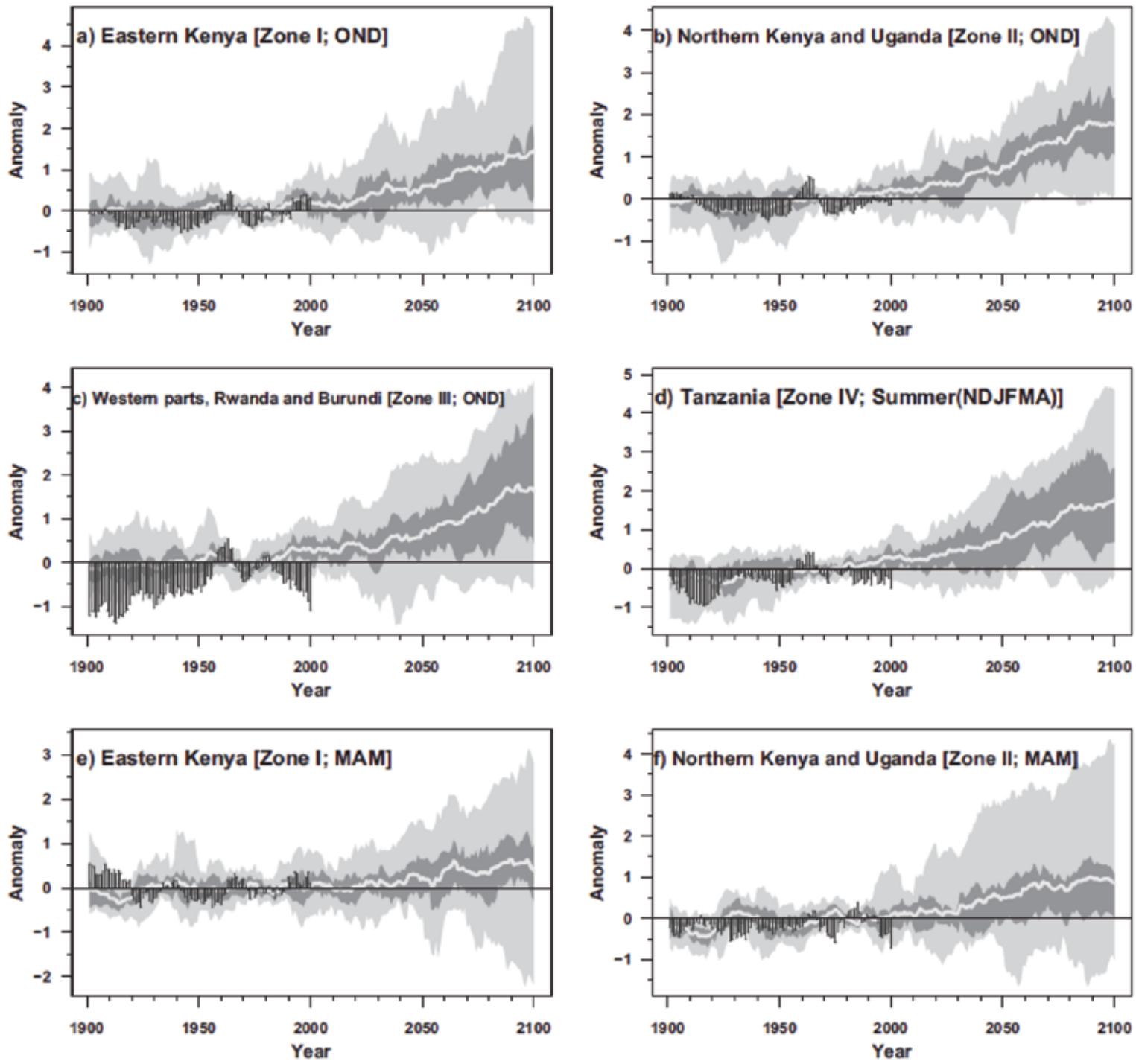


Figure 3.5: Trends for observed and simulated rainfall anomalies over East Africa over the 1961-1990 baseline period

Source: Shongwe et al 2010

trajectories for the East African region in respect of the March, April, May (MAM) season.

Figure 3.5 demonstrates the trends for observed and simulated rainfall anomalies over East Africa over the 1961-1990 baseline period. Panels a), b) and c) are for OND rainfall. Panel d) represents much of Tanzania during austral summer-autumn that lasts from November-April (NDJFMA). The bottom two panels display the series for MAM precipitation in (e) eastern Kenya, and (f) northern Kenya and Uganda. The black vertical lines terminated by circles display the observed 20th century precipitation from CRU data. The white lines show the ensemble average, with the lighter and darker grey shadings indicating 50 percent and 95 percent of the distribution, respectively.

During the 21st century, this warming trend and changes in precipitation patterns are expected to continue. The warming will be greatest over the interior of the semi-arid margins of the Sahara and central southern Africa (Desanker undated). These effects will be accompanied by a rise in sea level and increased frequency of extreme weather events. These climatic conditions will combine with social, economic and environmental factors to exacerbate the region's vulnerabilities including lack of water, food insecurity, diseases, conflict and degradation of natural resources.

Kenya

An analysis of the trends in temperature, rainfall, sea levels and extreme events points to clear evidence of climate change in Kenya. Studies indicate that temperatures have generally risen throughout the country, primarily near the large water bodies (King'uyu et al 2000, GoK 2010). Other projections also indicate increases in mean annual temperature of 1 to 3.5°C by the 2050s (SEI 2009). The country's arid and semi-arid lands (ASALs) have also witnessed a reduction in extreme cold temperature occurrences (Kilavi 2008). This warming is leading to the depletion of glaciers on Mount Kenya (IPCC 2007, UNEP 2009). Because of the vital ecological role of mountains, this will have negative implications on biodiversity and water supply in the country and tourism, whose continued double-digit growth is crucial to achieving

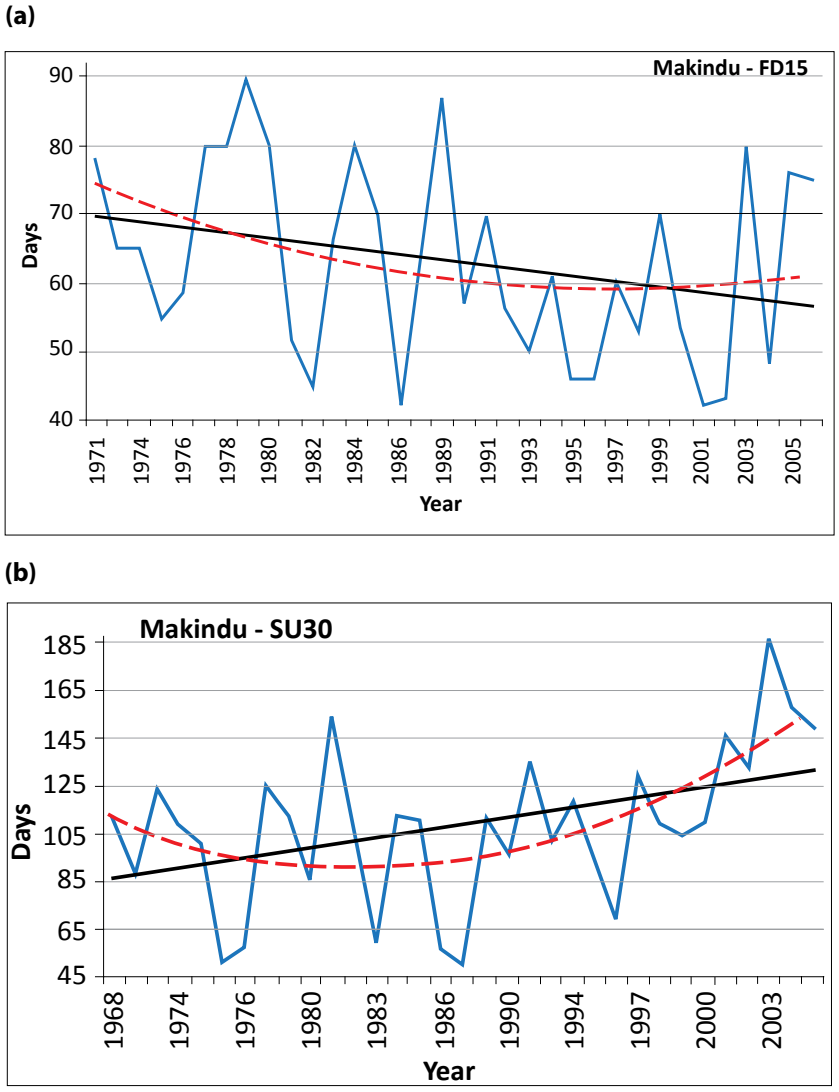


Figure 3.6: Trends for days with (a) minimum temperature below 15°C, and (b) maximum temperature above 30°C at Makindu

Source: King'uyu et al. 2010

the 10 percent economic growth rate anticipated by Vision 2030. Figure 3.6 shows the general warming trends over the country's land stations as indicated by positive day and night time temperatures.

Mean temperatures are also predicted to increase with a greater frequency of 'hot' days and nights and fewer 'cold' days or nights. A hot day or night is defined by the temperature exceeded on 10 percent of the days or nights in the current average climate of an area (station); and cold days or nights are defined as the temperature for the coldest 10 percent of the days or nights. In some areas like Nairobi, night-time warming features more prominently than day-time warming. This is shown in Figure 3.7. However, some of the observed trends may be related to rising urbanization (King'uyu 2002) with the effect that more pressure will be exerted on already stretched resources. This will in turn exacerbate the climate change signals already being observed. Effective urban planning could nevertheless help to reduce urban environmental degradation.

The country's growing motor vehicle numbers are commensurate with growths in the human population. Vehicles emit significant levels of air pollutants, including GHGs while charcoal burning emits methane (CH_4), carbon monoxide (CO) and particulate matter into the atmosphere. These, together with rising industrial emissions, use of charcoal and wood fuel and open burning of waste, are some of the main sources of atmospheric pollution. Figure 3.8 shows variability of average monthly ozone (O_3) and carbon monoxide (CO) at the Mount Kenya Global Atmosphere (GAW) station. The ozone and carbon monoxide average values range between 20-50 ppb and 50-150 respectively. These patterns are consistent with the prevailing wind patterns and

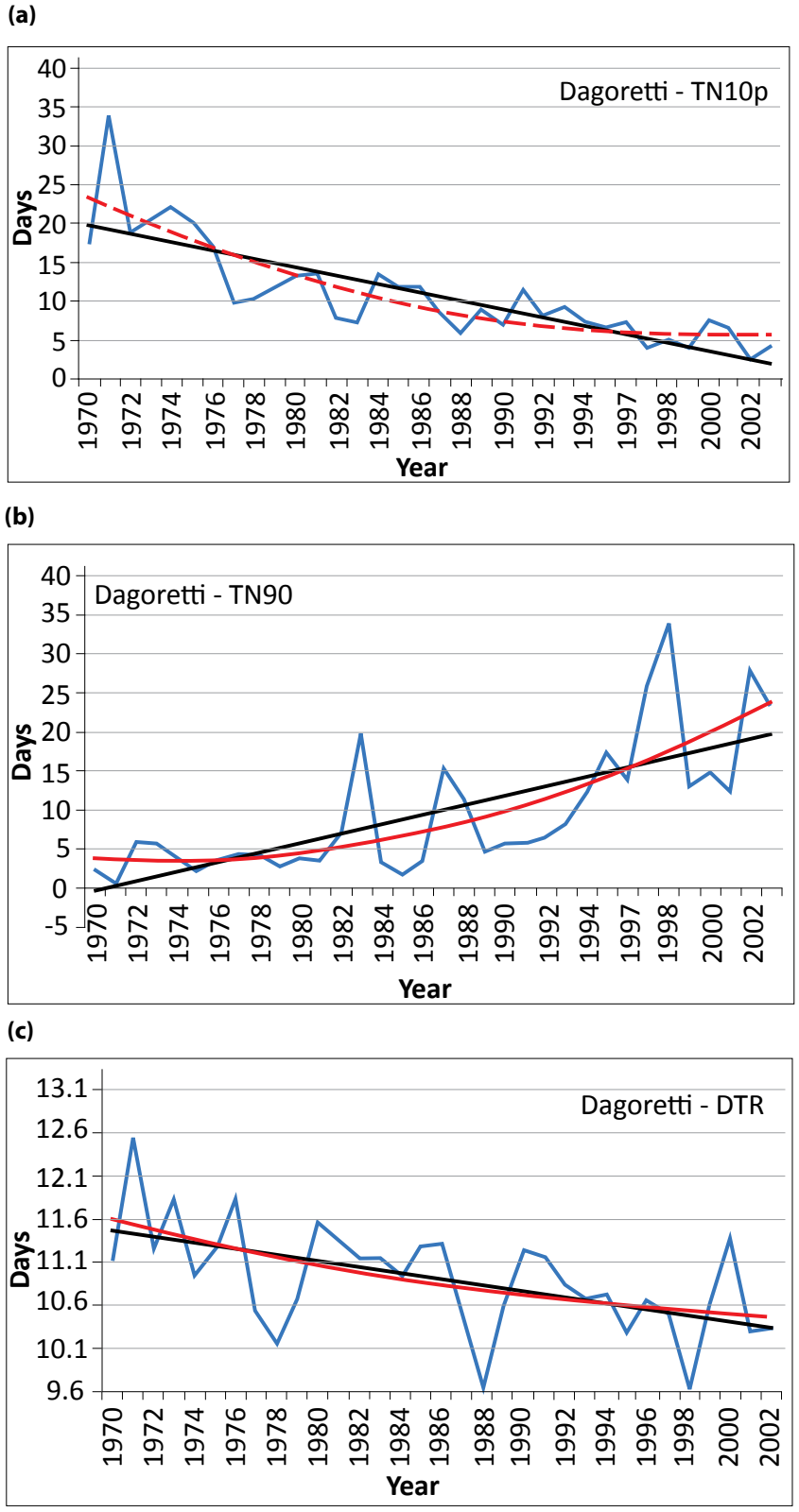


Figure 3.7: Number of days with minimum temperature at Dagoretti (Nairobi): (a) Below the 10th percentile; (b) above the 90th percentile; and (c) daily temperature range

Source: King'uyu et al. 2010

provide a unique opportunity to monitor sources, transport and sinks of air pollution over Kenya.

Rainfall is also projected to increase with many models indicating an intensification of heavy rainfall especially during the wet seasons, and an associated flood risk. Seasonal rainfall trends are mixed, with some locations indicating increasing trends while others show no significant changes. The annual rainfall totals show either neutral or slightly decreasing trends due to a general decline in the main long rains (MAM) season.

There are indications of sea level rise along the coast. This has the potential to inundate agricultural lands and cause groundwater salinity. These effects will be exacerbated by increasing human-induced pressures on coastal areas. Sea level rises will also increase the impact of storm surges which have the potential to devastate the coastal infrastructure. Evidence of the sea level rise is illustrated in Figure 3.9.

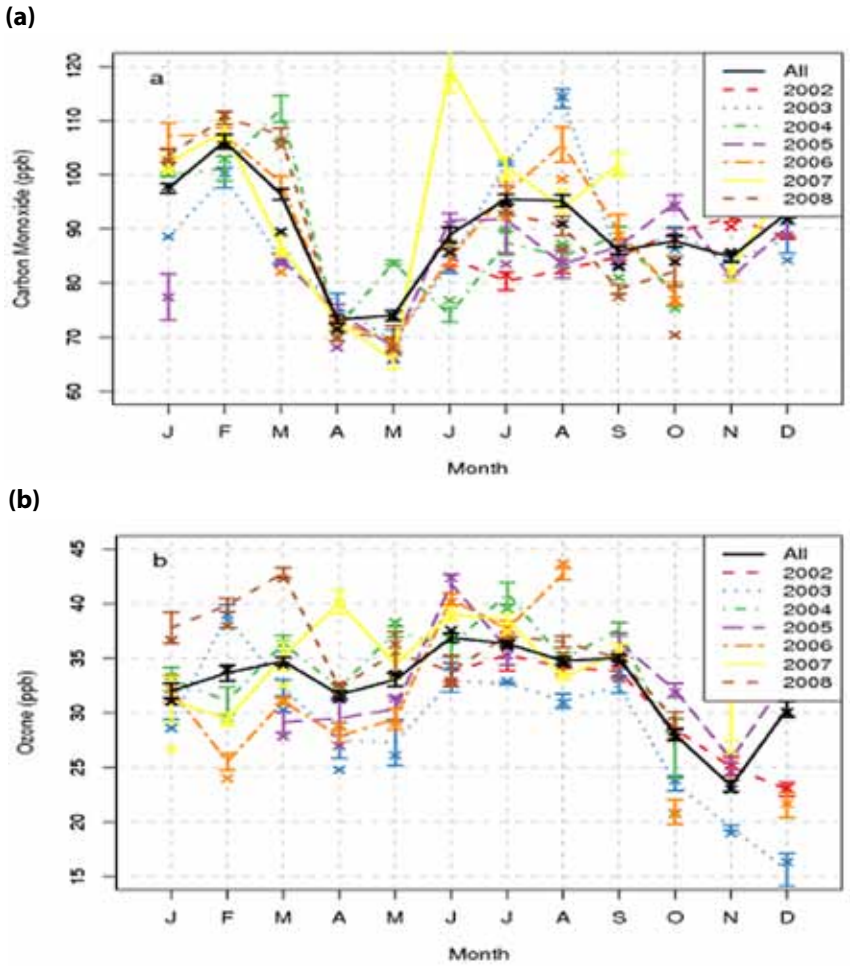


Figure 3.8: Climatology of carbon monoxide (a) and Ozone (b) at Mount Kenya GAW station for the period 2002-2008

Source: Henne et al. 2008

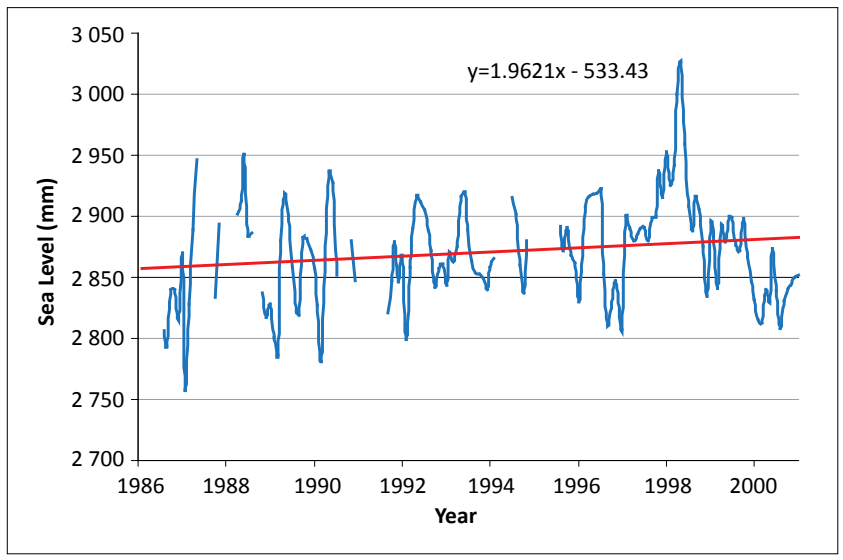


Figure 3.9: Sea level trend at Mombasa Coast

Source: KMRFI

Impacts on systems and sectors in Kenya

Climate change and variability present a number of economic, social and environmental challenges and opportunities to Kenya that should be addressed and harnessed to avoid slowing development gains or hampering attainment of Vision 2030. Some of these challenges include increases in the incidences of waterborne and water related diseases, crop destruction by excessive and erratic rainfall, escalation of pests as well as crop and livestock diseases. Other impacts include water scarcity which may foment natural resources conflict, food insecurity and malnutrition. Unless remedial measures are taken, this is likely to adversely affect the attainment of Vision 2030 because the key sectors of Kenya's economy, including agriculture, horticulture, hydro-energy generation, transport, and tourism are extremely climate-sensitive.

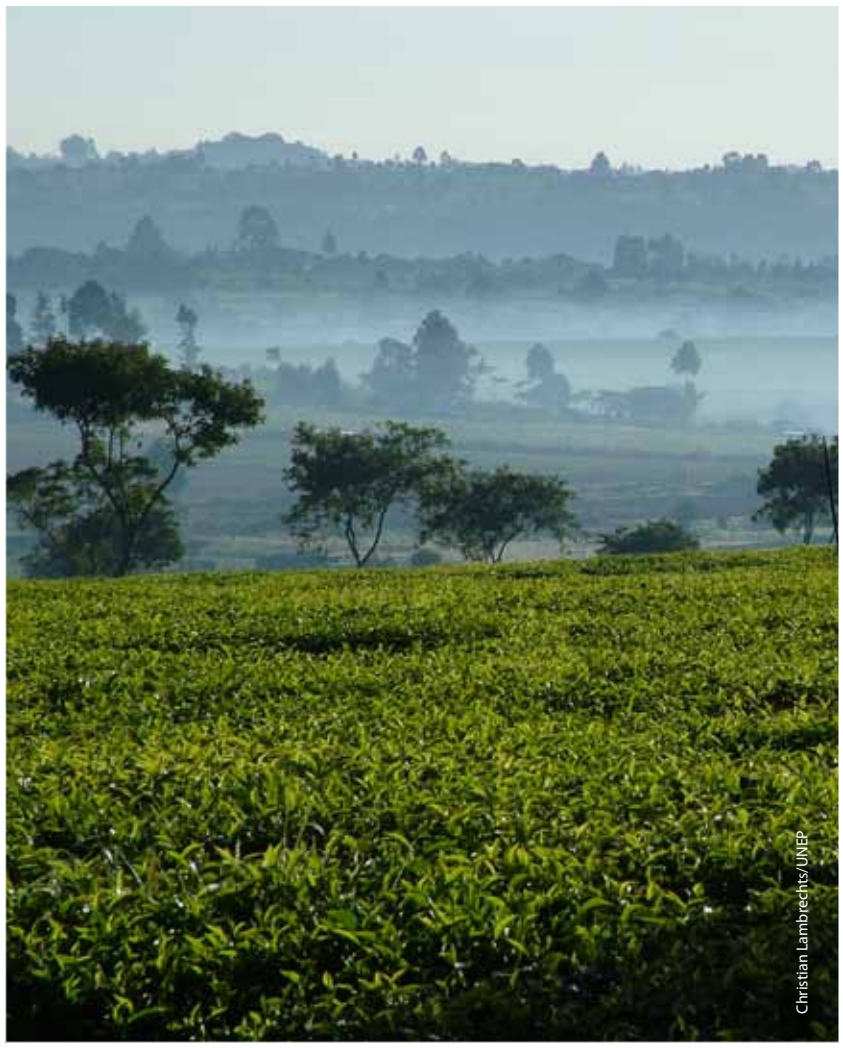
The continued annual burden of these extreme climatic events carries large economic costs which could be as high as US$ 500 million per year, which is equivalent to around 2 percent of the GDP and is likely to stunt long-term growth (SEI 2009). Although Vision 2030 recognizes that the key sectors of the economy are heavily weather-dependent, it does not contain an in-depth discussion of the effects of climate change and variability on the numerous set of goals under the economic, social and political pillars. The current and emerging climate-related hazards need to be researched and managed to minimize their negative impacts and to take advantage of the opportunities they present. In addition, there is urgent need to address the potential inconsistencies in the adaptation and mitigation strategies to climate change by shifting from a sectoral perspective to a holistic and integrated approach (Mickwitz 2009).

Agriculture and food security

Rain-fed agriculture—which accounts for 98 percent of the agricultural activities in the country (UNEP 2009)—is the backbone of Kenya's economy and is very vulnerable to increasing temperatures, droughts and floods, which reduce productivity. Drought results in agricultural losses, reduction in water quality and availability and is a major driver of food insecurity. On the other hand, floods lead to large-scale crop destruction, and devastation of food stores, farming equipment as well as erosion of agricultural land. Perennial floods in the Nyando River catchment alone have, for example, put KSh 1.16 billion worth of livestock at risk in the lower reaches of the Nyakach, Miwani and Nyando Divisions (Ochola 2009).

Increasing temperatures are also likely to affect the growing of major crops such as tea in the country (Otto 1999). As is shown in Figures 3.10, traditional tea growing areas are expected to become less suitable for growing the crop if the average temperature rises by 2° C or more. This will threaten the livelihoods of the tea farmers, processors and exporters and by implication, the attainment of Vision 2030 goals.

A tea plantationin the Nandi District.



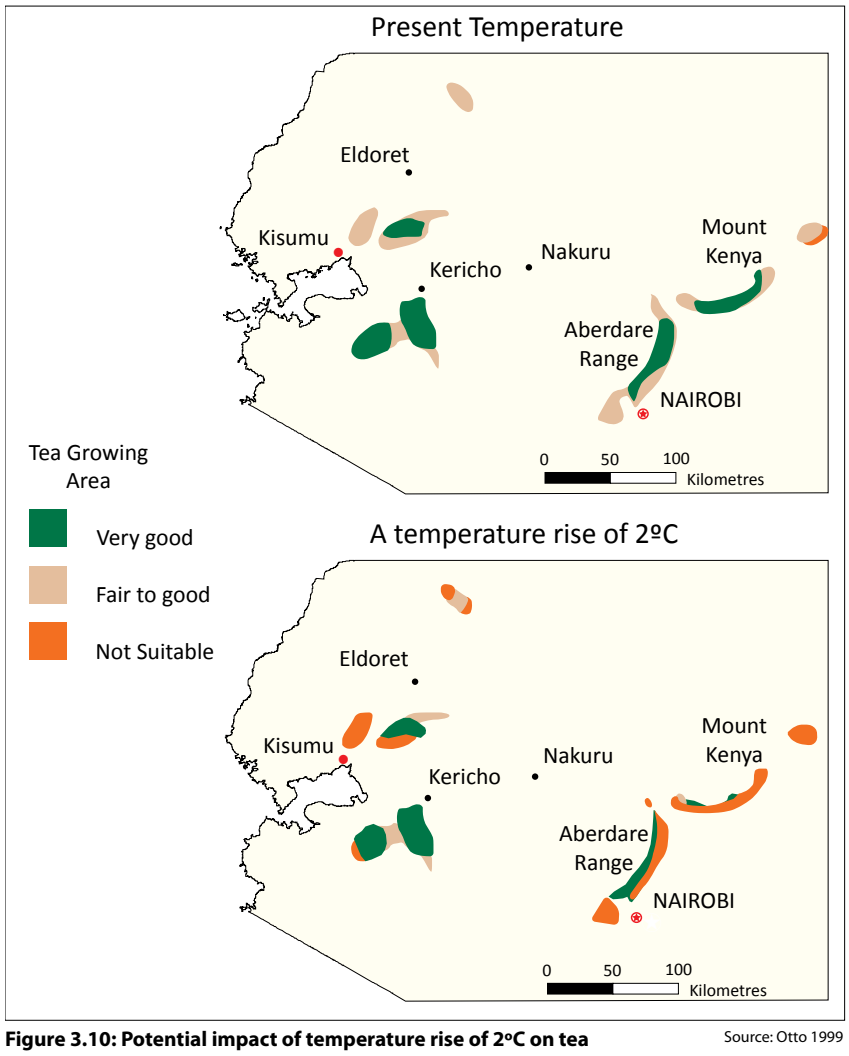


Figure 3.10: Potential impact of temperature rise of 2ºC on tea growing in Kenya

Source: Otto 1999

Climate change also compounds persistent development challenges such as population dynamics, land fragmentation, migration of people into sparser and drier lowland areas, inadequate infrastructure and provision of social services (Awuor 2008, Wandiga et al 2008, CCCCD and IISD 2009). Further, along with other factors like human population growth, poor soil management, and deforestation (Batiano et al 2006), it is a major cause of environmental degradation. In addition, agricultural intensification has led to cultivation on marginal lands which typically record erratic rainfall and are therefore associated with a high risk of crop failure (WRI et al 2007, NEMA 2007, UNEP 2009).

The National Climate Change Response Strategy (NCCRS) highlights various measures for adaptation and mitigation to the impacts of climate change on agriculture (GoK 2010). These include use of a range of innovative technologies such as irrigation; early maturing and high yielding crop varieties as well as drought and pest-resistant crop varieties and disease-resistant livestock. The NCCRS also advocates diversification of livelihoods; adaptation of agricultural technologies from analogue environments; and enhancing early warning systems with drought monitoring and seasonal forecasts with respect to food security.

A number of households already practise a range of adaptation measures. The most popular of these is crop diversification or mixed cropping adopted by 37 percent of all households, tree planting which is used by 16 percent and irrigation which is employed by 10 percent of the households (CEEPA 2006). Adaptation interventions are becoming increasingly innovative with private sector support. Box 3.2 highlights some of these interventions in the livestock sector.

The integration of indigenous and scientific knowledge can enhance a community's resilience to the impacts of climate change. Indeed, Kenyan farmers have demonstrated willingness to pay for climate-related information provided that this is communicated in a manner and language that they understand (KMD 2009). The importance of using appropriate communication methods was highlighted by the poor maize yields recorded in Machakos district during seasons when above-average rainfall was recorded (Rao and Okwach 2005) as shown in Figure 3.11. This could be attributed to continued use of low-yielding and short maturing varieties or lack of access to capital, water or appropriate agricultural inputs. The drop in yield from the mid-1990s cannot be blamed on changing rainfall patterns (and therefore on climate change) although it could be attributed to land exhaustion and prohibitive farm input prices that necessitate the continued use of low-yielding and short-maturing varieties. As such, it can be inferred that climate change is often used as a scapegoat for poor crop husbandry. Table 3.1 contains reasons inhibiting the uptake of climate change adaptations.

Poor farming practises, such as cultivation on flood plains have also increased the vulnerability of the agricultural sector to floods. The resulting economic losses have been erroneously blamed on climate change yet the underlying problem is ignoring the traditional buffer zones around protected communal areas.

Box 3.2: Impacts of climate change on the livestock industry

Livestock dynamics in the arid and semi-arid lands (ASALs) of Kenya have been widely researched (McCabe 1987). Droughts particularly hit the ASALs hard because they reduce the availability of forage, increase disease incidences and lead to a breakdown of marketing infrastructure. Although there have been 28 droughts in the area over the past century, four have struck in the past decade alone, causing significant livestock losses and pushing many families into the poverty bracket. Plans are underway to offer livestock insurance to herders in northern Kenya in a pioneering project that will use satellite imagery of available grazing to determine when and what amount of payouts occur. The scheme was launched in Marsabit district in 2010 where pastoralists keep more than 2 million cows, camels, goats and sheep worth an estimated US $67 million. These pastoralists however do not have the means to rebuild herds decimated by drought. Under a new scheme administered by Equity Bank and UAP insurance, around 1 000 farming households are expected to pay insurance premiums ranging from 3.25 percent to 5.5 percent of the value of their herds to cover them for a year. Eagle Africa Insurance also provides a similar livestock insurance scheme.

Table 3.1: Constraints on short-term climate change adaptation (percent of households)

Source: CEEPA 2006

Constraints faced (all regions)	All regions	High potential	Medium potential
Lack of information about short-term climate variation	8	7	10
Lack of knowledge of appropriate adaptations	19	16	25
Lack of credit or savings	59	56	64
No access to water	8	12	3
Lack of appropriate seed	5	4	6
Other constraints	13	12	14
No barriers to adaptation	8	9	8

An example of good use of climate information for adaptation to climate change and variability. This farmer (middle) was part of the small minority that registered a bumper maize harvest in the 2009 MAM season around Machakos despite poor rains (Source: KMD 2009).

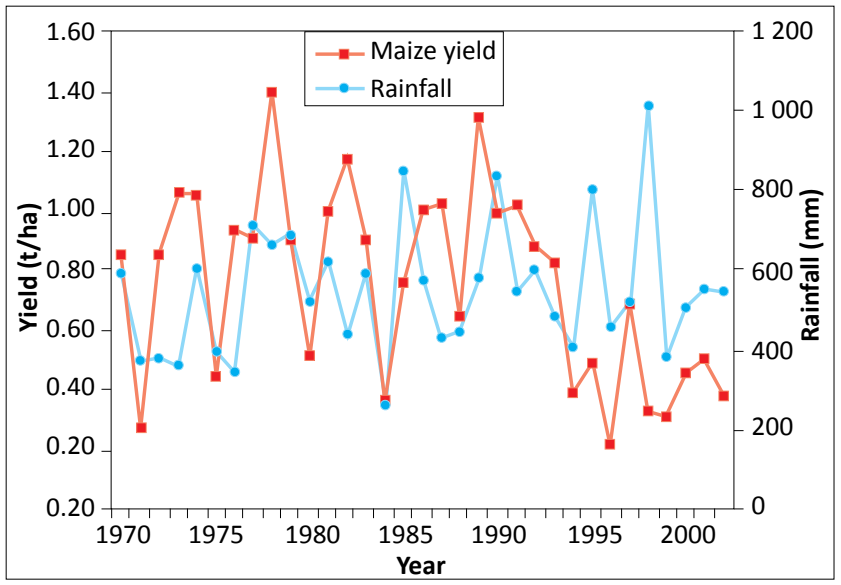


Figure 3.11: Five-year maize yields and observed rainfall in Machakos Source: Cooper 2008

As agriculture is the leading sector of the Kenyan economy and the biggest source of employment, severe weather, extreme events and other climatic fluctuations are bound to adversely impact the delivery of Vision 2030 and could even reverse the gains made under the social and economic pillars of the long-term development blueprint.

Water resources

Kenya is classified as a chronically water-scarce country and has one of the world's lowest water replenishment rates per capita (World Bank 2009). The combined effect of rising temperatures, more frequent droughts and decreasing rainfall has led to lowering river, lake and groundwater levels. For instance, the water level in Lake Naivasha has varied by about 12 metres in the last century as shown in Figure 3.12 (Becht 2007). The country has also witnessed disappearance of some seasonal rivers and falling levels of permanent rivers. Nyando River, for instance, had low discharges for most of 2010, jeopardizing the viability of the rice irrigation schemes on the Kano plains.

Besides adversely affecting the water services sector, water scarcity impacts fisheries, agriculture and tourism. The 1998-2000 drought spell is estimated to have led to an economic loss of about US$ 2.8 billion emanating from the loss of crops and livestock, forest fires, damage to fisheries and reduced hydropower generation and industrial activity. The 1997/98 floods affected almost 1 million people and were

Flooded maize farms due to encroachment of agricultural activities along the banks of River Nyando during the 2006/2007 flooding.

A community water pan on the Kano plains which is used for livestock watering and domestic needs dries up.

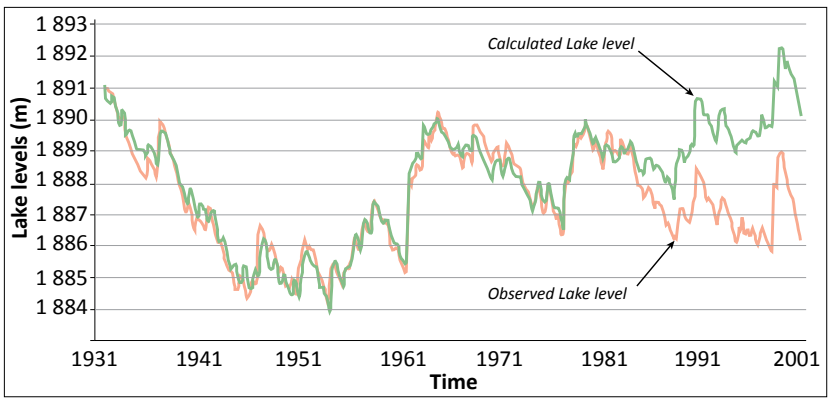


Figure 3.12: Long-term change in the observed and modelled Lake Naivasha water level Source: Becht 2007

estimated to have cost the economy US $0.8-1.2 billion arising from damage to infrastructure (roads, buildings and communication systems), public health effects (including fatalities) and loss of crops. Widespread flooding, property destruction, soil erosion, mudslides and landslides, surface and groundwater pollution and sedimentation of dams and water reservoirs led to losses amounting to US$ 9 million (Obati 2005).

Development and implementation of mechanisms that help communities and individuals to mitigate and adapt to climate change vulnerabilities should therefore be intensified (Charles et al 2010, GoK 2010).

Health

Global climate change affects human health through pathways of varying complexity and scale and with different timing (McMichael 2003). The impacts vary geographically depending on the environment, topography and vulnerability of the local population. Climate change and variability affect natural processes which in turn lead to an increased incidence of a range of diseases, such as asthma, malaria, diarrhoea, Rift Valley Fever and nutrition-related ailments. Figure 3.13 illustrates the pathways through which climate change can affect human health.

Global warming and the considerably wetter conditions related to climate variability-induced floods have expanded the habitat ranges of human, livestock and crop disease vectors. These factors have also contributed to the spread of alien invasive species. The change in the geographic distribution and migration of the anopheles mosquito to the highland areas is, for example, exposing large numbers of people to malaria (Chen et al 2007, Pascual et al 2006). Evidence of micro-climate change due to land use changes, such as swamp reclamation for agricultural use and deforestation in the western Kenya highlands has also increased the risk of malaria outbreaks (Munga et al 2006).

During floods which destroy water and sanitation facilities, environmental diseases such as typhoid, amoeba, cholera and bilharzia —which are normally associated with contaminated water and poor sanitation—reach epidemic levels. The Nyanza, Western, Coast, Eastern and North Eastern provinces, for example, recorded several cholera outbreaks during the 1997/1998 El-Niño rains. Further, amoebae thrive in warmer waters and this may explain why amoeba infections have risen steadily in areas that were historically cold but are now experiencing temperature rises, like Meru.

Air pollution as a result of rising fossil fuel combustion to meet the energy needs of a growing population, has resulted in increased frequency of cardio-respiratory diseases such as asthma. Increased morbidity affects the productivity of the population and slows economic development. It also places further burdens on the country's health and social security services, which in turn necessitate larger budgetary allocations. Hiving off large chunks of public finance for these services however, reduces allocations to the wealth and job creating sectors of the economy, adversely affecting the attainment of Vision 2030.

Human settlement

The manifestations of climate change and variability, including extreme events such as storms, floods and prolonged droughts, have marked impacts on settlements and infrastructure (Magadza 2000). For instance, sea level rise can result in the inundation of low-lying coastal lands and the destruction of the physical infrastructure of coastal areas. It

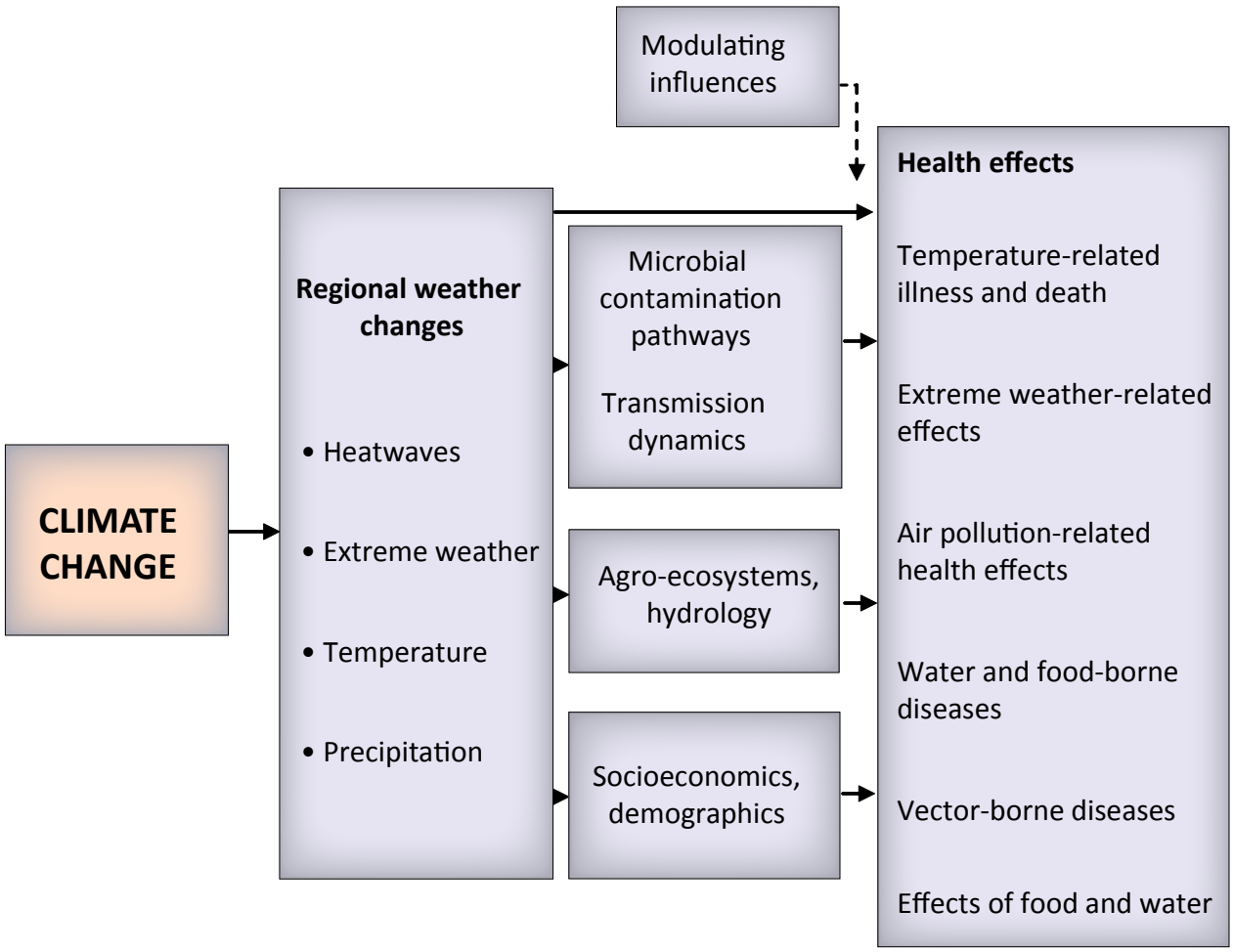


Figure 3.13: Pathways by which climate change affects human health, including local moderating influences and the feedback influence of adaptation measures

Source: Adapted from Patz 2000

may also affect ecosystems such as mangroves and coral reefs, with negative consequences on the fisheries, health and tourism sectors. These in turn increase the physical and socio-economic vulnerability of coastal communities.

Climate change impacts such as water stress, food insecurity and poverty could displace entire communities, turning them into environmental refugees. These may migrate into new settlements or seek new livelihoods, putting more demand on infrastructure and causing or exacerbating environmental degradation. Droughts and floods are, for example, known to have contributed to family dislocation and cultural erosion. Flash floods have triggered landslides in central and western highlands, leading to loss of life and destruction of physical infrastructure. These impacts are often accompanied by health problems such as diarrhoea, cholera and malaria (Boko et al 2007).

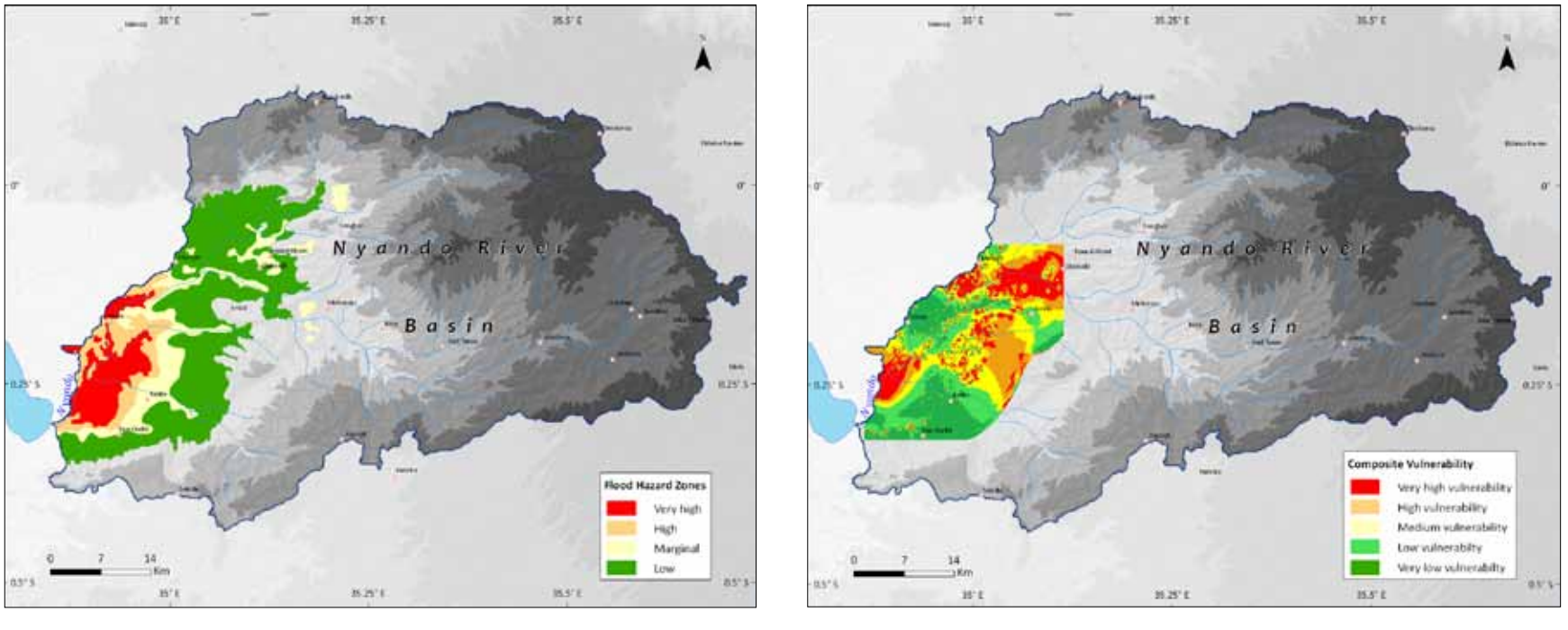
The absence of land use planning and minimum building standards contributes to the high vulnerability of homesteads and schools (Ochola 2009, Ochola et al 2010). Vulnerability to floods may also be due to lack of funds, poor building standards, local topography, soil types and inadequate drainage (Ochola et al 2010). For example in the Nyando River catchment area, only 12 percent of the primary schools and 19 percent of the secondary schools were found not to be prone to flood risk (Ochola et al 2010). Kenya needs to align the policies and plans for sustainable rural and urban planning in order to cater for the impacts of climate change. This is because planners play a direct role in shaping and controlling land use and urban form which are significant determinants of a settlement's adaptive capacity and resilience to climate change (UN HABITAT 2010). Figure 3.14 a and b shows the relationship between flood hazards and community vulnerability.

Figure 3.14: Flood hazard and vulnerability maps in the Nyando River catchment

(a)

(b)

Source: Ochola 2009



Gender aspects of climate change

Because men and women play different roles at the household and community levels, climate change affects each of these differently. Therefore, climate change has a disproportionately greater effect on women because they carry a heavy work burden, interact with natural resources a lot more and have limited mitigative and adaptive capacities. Climate change and variability are therefore likely to amplify existing patterns of gender disadvantage (UNDP 2009). Analyzing climate change through the gender lens is therefore important for a number of reasons. First, recognition of how gender identities determine different vulnerabilities and capacities to deal with climate change (Brody et al 2008) can help to attenuate its impacts. Figure 3.15 shows some of the vulnerabilities of women to the impacts of climate change. Second, this approach can be helpful in designing and implementing policies, programmes and projects that lead to greater gender equity and equality. In particular, it may contribute to enhancing capacity to mitigate and adapt to climate change because it takes cognizance of the relations men and women have with natural resources and ecosystems.

Opportunities and endowment value of climate change

Kenya is endowed with diverse and abundant climatic resources which include solar insolation, sunshine, wind, rainfall and air. These resources which provide life-supporting goods and services are however not evenly distributed throughout the country with some regions being better endowed with more of a particular resource than others. Rainfall plays a critical role in supporting life and is the main source of water resources (surface and ground) that sustain humans, animals and plants and are indispensable for rain-fed agriculture and industrial activities. Rainfall also replenishes the dams that are used to produce the country's hydro electric power. Most of the streams that flow downstream into the dams that are used for hydropower generation originate in the country's highlands, some of which receive more than 1000 mm of annual rainfall. Solar insolation provides natural light and energy while sunshine and wind can be used to generate electricity. The ASALs, which constitute 80 percent of the country's land mass, experience long hours of sunshine which typically amount to over 7 hours a day. These accordingly have enormous potential for solar energy generation with the highest potential being in north western Kenya in Lodwar. High speed winds are generally common in northern Kenya (around Marsabit), the coastal zone, Maralal, Keiyo, Eldoret and Ngong Hills with these areas being ideal for wind power generation.

These resources can be optimally tapped with better-informed resource user and producer groups (Vogel and O'Brien 2006). It is therefore important for Kenya to build on the gains made under the NCCRS by developing a comprehensive national climate change policy and action plan. This will stimulate investment in programmes and businesses that mitigate against or adapt to the effects of climate change and variability. A national climate change policy would also provide a framework for government, private sector, civil society and other stakeholders' participation to integrate climate change considerations into development planning and implementation at various levels. This would lead to positive outcomes for the environment and Vision 2030 because the climate change mitigative and adaptive mechanisms would create considerable business and employment opportunities but also help protect the natural resource base on which many sectors of Kenya's economy are based.

Partnerships opportunities

Partnerships for improved climate change management abound in the country. Key development partners have come together to form a Donor Climate Change Coordination Group. They include the World Bank, DANIDA, USAID, JICA, SIDA and FINNIDA. Through various financing mechanisms, activities are supported at national and sub-national levels. For instance, there are efforts to work with pastoralists communities in the ASALs for better rangeland management. This is described in more detail in Box 3.3.

Regional climate change partnerships exist under the auspices of the EAC, COMESA, IGAD and AU. These seek to enhance resource mobilization, mitigation and adaptation, capacity building and technology transfer. The EAC Climate Change Policy and Master Plan provides a number of guidelines that partner states and other stakeholders can use in the preparation and implementation of collective measures to address climate change. COMESA operates a carbon fund that encompasses a range of climate change initiatives in carbon sequestration such as clean energy, forestry, conservation agriculture, land use and other low carbon projects such as the Reducing Emissions from Deforestation and Forest Degradation (REDD). The 13th AU Assembly of Heads of State and Government, held in Libya in 2009, approved the Conference of African Heads of State and Governments on Climate Change (CAHOSCC). It aims to present a united position in global climate change negotiations and interventions. The African Ministers' Conference on the Environment (AMCEN) also addresses climate change-related developments and environmental initiatives.

Some of the ongoing regional projects in Kenya for climate change include:

- Climate Change Adaptation in Africa (CCAA) that focuses on research and capacity development to improve the capacity of vulnerable communities to adapt to climate change.
- The Africa Adaptation Programme (AAP) which aims to strengthen Kenya's institutional and systemic capacity to implement the NCCRS and to address climate change risks and opportunities through a national approach to adaptation.
- Kenya Adaptation to Climate Change in Arid and semi-arid Lands (KACCAL) which aims to facilitate long-term adaptation of the key stakeholders in the ASALs to climate change.

Kenya is signatory to and has ratified a number of MEAs including the United Nations Framework Convention on Climate Change (UNFCCC). Kenya's commitments under the UNFCCC include: periodic updates and publication for inventories of anthropogenic GHG emissions, implementation of national and regional mitigation and adaptation programmes. So far, only the First National Communication to UNFCCC was submitted in 2002. The main challenge is the limited capacity to domesticate and share information among stakeholders. Articles 4-7 of the UNFCCC present opportunities for Kenya to access international funding through the Global Environment Facility (GEF) for inventorying GHG emissions, technology development, transfer and diffusion; capacity building; adaptation; mitigation; research; training, education and public awareness. Further, under Article 12 of

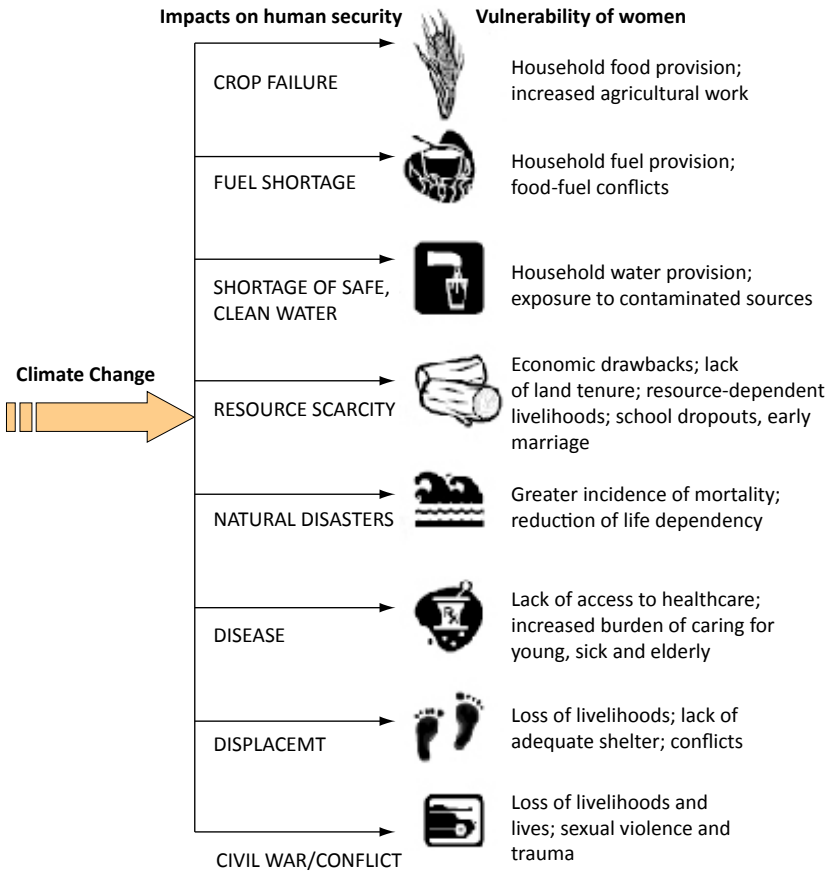


Figure 3.15: Vulnerability of women to impacts of climate change Source: WEDO 2007

the Kyoto Protocol, resources can be accessed under the Clean Development Mechanism (CDM). However, only three CDM projects have been registered in Kenya. These are Ol Karia II Geothermal Expansion project; Ol Karia III Phase II Geothermal Expansion project; and Lake Turkana 310 MW Wind Power project (UNFCCC 2011). A key concern however it that although the Kyoto Protocol's first commitment period expires in 2012, there is neither firm international commitment to extend it nor a successor mechanism in place.

An initial estimate of immediate needs for addressing current and future climate change impacts is US $500 million per year. The cost of climate change adaptation alone could increase to between $1-2 billion per year (SEI 2009) by 2030. Clearly, effective mitigation and adaptation mechanisms need to be devised urgently if Kenya is to remain on course to accomplishing the social and economic targets specified in Vision 2030. The urgency with which these remedial measures should be instituted is informed by the stark projection by the Stern Report that climate change could cost African countries in excess of 20 percent of GDP per year by 2100 (Stern 2006).

Integrating climate into policy and governance

Climate change policy integration consist of three main components: incorporation of climate change mitigation and adaptation considerations into all stages of policy making; attempts to aggregate expected consequences of climate change mitigation and adaptation into the overall evaluation policy; and a commitment to minimize contradictions between climate change policies and other policies (Lafferty and Hovden 2003, Underdal 1980). Mainstreaming climate issues into the Kenya government's programmes is important given that climate is a major driver of the economic activities—such as agriculture and tourism—that are central to the achievement of Vision 2030.

Currently, there are no policy-level instruments that specifically deal with climate change. EMCA 1999 does not mention climate change while there is little express reference to the phenomenon in Vision 2030. Policy strategies and instruments are thus needed to build climate change mitigation and adaptation mechanisms into the national development agenda. Besides formulating a national climate change policy and climate change law that would consolidate the gains made by the NCCRS (which is a strategy and not a policy), there is need to integrate climate change considerations into all government planning, budgeting and development processes at the national and county government levels.

Box 3.3: Poverty Reduction and Additional Income Generation through Trading Carbon Embedded in Rangelands—Support to Laikipia Wildlife Forum

The challenge for any sustainable poverty reduction measures for the poor and marginalized communities in the arid and semi-arid lands (ASALs) is the creation of income generating opportunities. Setting aside land for tourism and wildlife can provide additional, but limited, income. One asset that has yet to be fully exploited is the value of the carbon embedded in ASALs and forestry systems.

Traditionally the nomadic tribes of the ASALs regions have followed the rains. However, increasing pressure for agricultural land and rising populations have placed a great strain on the ability of the remaining grasslands to support their herds. Dry land grazing areas are now being used throughout the year, further straining already damaged ecosystems.

Wildlife sanctuaries offer some respite, but there is a limit to how much can be set aside. In an effort to redress this situation many Non Governmental Organisations (NGOs) and Community Based Organisations (CBOs) are advising pastoralist communities on improved management techniques. One such methodology is known as Holistic Management. The technique was first "developed" in Zimbabwe some 20 years ago, though in truth it has been used by the traditional pastoralists of East and Central Africa for millennia. The net result of this technique is an increase in biomass leading to better grazing, higher stocking rates and higher levels of carbon sequestration.

The Sanctuary at Ol Lentille (2), situated about 75km North of Nanyuki, was started in 2006 with the Kijabe Group Ranch setting aside about 2 000 hectares of their 6 000 hectare group ranch. It has since been expanded, now incorporating some 5000 hectares, and will eventually grow to 14 000 hectares. At its full extent the Sanctuary will be the guardian for land set aside from 5 group ranches covering approximately 80 000 hectares, with the potential to benefit the lives of over 70 000 people.

The project seeks to ascertain the value of carbon in the soils of the sanctuary and the neighbouring group ranches. It will also establish modules that can be used to monitor and verify the carbon sequestered on a year by year basis. Working closely with existing NGOs and CBOs it will assist in establishing community based savings societies to ensure any funds generated from carbon sales are effectively used within the communities. Finally, it will identify markets and facilitate efforts that will enable the communities to trade this carbon.

Source: Ministry of Foreign Affairs of Denmark (MFA)

Local opportunities presented by climate change

The envisaged opportunities are numerous and include but are not limited to the following:

Rainwater harvesting

Collecting rainwater for drinking, livestock and domestic use is an established practise in Africa (UNEP 2006). It is also common in Kenya and its popularity is growing. Rainwater is an increasingly promising complement to other sources of household water, especially in the face of increasing scarcity and rising demand. Kenya is already facing a water crisis so rainwater harvesting is expected to enhance access to potable water.

Population growth and reduced rainfall have combined to make the traditional rain collection methods insufficient. There is need to employ new, more efficient collection and storage techniques. These may include use of roof catchments and collection in plastic or concrete tanks. Metal tanks are not recommended as they corrode. With the use of appropriate technologies, rainwater could also play a bigger role in irrigation and combating the effects of drought. However, appropriate technologies will need to be made widely available.

Conservation agriculture

Conservation agriculture is one of the approaches that are envisaged to climate-proof agriculture. Given the significant role that agriculture plays in the country's economy, in Kenyans' livelihoods and in the attainment of Vision 2030, conservation agriculture is an important climate change adaptation method. It involves minimizing soil disturbance (no-till), ensuring permanent soil cover (mulch) and using a blend of crop rotation or inter-cropping (FAO 2006). The synergy of these factors leads to improved agricultural productivity and food security, increased incomes and enhanced carbon sequestration. The government, with the support of the COMESA Secretariat, has concluded the design of an Investment Framework for up-scaling conservation agriculture. The framework is anchored on both the NCCRS and the Agricultural Sector Development Strategy.

Clean energy

Clean and renewable energy sources, such as wind and solar, can power small-scale rural industries and hence improve livelihoods. Harnessing them can also help to reduce reliance on hydro electric power whose generation is particularly prone to climate change stressors. They can also enhance reliability of the national electricity supply and lower costs of electricity to the productive sectors, which will in turn help to achieve the economic goals of Vision 2030. For instance, access to electricity would reduce the time rural women and girls spend in search of wood fuel and water, and improve school enrolment and retention rates for the girl child.

Wind energy

Marsabit, Ngong, Maralal, Eldoret and the coastal areas which have frequent high speed winds are ideal locations for tapping wind energy which can be used for powering small-scale industries and water pumping. Despite the existence of wind turbines at Ngong and Marsabit, the full potential of this resource is yet to be exploited. Investment in local capacity to plan, design and construct wind mills is essential to taking full advantage of this opportunity as it would make tapping this source of energy more affordable. Because many households may be unable to afford individual systems, community-level systems could prove to be more viable. Hybrid energy systems that couple wind turbines with conventional generators may be used to mitigate against wind intermittency in order to ensure constant energy supply.

Solar energy

Solar power could improve the percentage of households with lighting and power, and increase livelihood and educational opportunities. It is primarily suitable for meeting small-scale energy needs for isolated off-grid communities. It is able to light up houses, power and charge electronic equipment, telecommunication devices, and meet the needs of schools and community health centres.

Natural solar drying of foodstuffs such as grains and tubers is commonly used to preserve and prepare food for milling in Kenya. However, current practises do not make efficient use of the available solar heat. Investment in the appropriate technology would create new business opportunities in the manufacturing and marketing sectors and diversify income-generating opportunities. There is potential to develop and widely use solar drying systems for the preservation of food which is an important part of the food security strategies. Clean energy increases participation in global business (where goods' environmental friendliness is coming under increasing scrutiny), improves income, enhances development and reduces air pollution. However, the high prices of solar photovoltaic equipment have significantly contributed to low sales and poor adoption by the less affluent households which are also more likely to be off-grid.

Science and technology

If the atmospheric resources are to be effectively harnessed in order to meet the ambitious targets outlined in Vision 2030, it is important for the country to invest in broadening and strengthening the requisite scientific and technological capacity. This is in recognition of the useful but insufficient role indigenous knowledge and traditional coping strategies play in mitigating against and adapting to climate change and variability. Global and regional (COMESA, EAC and IGAD) partnerships in training and research can help to improve the degree to which appropriate technologies and innovations in climate change adaptation and mitigation are harnessed to meet the far-reaching challenges in the agricultural, forestry and business sectors.

Conclusion and recommendations

Kenya, like the rest of the world, is experiencing adverse impacts of climate change and variability. These have exacerbated environmental degradation, reduced agricultural production and food security, increased incidences of flooding, landslides, droughts, disease epidemics, led to the destruction of physical infrastructure and heightened the risk of natural resource conflicts. While vulnerability to these impacts is differentiated and context-specific, it has the potential to result in significant economic costs that can derail attainment of the Vision 2030 goals.

The development of the NCCRS provides a broad coordinated framework for government, private sector, civil society and other stakeholders to integrate climate change and variability considerations

into national development planning and implementation at various levels. While the trajectories of future climate change and variability impacts in Kenya are uncertain, there is need to institute robust strategies to prepare for the uncertain future rather than using uncertainty as a reason for inaction. In addition to formulating a national climate change policy and enacting a climate change law, there is need to implement the following recommendations:

- **Identify potential opportunities presented by climate change and variability** (such as emissions trading) and tap these.
- **Establish specialized institutions and centres of excellence** that will enable Kenya to enunciate the science-policy nexus, and allocate funds to adequately research feasible mitigation and adaptation mechanisms.
- **Develop early warning systems** and link climate change and disaster risk reduction at all levels.
- **Enhance communication of climate change adaptation and mitigation programmes** at the national, county and community levels in order to upscale monitoring and reporting.
- **Develop a database of experts on the various aspects of climate change and variability** in order to enhance networking, information exchange and avoid duplication.
- **Use a number of policy and financial instruments to encourage use of alternative, cleaner sources of energy that are gentler on the world's climate systems.** These could consist of command and control legal provisions, taxes that are predicated on the 'polluter pays' principle, green budgeting and a range of fiscal incentives.

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PART 2
STATE OF THE ENVIRONMENT

CHAPTER 4
BIODIVERSITY

Introduction

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The Convention on Biological Diversity (CBD) defines biodiversity as 'the variability among living organisms from all sources including, among others, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part [and] includes diversity within species, between species and of ecosystems.' Biodiversity therefore comprises genetic and species diversity of animals and plants as well as ecosystem diversity. Kenya is endowed with an enormous diversity of ecosystems and wildlife species which live in the terrestrial, aquatic and aerial environment. These biological resources are fundamental to national prosperity as a source of food, medicines, energy, shelter, employment and foreign exchange. For instance, agricultural productivity and development are dependent on the availability of a wide variety of plant and animal genetic resources and on the existence of functional ecological systems, especially those that influence soil fertility and water availability. Kenya's biodiversity wealth is integral to the delivery of Vision 2030 as it lies at the heart of the tourism sector, which along with agriculture, manufacturing, wholesale and retail trade, business process outsourcing (BPO) and financial services, is expected to deliver the 10 percent annual growth rate envisaged by the country's long-term development blueprint.

Kenya's rich biodiversity can be attributed to a number of factors, including a long evolutionary history, variable climatic conditions, and diverse habitat types and ecosystems. The major biodiversity concentration sites fall within the existing protected areas network (national parks, reserves and sanctuaries) which are mostly managed by the Kenya Wildlife Service (KWS). However, over 70 percent of the national biodiversity occurs outside the protected areas.

In spite of its immense biotic capital, Kenya experiences severe ecological and socio-economic problems. Drought negatively impacts the country's biodiversity as well as the national economy and people's livelihoods. There are also problems of human-induced environmental degradation, such as destruction of natural landscapes, soil erosion, water pollution and loss of species. Inappropriate policies and political impunity have contributed to nationwide habitat destruction, loss of

The African Grey Parrot can be found in forests in Eastern Africa

Johannes Akiwumi/UNEP

species and the associated genetic resources. The sustainable management of the country's biological resources is also hampered by lack of a comprehensive biodiversity policy, of a biodiversity inventory and of formal procedures for benefit sharing as well as threats from invasive alien species (MNPDV 2010).

Current status of biodiversity

Overview

Kenya is considered to be one of the countries that are best endowed with biodiversity due to the abundance and variety of species that are manifest in the country's varied ecosystems. The rich biodiversity is partly attributed to the diversity of landscapes, ecosystems, habitats and the convergence of at least seven bio-geographic units (NEMA 2005).

Kenya is famous for its large mammals such as zebras.

Kenya is home to five hot spots of globally important biodiversity and 61 important bird areas (IBAs). These unique and biodiversity-rich regions include the Indian Ocean Islands of Lamu and Kisite; the coastal forests of Arabuko-Sokoke and the lower Tana River; the Afro-montane forests of Mount Kenya, Aberdare and Mount Elgon; Kakamega's Guineo-Congolian equatorial forest; and the Northern dry lands that form part of the distinct Horn of Africa biodiversity region. These ecosystems collectively contain high levels of species diversity and genetic pool variability with some species being endemic or rare, critically endangered, threatened or vulnerable (NEMA 2009a).

Kenya's known biodiversity assets include 7 000 plants, 25 000 invertebrates (21 575 of which are insects), 1 133 birds, 315 mammals, 191 reptiles, 180 freshwater fish, 692 marine and brackish fish, 88 amphibians and about 2 000 species of fungi and bacteria (NEMA 2009a). Kenya is ranked third in Africa in terms of mammalian species' richness with 14 of these species being endemic to the country (IGAD 2007). The country is famous for its diverse assemblage of large mammals like the African elephant (*Loxodonta africana*), black rhino (*Diceros bicornis*), leopard (*Panthera pardus*), buffalo (*Syncerus cafer*) and African lion (*Panthera leo*) (NEMA 2009a). Protection of these will therefore to be crucial to securing livelihoods and to consequently reducing poverty levels—which currently stand at 46.6 percent of the population—by up to nine percent in order to attain social equity at the scale anticipated by the social pillar of Vision 2030.

Of the 7 000 plant species occurring in Kenya, 146 species have been assessed according to the IUCN Threat Criteria (2008) and 103 have been categorized as being threatened (critically endangered, endangered or vulnerable). Although the country's flora numbers have shot up due to the influx of invasive alien species, the invasive species pose a major threat to indigenous biodiversity. In order to effectively stem the loss of plant populations and the associated genetic diversity, the country should prioritize development of a national plant conservation strategy.

Nevertheless, much of the country's bio capital remains unknown and even with regard to the recorded species, there are information gaps on the proportion of those that are endemic, threatened, critically endangered or extinct. A contributory factor has been that most of biodiversity research is largely funded by foreign donors which retain the data at the end of the project lifecycles. The situation is exacerbated by the fact that for the last two decades, Kenya has not conducted a comprehensive biodiversity inventory to determine the number of species it hosts or the magnitude of habitat loss. The existence of such bioinformatics would facilitate informed decision making and enable the country to better carry out the niche marketing advocated by Vision 2030 that would increase domestic, regional and international tourism while easing the pressure on over-visited destinations such as Maasai Mara National Reserve, Amboseli National Park and Lake Nakuru National Park.

National forests

Kenya's forests support a large variety of floral and faunal species while the forest ecosystems provide multifarious services to a range of stakeholders. For example, forests are a major source of biomass energy, accounting for approximately 56 percent of the national energy needs. The sector also significantly contributes to foreign exchange earnings from exports of non-timber products such as honey and gum. Forests also sustain vital water catchments on which rivers, hydropower dams and underground aquifers depend for water recharge. They are also a source of herbal medicine, pharmaceutical ingredients and cultural nourishment for local communities. With a forest cover of 1.7 percent which is significantly lower than the internationally accepted threshold of 10 percent, Kenya is considered to be a low forest country. The decrease in forest cover is primarily due to encroachment, expansion of human settlements into previously forested areas, illegal logging, forest fires, agriculture and government excisions (NEMA 2009a).

However, efforts to enhance the protection of forest biodiversity through the gazettement of an additional 19 000 ha of national forest and increased tree seed production are underway. Indeed, between 2005 and 2010, the Kenya Forestry Research Institute (KEFRI) increased tree seed production by 25 percent although owing to a range of intervening factors, the effect of seed production in increasing forest cover has not yet been established (MNDV 2010). Despite these laudable developments, threats to the country's indigenous forests remain substantial. A comprehensive strategy for documenting and monitoring planted tree seedlings therefore needs to be instituted as the present approach is fragmented and uncoordinated. Chapter 5 contains a detailed discussion on forests and woodlands.

Dry lands

Dry lands cover about one third of the earth's total land surface and are the habitat and source of livelihood for about one quarter of the earth's population. They include arid, semi-arid and hyper-arid areas in which annual evapo-transpiration exceeds rainfall and in which agricultural productivity is limited by the low levels of moisture. Kenya's dry land ecosystems have immense scientific, economic and social value as they contain a variety of native animal, plant and microbial species. These species have developed unique strategies to cope with low and sporadic rainfall and the extreme temperature variability that prevails in these ecosystems. They are also highly resilient and recover quickly from disturbances such as fires, herbivore pressure and drought. These attributes and the iterative and complex interactions between desertification, climate change and biodiversity underline the significance of dry lands for the global environment's integrity (Oguge et al 2006).

About 80 percent of Kenya's land area comprises dry lands which support nearly 20 percent of the national population. The prevailing production systems are pastoralism, agro-pastoralism, irrigated agriculture and increasingly, wildlife conservation. Dry land wildlife conservation has, for instance significantly contributed to the socioeconomic development of the Samburu community at Wamba (Nikundiwe and Kabigumila 2006). Despite the significant contribution of dry lands to the country's formal and informal economies, national awareness about them remains appallingly low. As a result, the wealth of dry land biodiversity and indigenous knowledge is not well documented, and has received much less support and advocacy in conservation arenas, media and other national forums. However, this

Kenya's drylands host a variety of native animal and plant species that have adapted to the climatic extremes that prevail.

Eugene Apindi Ochieng/UNEP

Dryland biodiversity supports the livelihoods and subsistence needs of nearly 10 million people in Kenya.

may well change if the Vision 2030 goal to enhance wildlife conservation by protecting all wildlife ecosystems, including dry lands, is followed through. Chapter 6 on land contains a comprehensive discussion on the country's arid and semi-arid lands (ASALs).

Although pockets of healthy dry land biodiversity exist, biodiversity that inhabits the country's ASALs has to confront a number of threats. Key among these is land degradation which leads to the loss of a spectrum of species and genes as well as the ecological services these provide. The most threatened dry lands are located in the north eastern, upper eastern and north portions of the Rift Valley province.

The environmental degradation facing the dry lands is largely anthropogenic in nature and can be classified into demographic failure (phenomenal population growth caused by advances in medical science), information failure, market failure (mainly with regard to the livestock economy), institutional failure, and educational failure. Other challenges to dry land biodiversity relate to ecosystem and habitat degradation caused by urbanization and other forms of human settlement, commercial ranching and monocultures, industrialization, mining operations, wide scale irrigation of agricultural land, poverty-induced overexploitation of natural resources as well as disincentives and distortions in the operating environment (Jama and Zeila 2005). The synergy, magnitude and frequency of these disturbances overwhelm the traditional resilience of dry land ecosystems and constitute potentially serious threats to dry land biodiversity with the wetlands, oases and groves which form 'micro hotspots' of dry land biodiversity being particularly vulnerable.

Table 4.1: The estimated economic value of different wetland types in Africa

Type of wetland	Area ('000 ha)	Estimated economic values ('000 US $ per year)
Mangrove	3 686	84 994
Unvegetated sediment	4 632	159 118
Salt/brackish marsh	487	2 466
Freshwater marsh	48	334
Fresh water woodland	310	9 775
Total wetlands	5 477	256 687

Source: WWF 2004

Because dry lands are not well-incorporated in the conservation debate, it is difficult to provide a definitive picture of their biodiversity status and trends. The absence of comprehensive and regular inventorying of biodiversity resources has led to a dearth of information in this area. As the custodian, regional repository and reference centre for biodiversity research and heritage conservation in the country, the National Museums of Kenya (NMK) should be supported to take the lead in plugging these information gaps. More specifically, it is recommended that the issues relating to dry lands biodiversity be addressed from two parallel fronts; addressing potential and actual biodiversity loss through documentation, advocacy, capacity building and improvement of the operating environment; as well as highlighting and scaling up the success stories.

Wetlands

In Kenya, wetlands were the first ecosystems to receive international attention through the Ramsar Convention which was ratified in 1990 and Lakes Nakuru, Naivasha, Bogoria and Baringo, which cover a combined area of 1 045 km^2, have since been designated as wetlands of international importance (Ramsar sites). The process to designate Yala swamp, Tana River delta, Lakes Natron and Kiunga as Ramsar sites is currently underway. Figure 4.1 maps out the locations of the country's important wetlands.

Although wetlands are one of the most undervalued ecosystems, they provide a range of vital services. They host a range of floral and faunal species, provide food and filter water, making it safe for drinking and foster inter-communal unity. For example, in addition to the traditional uses such as farming, transportation and fishing, the Pokomo and Wardei communities use the Tana River delta to meet the communities' security and socio-cultural needs with these being an important incentive for conservation (Terer et al 2004).

The Ramsar Convention has estimated the global wetland area to be 12.8 million km^2 with their total economic value topping US$70 billion per year although the Millennium Ecosystem Assessment gave wetlands a value of US$15 trillion in 1997. Table 4.1 summarizes African wetlands by type and estimated economic values.

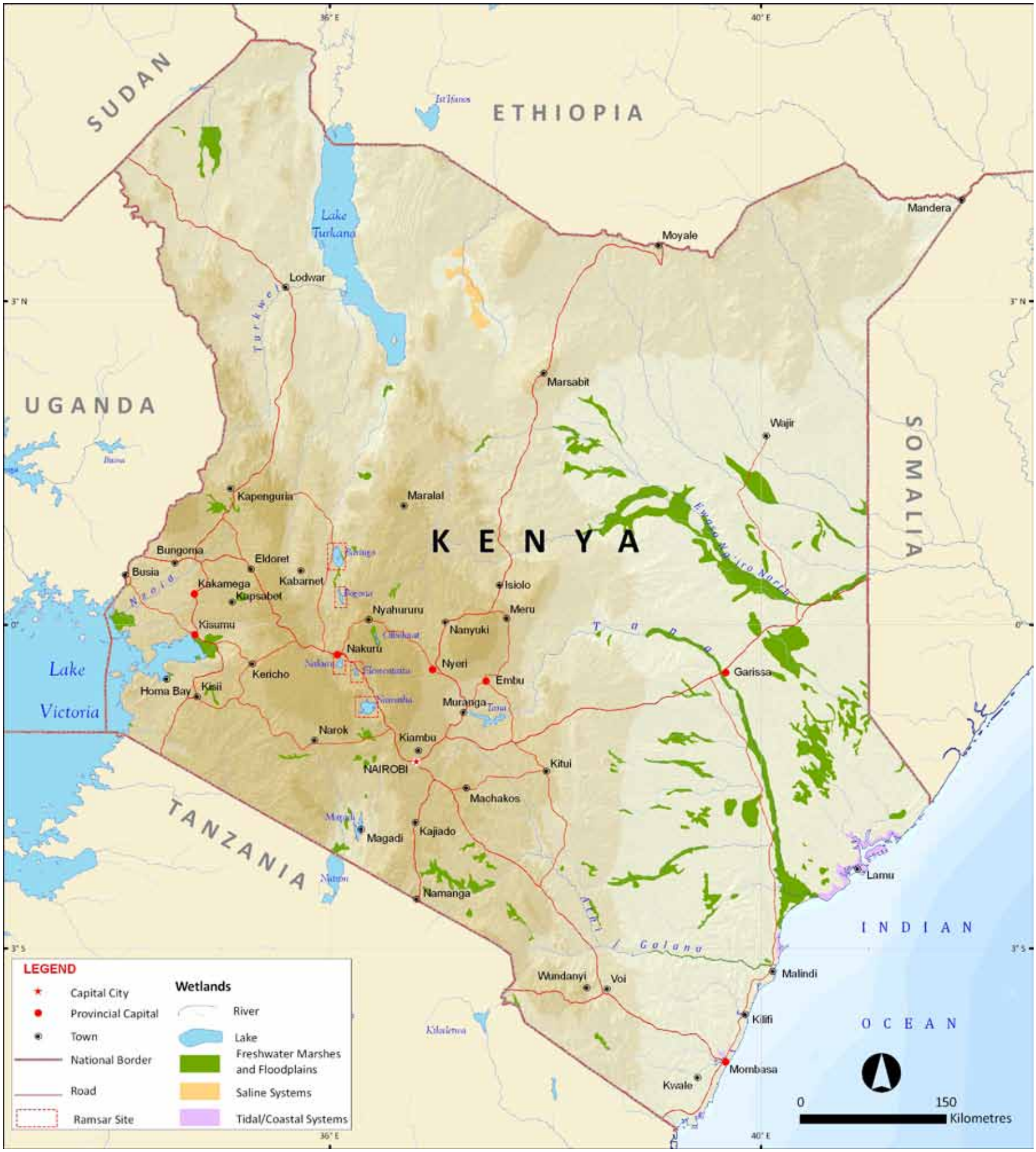


Figure 4.1: Location of Wetlands and Ramsar sites in Kenya

Source: UNEP WCMC 2006

The above estimates also include the economic value of Kenya wetlands, since the country is home to five Ramsar sites. Kenya's Shompole wetland, located south of Ewaso Ng'iro South River has an estimated economic value of US$ 2 505 463 931 per year (Ndungu 2009) broken down as follows:

- Water cleansing—US$ 2 492 051 429 per annum
- Flood and storm protection to Lake Natron (which is as a flamingo breeding site)—US$ 11 819 091 per annum
- Habitat service provision to biodiversity (wildlife, fish and birds)—US$ 1 340 978 per annum
- Nutrients storage and cycling (nitrogen only)—US$ 577 396 per annum

Due to the immense significance of wetlands, it follows that their sustainable use will be indispensible to improving Kenyans' welfare, which is the overarching goal of Vision 2030. It is therefore important to provide policy strategies to develop and support public education and awareness programmes so as to promote better understanding and appreciation of the values and multiple uses of wetlands.

Kenya's coastline has beautiful, soft and sandy beaches that are popular holiday spots.

Sea urchins are part of Kenya's coastal and marine biodiversity.

Coastal and marine biodiversity

Kenya's coastal and marine ecosystems support some of the most spectacular coral reefs, seagrass beds, mangroves, salt marshes and salt flats and exhibit remarkable levels of species richness and endemism. Coral reefs are important feeding and breeding grounds for numerous marine species, including fish and provide recreational activities for tourists (IGAD 2007) although owing to capacity constraints, the lucrative opportunities these offer for deep sea fishing and water sports remain largely untapped. The coastal and marine resources' potential for agriculture, fishing and mining is also underutilized. Given the importance of tourism and agriculture to the Kenyan economy and that these are earmarked as key growth sectors in the long term development blueprint, the optimal use of the country's attendant coastal and marine biodiversity will determine whether tourism and agriculture, complemented by coastal fishing and mining, contribute to attaining and maintaining the 10 percent annual economic growth rate envisaged by Vision 2030. Coastal and marine resources are discussed in greater detail in Chapter 7.

Species biodiversity

Large mammals

This section discusses the state and trends of large mammals in selected protected areas namely; the Meru Conservation Area, Amboseli National Park and Maasai Mara National Reserve.

Meru Conservation Area

The Meru Conservation Area covers an estimated area of about 4 008 km^2. It includes Meru and Kora National Parks, Bisinadi and Mwingi (North Kitui) National Reserves, Rahole Game Reserve and the northern grazing area. According to the 2007 wet season aerial count for large mammals in the Meru Conservation Area, there was a general increase in the number of mammals in the Meru Conservation Area compared to the 2006 count. There was also a notable increase in the population of large mammals like the giraffe, buffalo, eland, Burchell zebra, lesser Kudu, impala, Grants gazelle, gerenuk and elephant with the latter growing from 504 in 2006 to 747 in 2007.

Amboseli National Park

Amboseli National Park is a wooded savannah ecosystem that is rich in both flora and fauna. It covers an area of 392 km^2 and is part of the larger 5 000 km^2 Amboseli savannah ecosystem. The ground game count which was conducted in the February-April 2010 wet season and July-September 2010 dry season showed a marked decline in the large mammal population and trends.

The Giraffe population is on the rise in the Meru Conservation Area.

Eugene Apindi Ochieng/UNEP

Figure 4.2: Distribution of Grevy's Zebra in the Greater Horn of Africa Source: KWS 2010

Animal	2007	2009	2010
Buffalo	730	320	179
Zebra	7 579	2 686	2 052
Wildebeest	12 974	5 435	1 141
Giraffe	56	55	81
Water buck	69	54	18

Table 4.2: Ground counts of selected large mammals in 2007, 2009 and 2010 Source: KWS 2010

The total number of individuals counted during the September 2010 exercise was 6 205 compared to 11 148 counted in September 2009 and 25 918 in September 2007. During the 2010 counts, wildebeest, buffalo and zebra numbers showed a sharp decrease from the previous counts. For instance between September 2007 and September 2010, buffalo populations decreased by 75 percent, zebras by 73 percent, wildebeest by 91 percent while waterbuck decreased by 74 percent. Table 4.2 shows the ground counts of selected large mammals while Figures 4.2 and 4.3 show the trends in the distribution and number of Grevy's zebra respectively. The plummeting wildlife population in the park is largely attributable to the severe drought that affected the entire Amboseli ecosystem. However, a few large mammals, such as the giraffe, weathered the climatic trauma to increase by 45 percent between 2007 and 2010. Nevertheless, the general declines in Amboseli National Park—which is one of only

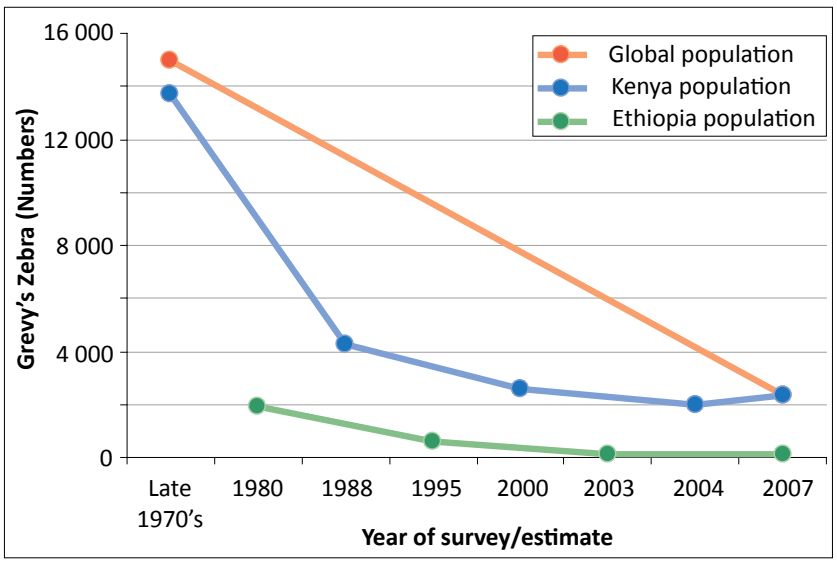


Figure 4.3: Trend in distribution and numbers of Grevy's Zebra in Kenya Source: KWS 2010

three premium wildlife parks in the country —highlights the need to, in line with the aspirations set out in Vision 2030, diversify the tourism product by tapping the underutilized potentials of the wildlife-sensitive eco-tourism and the wildlife-neutral conference and business tourism.

Maasai Mara National Reserve

The Kenyan portion of the Serengeti-Mara ecosystem which covers an area of 4 761km^2 encompasses the Maasai Mara National Reserve—regarded as the crown jewel of the country's wildlife parks—and the adjacent Lemek, Koyiaki and Siana Group Ranches.

According to the 2010 aerial count of large herbivores, the ecosystem is home to 3 162 elephants, 4 649 buffaloes, 1 619 giraffes and 1 283 elands, 15 031 impala, 5 133 Grant's gazelle, 14 414 Thomson's gazelle, 36 487 zebra and 18 825 wildebeest. The elephant and buffalo population increased by 43.5 and 2.7 percent respectively over the last 3 years, possibly due to improved habitat protection by the local communities and government. The declines witnessed for other wildlife species have been primarily attributed to predation, poaching, migration, human-wildlife conflict, loss of habitat due to land fragmentation and unfavorable weather conditions.

Bird biodiversity

Kenya is home to 61 Important Bird Areas (IBAs) dispersed over 22 forests (20 of which lie in protected areas); 18 wetlands (5 of which are protected); 12 arid and semi arid areas (7 of which are protected); 6 moist grasslands (3 of which are protected); and 3 unprotected sites. 46 of these IBAs shelter globally threatened bird species, 29 host range-restricted birds, 32 contain biome-restricted bird species, and 13 IBAs hold globally important congregations of birds (Bennun and Njoroge 1999). Some of the birds found in these IBAs include the Lesser Flamingo whose principal breeding site in East Africa is Lake Natron. Other large birds that abound in Kenya are the ostrich, Kori bustard, Crowned cranes, Goliath heron, Saddle-billed stock, Spoon-billed stock, African fish eagle and the Lammergeyer (NMK 2010). Figure 4.4 shows the important bird areas in Kenya.

Birds play an important role in Kenyans' social, cultural and economic life. Many of the species aesthetically enrich landscapes, attracting international ornithologists. Bird watching, photography and art earn the country revenue some of which filters through to the

The Maasai Mara National Reserve is Kenya's preeminent wildlife park.

Michael Mwangi

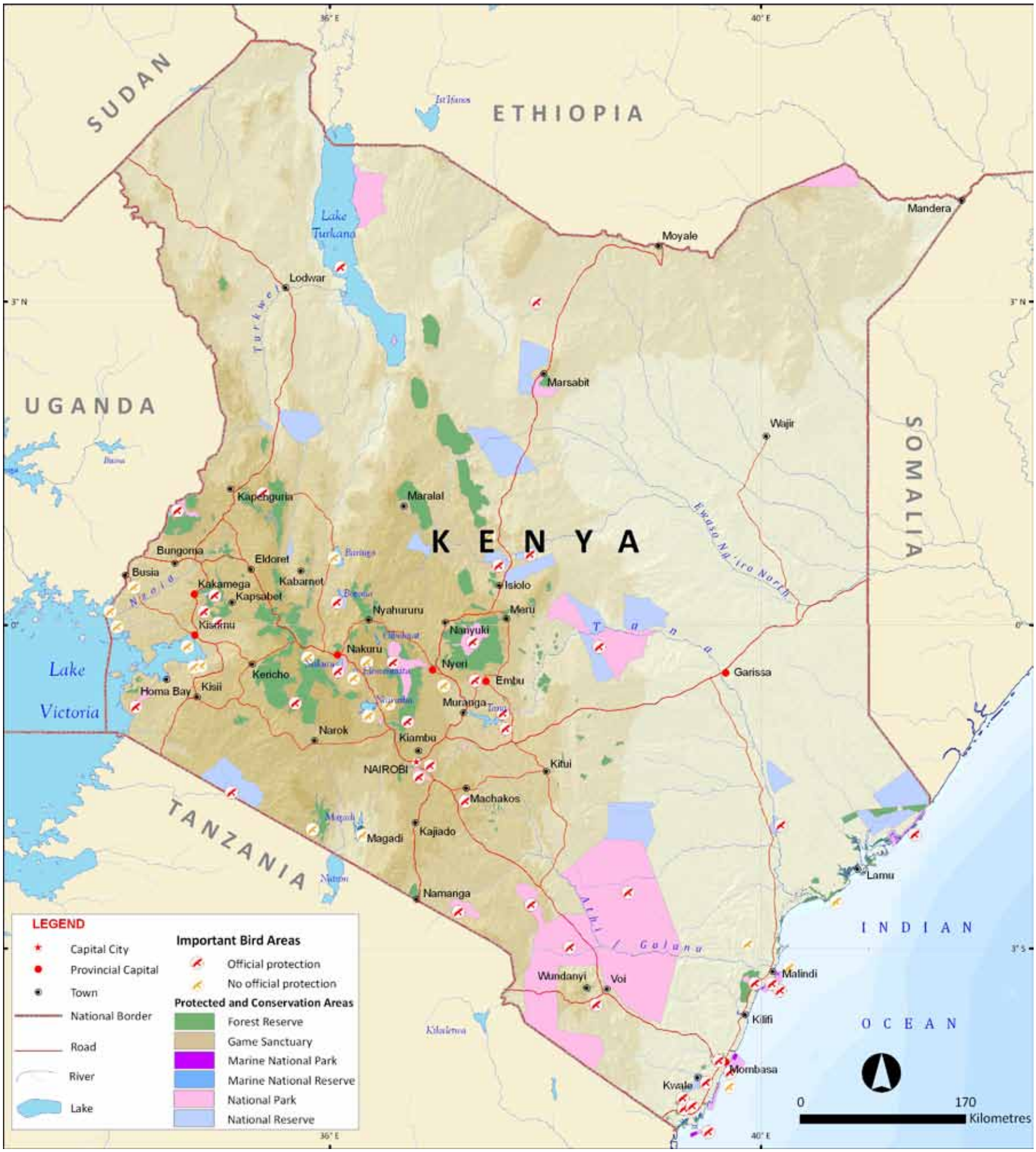


Figure 4.4: Kenya's Important Bird Areas

Source: KWS 2010

grassroots Kenyans who are employed as driver-guides and at various levels in the country's burgeoning hotels and lodges. Other birds, such as the ostrich, are an important source of livelihood with ostrich farms abounding in Kajiado, Naivasha, Elementaita and Laikipia. Individuals are also increasingly domesticating wild birds such as the quail and duck as these are sources of both food and income.

Policy and legislative implementation failures resulting from weak institutional capacity, inadequate human and financial resources, encroachment into bird habitats, pollution, and climate change-induced habitat loss however continue to impede bird conservation in Kenya. An assessment of some of Kenya's IBAs notably; Yala swamp, Kianyaga valleys and Busia grasslands reveals that some sites deteriorated during 2009 due to drought and overexploitation. Plans to convert the Dakatcha woodlands, Tana River delta and Yala swamp into large-scale food and bio-fuel plantations pose additional threats to these IBAs. Further, diversion of water from Lake Natron which is designated as a Global Biodiversity Hotpoint because it is the only known breeding spot of the Lesser flamingo is threatening the very existence of these avian species.

Birds are an important aspect of biodiversity in Kenya and efforts to address threats to their survival should be intensified. Community awareness should be enhanced to increase public participation in bird

Fresh Water Fish	2005		2006		2007		2008		2009	
	Quantity Metric ton	Value to Fishermen KShs '000	Quantity Metric ton	Value to Fishermen KShs '000	Quantity Metric ton	Value to Fishermen KShs '000	Quantity Metric ton	Value to Fishermen KShs '000	Quantity Metric ton	Value to Fishermen KShs '000
Lake Victoria	133 526	6 948 611	143 908	7 766 074	117 231	7 451 781	111 369	9 429 765	120 231	9 834 716
Turkana	2 493	99 245	4 559	120 783	5 122	245 366	8 070	229 171	9 118	288 545
Baringo	43	2 285	68	2 079	173	4 872	262	10 065	211	9 682
Naivasha – Commercial	108	5 738	189	6 396	203	12 416	225	13 384	197	12 998
Jipe	74	3 932	109	3 998	96	5 636	109	6 740	89	5 867
Rivers and Dams	950	50 474	1 024	52 447	1 112	23 455	1 302	62 205	974	62 515
Fish Farming	1 047	55 627	1 012	58 577	4 245	226 259	4 452	917 860	4 897	971 120
Others	785	41 707	842	45 891	706	13 842	883	48 729	812	47 723
Total	**139 026**	**7 207 619**	**151 711**	**8 070 557**	**128 888**	**7 983 627**	**126 672**	**10 717 649**	**136 529**	**11 233 166**

Table 4.3: Quantity and value of fish landed by freshwater body, 2005-2009

Source: Economic Survey 2010

Marine Fish by District	2005		2006		2007		2008		2009	
	Quantity Metric ton	Value to Fishermen KShs '000	Quantity Metric ton	Value to Fishermen KShs '000	Quantity Metric ton	Value to Fishermen KShs '000	Quantity Metric ton	Value to Fishermen KShs '000	Quantity Metric ton	Value to Fishermen KShs '000
Lamu	1 309	77 077	1 309	76 515	1 801	80 654	2 028	92 920	2 037	94 123
Tana River	57	3 117	55	3 171	163	11 296	89	5 593	136	6 893
Malindi	1 132	55 515	1 192	60 527	1 160	84 419	1 345	113 667	1 367	122 007
Kilifi	434	20 746	435	22 746	729	57 539	817	66 647	890	69 524
Mombasa	1 221	66 819	1 225	65 428	680	66 457	676	76 086	712	81 068
Kwale	1 709	82 597	1 750	84 011	1 822	121 681	2 606	186 031	2 669	199 176
Total	**5 862**	**305 871**	**6 023**	**334 624**	**6 355**	**422 046**	**7 561**	**540 954**	**7 811**	**572 791**

Table 4.4: Quantity and value of marine fish landed by district, 2005-2009

Source: Economic Survey 2010

conservation. National and regional partnerships revolving around international obligations should be scaled up for better management of the country's IBAs. Institutions responsible for bird biodiversity should diversify their bird counts to better enable them to identify emerging trends well before these become crises. The above measures would, of course, necessitate the scaling up of bird conservation financing, particularly in the IBAs.

Fish biodiversity

Fishery production in Kenya mainly comes from the country's freshwater bodies and the Indian Ocean which accounts for the majority of the marine fish and aquaculture. The main fisheries resources are Lake Victoria and the western Indian Ocean although these are complemented by the country's major rivers, other freshwater lakes, dams and ponds. At 96 percent in 2008, capture fisheries accounted for the bulk of the national nominal production. Although fish landed increased from 136 355 metric tonnes in 2007 to 145 532 metric tonnes in 2009, it is still considerably lower than the 158 670 of the fish landed in 2006 (GoK 2010). With 120 231 metric tonnes of fish landed in 2009, which represented 82.6 percent of the national catch and 88.1 percent of the freshwater catch, Lake Victoria accounts for the largest proportion of the fisheries sub-sector and its role in meeting the protein and income needs of adjacent communities cannot be overemphasized as this has positive effects for the attainment of the Vision 2030 economic and social pillar goals. Table 4.3 shows the fish production by freshwater body between 2005 and 2009.

Marine fisheries have the potential to significantly contribute to the national economy through employment creation, foreign exchange earnings, poverty reduction and food security but this potential is yet to be realized particularly in the Exclusive Economic Zone (EEZ). Artisanal fishermen predominantly fish in the inshore areas within the reef ecosystem because they lack the capacity to venture offshore to exploit the fisheries resources in the EEZ. Aquatic ecosystems continue to be heavily exploited, imperilling the sustainability of food supplies and biodiversity. So even though the marine fish catch has been rising as detailed in Table 4.4, the underutilization of the EEZ highlights the huge untapped potential in the sub-sector. Any additional licensing of fishing activities in Kenya's EEZ waters must however be accompanied by strong monitoring and surveillance measures to prevent overexploitation and use of abusive fishing practises.

The sustainability of the country's fisheries resources depends on ecological processes that enable reproduction of different fish species and renewal of water, organic matter and nutrients in the freshwater and marine ecosystems. Anthropological activities have the potential to negatively impact the ecological balance in Kenya's water bodies as happened in Lake Naivasha with the introduction of

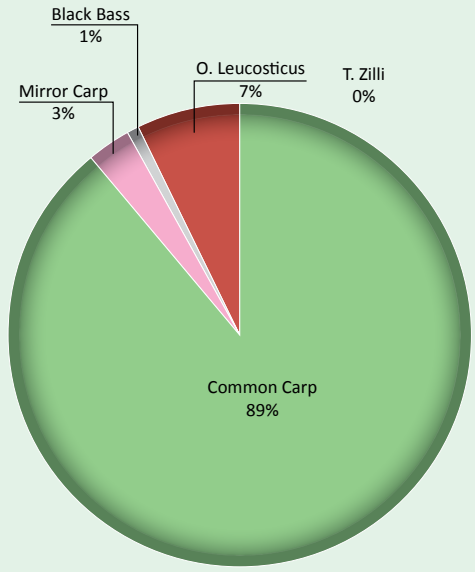
Table 4.5: Threatened species of higher plants, mammals, birds, reptiles, amphibians and fish in Kenya

Source: MOPND 2010

Species	Year	Total known	Year	Threatened species (Number)
Higher plants	1992-2002	6 506	2002	98
Mammals	1992-2002	359	2002	51
Breeding birds	1992-2002	344	2002	24
Reptiles	1992-2002	261	2002	5
Amphibians	1992-2002	63	2002	X
Fish	1992-2002	314	1992-2002	18

Box 4.1: Human activities and the ecological balance in Lake Naivasha

Lake Naivasha supports a small commercial fishery based on three fin-fish species and one crustacean species which include Oreochromis leucostictus (*Tilapia zillii*), *Microptrerus salmoides* (black bass), *Cyprinus carpio* (common carp) and *Procambrus clarkii* (crayfish) as the only crustacean. *Barbus amphigramma* and *Lebistes reticulata* (guppy) are also present in the fish population of Lake Naivasha but are not commercially exploited. The recent accidental introduction of Common carp (*Cyprinus carpio*) and mirror carp has created a shift in lake fish production. The Common carp is believed to have come from fish farms in Nyandarua highlands during the 1998-1999 El Niño period. According to the Fisheries Annual Statistical Bulletin 2009 it accounted for over 90 percent of the total fish catch of Lake Naivasha. It is imperative for government and research institutions to understand the effect of the Common carp on the other fish species in the lake's ecosystem.



Percentage of species composition of Lake Naivasha catches in 2008

Fish catches from Lake Naivasha, 2000-2009

Source: DFO 2010

Species	Trends in fish catches by weight									
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Common carp	-	-	910.0	5 858.0	45 912.5	100 312.0	178 629.5	191 745.5	200 868.5	655 453.5
Mirror carp	-	-	-	-	-	-	-	6 784.5	7 053.5	22 418.5
Black bass	13 742.0	-	25 138.0	7 315.0	4 344.5	9 184.5	8 363.5	4 719.0	1 924.0	1 882.5
Oreochromis leucostictus	363 445.0	-	1 734.0	20 091.0	3 197.5	1 880.5	222.5	127.5	14 828.5	341.5
Tilapia zilli	865.0	-	20 717.0	5 428.0	1 400.0	485.5	31.5	69.5	119.0	4.5
Total finned fish	384 735.0	-	91 178.0	38 690.0	60 384.5	111 851.5	192 097.5	202 933.0	222 793.5	680 095
Crayfish	6 885.0	-	35 316.0	No data	5 015.0	No data	555.0	2 153.0	2 149.0	No data

Common name	Scientific name	Habitat
Black rhinoceros	Diceros bicornis	Woodlands
White rhino	Ceratotherium simum simum	Wooded grassland
Hirola	Beatragus hunter	Woodlands
Tana crested mangabey	Cercocebus galeritus	Gallery forest
Roan antelope	Hippotragus equines	Wooded grasslands
Sable antelope	Hippotragus niger	Upland grasslands
Grevy's zebra	Equus grevyi	Wooded grasslands
African elephant	Loxodonta Africana	Woodlands and forests
Eastern bongo	Tragelaphus eurycerus isaaci	Montane Forests
African lion	Panthera leo	Wooded grasslands
Leopard	Panthera pardus	Woodlands
Cheetah	Acinonyx jubatus	Open grasslands
Sitatunga	Tragelaphus spekii	Freshwater swamps
Rothschild's giraffe	Giraffacamelopardalis rothschildi	Woodlands

Table 4.6: Threatened mammal species and their habitats in Kenya

Source: MOPND 2010

the Common carp. This is described in Box 4.1. and further elaborated on in Chapter 9.

In order to increase available fish stocks, efforts to eliminate use of destructive fishing gear and methods need to be scaled up. In addition, fishing communities which depend on overexploited resources such as Lake Naivasha need to be provided with alternative livelihood options in order to reduce pressure on the fisheries resources. Further, freshwater and marine fish breeding programmes need to be intensified. It is particularly important to encourage marine fish production which amounted to only 7 811 metric tonnes in 2009 (GoK 2010) with the total area under aquaculture standing at a mere 722 ha. As the area suitable for fish farming in Kenya is over 1.14 million ha, if this is fully utilized, it has the potential to produce up to 11 million metric tonnes per annum, which would accelerate the delivery of the economic, social and political goals set forth in Vision 2030. This would, in turn create enormous employment opportunities for artisanal fishermen and spur the growth of fish feed manufacturing, processing, trading and exporting enterprises.

Threatened ecosystem and species biodiversity

Threatened species are those classified by the IUCN as endangered, vulnerable, rare, indeterminate or insufficiently known. In Kenya, KWS has documented approximately 50 endangered or threatened ecosystems of national and global importance. There are major concerns on five of them due to their critical contribution to the national economy and community livelihoods. These are the Maasai Mara National Reserve, Lake Naivasha and the Nairobi, Lake Nakuru and Tsavo National Parks. A number of water towers and associated ecosystems have also been earmarked

The weaver bird, one of the avian species that abounds in Kenya, derives its name from its intricately woven nests.

for conservation. These include Mount Kenya, Aberdare, Mount Elgon, Mau Forest Complex, Cherangany Forests, Shimba Hills, Chyulu Hills, Taita Hills, Mount Marsabit, Matthews Range, Mua Hills, Loita Hills and Ndundori Hills. The other important water catchments are forest reserves at Kibwezi, Ngong, Karura, Kakamega, Bonjoge as well as Ol Donyo Sabuk National Park. To address these issues, several national parks are developing environmental management plans although the implementation of these is hampered by stakeholder conflicts. Moreover, there is no effective mechanism for enforcing compliance with these plans.

The threat to ecosystems obviously impacts the species therein. The number of large mammal species and genetic biodiversity are declining in both distribution and abundance. 51 mammals, some of which are found in Kenya, have been identified as endangered or threatened (IUCN 2002). Table 4.5 provides a summary of the known threatened plant and major animals groups in Kenya while Table 4.6 lists some of the threatened mammal species and their habitats in Kenya.

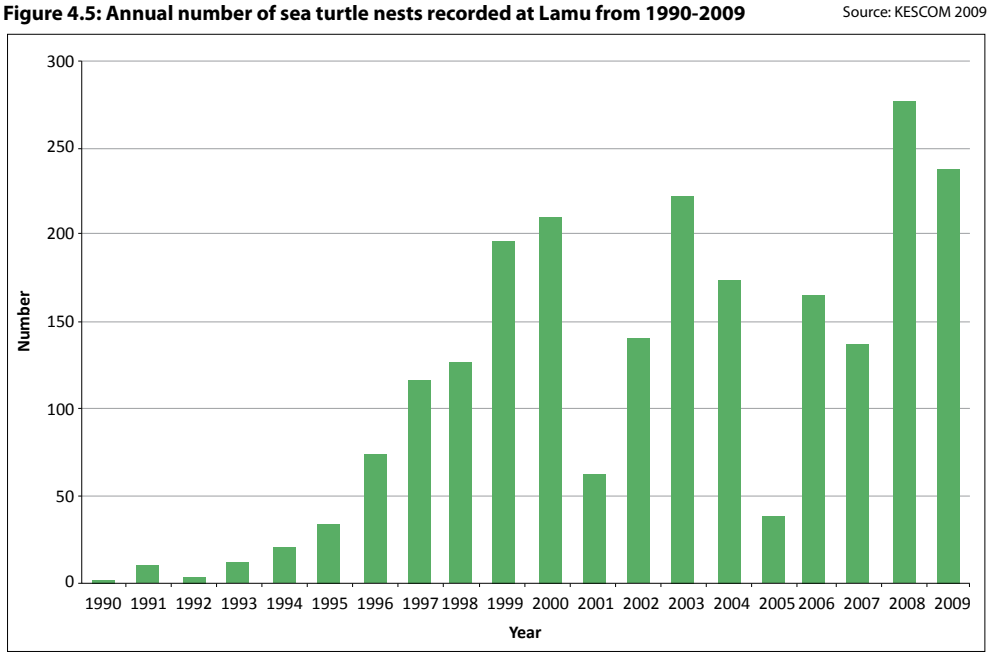
According to data obtained from KWS and Nature Kenya, 27 breeding birds were identified as endangered or threatened in 2010. The Taita apalis (*Apalis fuscigularis*) and Taita thrush (*Turdus helleri*) which are endemic to the upland forests of the Taita Hills in south-east Kenya are critically endangered. Other endangered and threatened breeding birds found in the country are the Madagascar pond-heron (*Ardeola idae*); Saker falcon (*Falco cherrug*); Egyptian vulture (*Neophron percnopterus*); Sokoke scops-owl (*Otus ireneae*); Aberdare cisticola (*Cisticola aberdare*) and the Basra reed-warbler (*Acrocephalus griseldis*).

The endangered and threatened amphibians and reptiles in Kenya include:

- Du toit's torrent frog (*Petropedetes dutoiti*)
- Shimba hills banana frog (*Afrixalus sylvaticus*)
- Shimba hills reed frog (*Hyperolius rubrovermiculatus*)
- Forest frog (*Afrixalus sylvaticus*)
- Hawksbill turtle (*Eretmochelys imbricata*)
- Green sea turtle (*Chelonia mydas*)
- Olive ridley (*Lepidochelys olivacea*); and the
- Rock python (*Python sebae*).

The programmes initiated for conservation of sea turtles at the Kenyan coast are predicated on the grim reality that the Green sea turtle and Hawksbill Turtle, which nest in the Lamu archipelego are two of the world's most endangered sea turtles. The most recent of these programmes is the launch of the country's national sea turtle conservation strategy in March 2011 (KWS 2011). It provides a coordinated framework for the conservation of sea turtles and their habitats in Kenya using a raft of tools that includes advocacy, education, public awareness, communication, targeted research and monitoring as well addressing the threats to their survival. This will likely add momentum to initiatives such as the Kenya Sea Turtle Conservation and Management Trust (KESCOM) which, cognizant of the importance of community participation in stemming the wanton killing of turtles and the destruction of their nesting habitats, was formed to support sea turtle conservation in collaboration with local communities at the coast. The conservation strategy is also likely to boost the efforts of the Lamu Marine Conservation Trust (LAMCOT), a community based organization whose primary objective is to support local community actions in sustainable management of coastal ecosystems. As illustrated in Figure 4.5, LAMCOT's efforts which include physically guarding sea turtle nests, offering

Figure 4.5: Annual number of sea turtle nests recorded at Lamu from 1990-2009 Source: KESCOM 2009



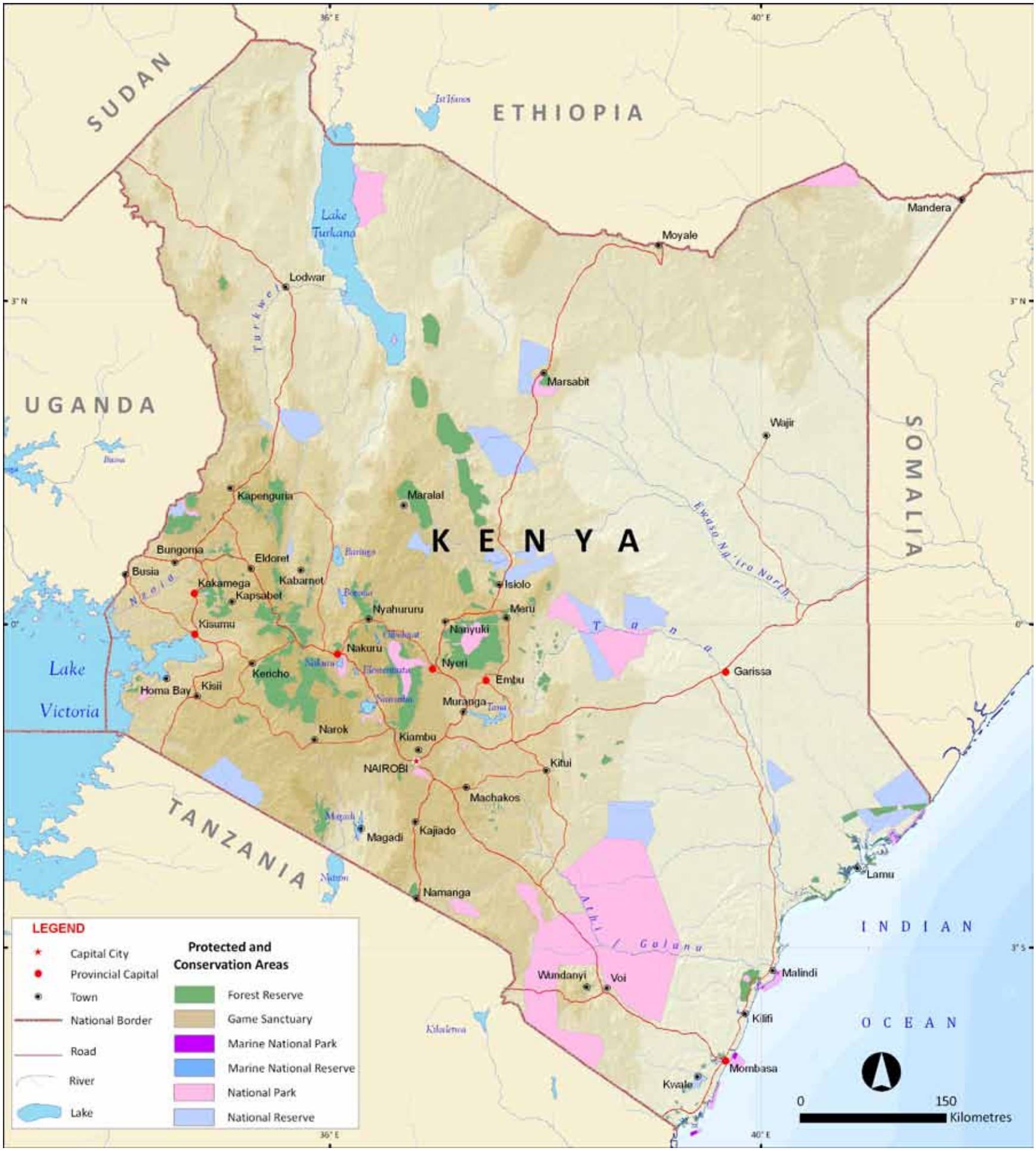
incentives to local fishermen to reduce turtle by-catch, educating school children and the general public on the value of turtles as well as tagging turtles and monitoring their movements, have resulted in the steady increase of successful sea turtle nesting.

In 2010, KWS classified 26 fish species as threatened with local extinction. The species include Singidia tilapia (*Oreochromis esculentus*); Lake Chala tilapia (*Oreochromis hunteri*); Jipe tilapia (*Oreochromis jipe*); Victoria tilapia (*Oreochromis variabilis*); Rainbow sheller (*Ptyochromis sp.*); Lake Victoria deepwater catfish (*Xenoclarias eupogon*); Montane dancing-jewel (*Platycypha amboniensis*); Magadi tilapia (*Alcolapia alcalicus*); Giant wrasse (*Cheilinus undulatus*); and Victoria stonebasher (*Marcusenius victoriae*). Because of inadequate data, many species have not been evaluated and hence threatened species could be as high as 71 (Froese and Pauly 2008) and probably include *Haplochromis ishmaeli* which was previously recorded in Lake Victoria. The main threat to these species is predation by Nile Perch, hybridization due to decreased water transparency. The latter is attributed to eutrophication and erosion which lead to increased sedimentation and runoff which in turn interfere with the fish species' mate recognition visual cues (Witte et al 2010).

The threatened plant species in Kenya include the Bauhinia mombassae, Brucea macrocarpa, Combretum tennuipetiolatum, Euphorbia tanaensis, Sorindeia, Voi cycad (*Encephalartos kisambo*); East African sandalwood (*Osyris lanceolata*); Red stinkwood (*Prunus*

Figure 4.6: Protected areas in Kenya

Source: KWS 2010



africana); Meru oak (*Vitex keniensis*); Camphor (*Ocotea kenyensis*); Parasol tree (*Polyscias kikuyuensis*); Rat aloe (*Aloe ballyi*); and the Tana river poplar (*Populus ilicifolia*) (KWS 2010). Combretum tenuipetiolatum, a small tree found in the Rabai forest, is currently listed as 'critically endangered.' *Bauhinia mombassae*, another tree found in rocky valley along Mwache River in the Shimba Hills National Reserve, is under threat from habitat destruction and intrusion by elephants. *Brucea macrocarpa*, a shrub only found in Kenya's central swampy areas and riverines of Kamiti, Thika Falls, Rojwero Swamp and Kiambu is also fast disappearing because of human population growth and agricultural development in the area.

Euphorbia tanaensis is a critically endangered plant found in the Witu Forest Reserve where there are only 20 mature plants according to the IUCN Red List of Threatened Species (IUCN 2009). Although the forest is a reserve and is therefore legally protected, this has not accorded adequate protection to this and other endangered tree species that it hosts.

The threats to ecosystem and floral and faunal species' biodiversity need to be urgently attenuated because they are likely to undermine the attainment of Vision 2030, which recognizes tourism as a major driver of economic growth and is central to the economic empowerment of the country's impoverished population segments.

Protected areas in Kenya

Kenya has various conservation systems which include national parks, national reserves, conservancies, Ramsar sites, biosphere reserves and world heritage sites. The area covered by protected areas grew from 12.1 percent in 1990 to 12.7 percent in 2007 (UNEP 2009). The national parks and reserves are strategically located in terrestrial and aquatic ecosystems that teem with wildlife and are globally recognized as havens for biodiversity protection. The biodiversity protection accorded by these national parks and reserves is complemented by private conservancies. Table 4.7 and Figure 4.6 show the surface areas covered by the breadth of protected area categories in the country.

However the biodiversity in the country's protected areas still has to grapple with a number of threats principally due to policy and legislation implementation failures which are themselves attributable to lack of sufficient human and financial capacity and political will. These problems are compounded by fragmented bioinformatics data and weak research links (ESEA 2010).

Protected Areas	Area Covered (km^2)	Numbers
National Parks	30,348.3	24
National Reserves	16,478.4	27
Marine National Parks	70.1	4
Marine National Reserves	706.0	6
National sanctuaries	71.3	4
Ramsar sites	286.0	5

Table 4.7: Area covered by protected area systems in Kenya Source: KWS 2010

Biodiversity and livelihoods

Biodiversity performs multiple roles in the daily lives of people through the supply of ecosystem services, food security, tourism, wealth creation and aiding a range of cultural services. As such, the value of Kenya's biodiversity resources cuts across the economic and social and ultimately, the political pillars of Vision 2030.

Box 4.2: Opportunities provided by biodiversity

- Employment
- Livelihoods and income
- Food
- Herbal and Western medicine
- Raw materials, industry
- Recreation, tourism and filming industry
- Research, education and knowledge
- Religious rites and transmission of cultural values
- Sustainability of gene pools and food chains

Ecosystem goods and services

Biodiversity supports agriculture by regulating and supporting services through soil formation, the nutrient cycle and pollination. People are dependent on biodiversity either directly or indirectly, for environmental goods and services. Direct benefits include food, medicine, honey, forage, vegetables, hides, skins and other raw materials which play a vital role in the lives of poor people in rural and remote places (UNEP 2007). Bees, for instance, provide honey and beeswax and pollinate crops and wild plants. According to the National Beekeeping Station, honey production increased from 24 940 to 27 000 metric tonnes between 2001 and 2007. However in 2008, it slumped to 14 000 tonnes mainly because of drought. With a kilogram of crude honey currently fetching KSh 200 (MLFD 2010), beekeeping has the potential to lift many Kenyans living in the dry lands out of poverty, which would go a long way in meeting the Vision 2030 overarching goal to improve the welfare of all Kenyans.

Indirect benefits that flow from biodiversity's environmental services include employment, income, nitrogen fixation, natural pollination, maintenance of water cycles, regulation of climate, photosynthetic fixation, protection of soil, storage and cycling of essential nutrients as well as absorption and breakdown of pollutants (Kimenju et al 2010). Because the latter eight are indispensable to sustaining human, wildlife and crop life, biodiversity's integrity is central to increasing agricultural productivity and further growing the tourism sector in order to deliver the projected 10 percent annual economic growth rate. The benefits of these are expected to percolate through to the social and political pillars of Vision 2030, reducing inequalities and fostering national and social cohesion.

Kenya's forests play a vital role in rural livelihoods by providing food and energy for domestic consumption, and watershed regulation.

Many of the hotels along the Kenyan coast are constructed using local materials in order to promote the local culture and blend in with the environment.

Hippos plunge into a pool to cool off.

It is estimated that 80 percent of the country's population uses biomass energy while hydro electric power production heavily relies on the availability of water (NEMA 2009b) that emanates from the country's forests, particularly the five water towers.

The tourist industry which largely depends on the country's biodiversity wealth is a major contributor to Kenya's GDP and is the leading foreign exchange earner. Differentiation of the safari product, encouraging the development of resort cities and of high value niche products such as cultural, eco-sports and water-based tourism are some of the trajectories under which the sector can grow in order to help deliver the 10 percent annual growth rate anticipated by Vision 2030.

The fisheries sector plays an important role in the national economy and contributed 0.6 percent to Kenya's GDP in 2010, up from the 0.4 percent contribution registered in the 2006 to 2009 period (GoK 2010). There is potential for this percentage to grow if aquaculture and coastal fisheries are fully developed and utilized, if value addition at the various stages of the supply chain is scaled up and post harvest losses are minimized. This is an important sub-sector because it supports about 80 000 fishermen directly and nearly 800 000 individuals (processors, traders and other service providers) indirectly (MFD 2008).

Threats to biodiversity

Human-wildlife conflict

As is the case in many parts of Africa, Kenya's protected areas were largely established by the colonial government for purposes of game hunting, photography or securing valuable mineral and timber resources. Many of the local communities were alienated because these protected areas were established without consulting them. In addition, traditional livelihood activities such as honey and wood fuel collection in the protected areas were proscribed, reducing local communities' access to natural resources and exacerbating poverty. The situation has since been compounded by inadequate public participation in wildlife park management and biodiversity conservation.

In addition, while the costs associated with protected areas are largely borne by neighbouring communities, the benefits are universally shared, which highlights the inherent inequity in cost and benefit sharing. Further, no due attention is paid to the interlinkages between biodiversity and the local people yet these bear the brunt of natural resources' and ecosystems' deterioration. There is therefore need to maintain interactive biodiversity governance dialogue and to adequately address the aspect of biodiversity benefit sharing.

Population increase and development

Kenya's rapidly rising population is causing changes in land use patterns which in turn drive biodiversity loss. It is associated with food shortages, energy insecurity and the consequent unsustainable harvesting of natural resources. For example, to supply the increasing demand for food, wetlands are being converted into agricultural land at an alarming rate. The rising demand for construction materials from wetlands is also triggering unsustainable harvesting levels and compromising the ability of wetlands to provide vital ecosystem services.

To supply the country's growing water and hydropower needs, rivers such as Tana and Kerio have been dammed although the building of impoundments on river valleys affects the diversity of ecosystems and results in reduced water flows. Less water is therefore available for domestic, agricultural and industrial use and leads to loss of pasture for livestock and wildlife. This is especially important given that over a million farmers, fishermen, fishmongers and nomadic pastoralists depend on the flooding regime of the country's rivers for their livelihoods. An estimated 2.5 million livestock heads and millions of biodiversity lives rely on the Tana's floodplain grasslands and water bodies for dry season pasture and water (IUCN 2003). A rising population is therefore likely to increase pressure on these natural resources, with adverse consequences for the country's biodiversity.

Box 4.3: Pollution-related biodiversity loss in Lake Nakuru National Park

Lake Nakuru and the area surrounding it comprise Lake Nakuru National Park. It is the second most important National Park in Kenya in terms of earnings from tourism. The national park is a UNESCO designated World Heritage site, Kenya's first Ramsar site, and also Africa's first bird sanctuary (Odada et al. 2005).

Noise, garbage and other hazardous wastes generated in tourist hotels are a source of environmental pollution, especially when they are dumped into poorly managed landfills or creeks. For instance, the raw sewage that is pumped into the lake has substantially damaged water quality, led to the mass death of the Lesser Flamingo and instigated the species' migration to Lake Bogoria. The bird deaths have been attributed to poisoning by heavy metals, pesticides, and algal toxins, bacterial infection, and malnutrition (Ndetei and Muhandiki 2005). Because the Lesser flamingo is a major tourist attraction especially for ornithologists, it is a significant contributor to the local and national economies. There is therefore urgent need for the Ministry of Environment and Natural Resources and KWS to redirect the flow of sewage (Ikiara and Okech 2002) and address the other problems cited above.

Buffaloes, flamingoes and pelicans in Lake Nakuru National Park.

Pollution

Uncontrolled domestic and industrial discharges, pollution and contamination are major threats to the country's biodiversity. In recent years, the Great Rift Valley lakes and coastal areas have experienced heavy pollution loads emanating from increased agricultural, industrial and municipal waste discharge. Wetlands are also used as waste dumps for commercial, municipal and institutional wastes, threatening their ecological integrity. Increased nutrient loads have led to eutrophication and frequent algal blooms in the wetlands near major settlement, industrial and agricultural areas.

Poor agricultural practises along the Sabaki/Tana/Athi River basin complex, such as cultivation close to the river banks has increased soil erosion, the levels of suspended sediment in the rivers and agricultural chemical run-off. These and other contaminants penetrate into organisms' biological systems and then get magnified and modified (through biomagnifications and bioaccumulation processes) causing irreversible damage to species. This is reported to be happening to the aquatic biodiversity of Lake Naivasha which is continually contaminated by sewage and the discharge from the flower farms. Box 4.3 highlights the effects of pollution in the Lake Nakuru National Park.

Land-based pollution alters ecosystems' productive systems and results in biodiversity loss and adversely affects human health. For example, increased human activity in the dry lands, combined with high velocity winds has increased the prevalence of particulate matter in the air, negatively affecting the human and biodiversity health (Jama and Zeila 2005).

Water pollution leads to water eutrophication and algal blooms which in turn reduce fish catches.

Habitat loss

Habitat loss and the subsequent alteration of ecosystems' composition are among the greatest threats to biodiversity. Assemblages of species and their interactions with the environment are critical for maintaining species diversity and for their evolution and survival. The continued wanton destruction of habitats is an indicator of institutional failure and lacklustre commitment to protecting biodiversity. This is aggravated by lack of a comprehensive national biodiversity inventory and surveillance mechanisms and the absence of synergies among national biodiversity institutions that are integral to synthesizing critical biodiversity issues through joint initiatives.

Biopiracy

Biopiracy is a re-emerging issue which dates back to the colonial period. It has been exacerbated by lack of appropriate legal and regulatory mechanisms such as strict patent laws that would control the exploitation of these renewable resources (Mwandambo 2010, Othieno 2010). As a result of these vacuums, valuable genetic materials are continually exported to developed countries. Examples of these are highlighted in Box 4.4. Kenya needs to increase efforts to control unregulated biological resources exploration and exploitation by first, becoming a signatory to the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity. Second, Kenya needs to institute a raft of measures to stem biopiracy and ensure that monetary benefits trickle down to the local communities.

Invasive alien species

Invasive alien species are important agents of biodiversity loss and represent a global threat to freshwater habitats and biodiversity because they suffocate, replace and often result in the extinction of indigenous species. Increasing global trade and changing land use patterns are likely to aggravate this problem in the coming years (UNEP 2003).

Box 4.4: Examples of loss of genetic materials in Kenya

1. **The Mawingo tree found in Sagalla forest in Taita** is among the strongest hardwood trees and is often used to make railway line slippers as a substitute for steel. It is reported to have been used for making furniture for the British royal family.

2. **Sandalwood from Taita forest** reportedly has immense medicinal value that fetches a premium price. It is frequently exploited and consignments of it are shipped through Tanzania with the connivance of the local administration authorities.

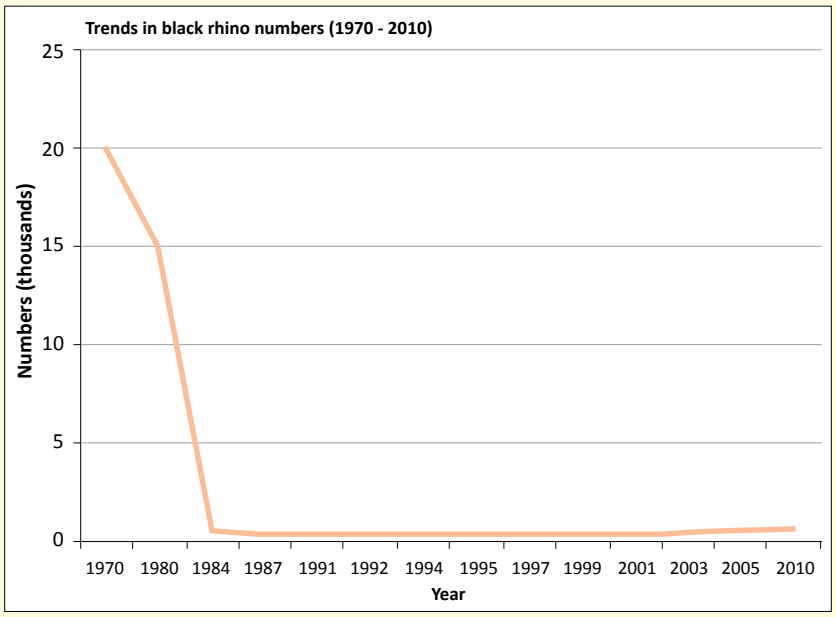
3. **Extremophile microbes, which are endemic to Lake Bogoria** were collected and taken to the US by Procter and Gamble. These microbes produce enzymes which are highly prized by the pharmaceutical industry and are estimated to generate about US$ 38 billion annually. The lake microbe is also used to convert jean material into popular stonewash shades and this property alone reportedly earns an American textile firm about US$ 3 billion annually. However, neither the Kenyan government nor the local community at Lake Bogoria has shared any of the ensuing monetary benefits.

Source: Mwandambo 2010, Othieno 2010

There are nearly 34 invasive alien animal and plant species in Kenya (Kedera and Kuria 2005). These include Coypu rat (*Myocastor coypus*), Speckled mousebird (*Colius striatus*), Ring-necked pheasant (*Phasianus colchicus*) and Mute swan (*Cygnus olor*). The most pervasive invasive alien plant species in Kenya include Mathenge (*Velvet mesquite*) (*Prosopis juliflora*), Tick berry (*Lantana camara*), Mauritius thorn (*Caesalpinia decapelata*) and the water hyacinth (*Eichhornia crassipes*). There is a detailed discussion on the water hyacinth in chapter 9.

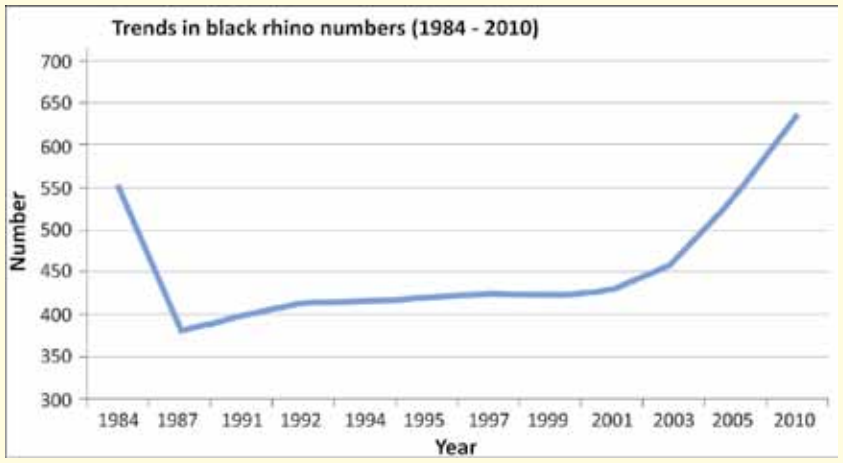
Water hyacinth on Lake Victoria.

UNEP



Decline phase

- Heavy poaching for the horn
- Population declined by 98%



Recovery phase

- Poaching threat still a challenge
- Recovery strategies including biological management established
- Population gradually increasing
- Still critically endangered
- Current Kenyan population 635

Figure 4.7: Trends in black rhino numbers, 1973-2010

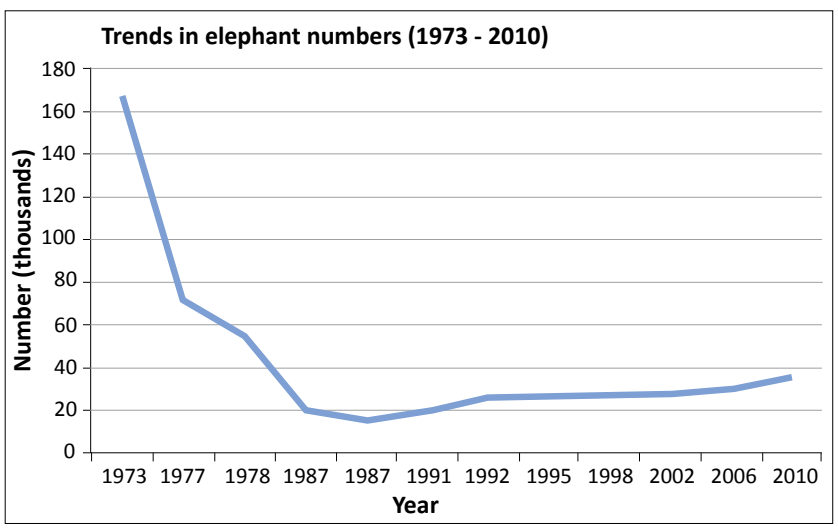
Source: KWS 2010

The introduction and dispersal of alien species in the wetlands and freshwater ecosystems have threatened the ecosystem services provided by the wetlands. For instance, the introduction of the Nile perch (*Lates nilotcus*) into Lake Victoria demonstrates the devastating effects a single invasive species can exact. Lake Victoria originally had a high diversity of fish species which included more than 300 cichlid species, 99 percent of which were endemic to it. While the introduction of Nile perch in the 1950s increased fish production nearly ten-fold, the lake's biodiversity was considerably diminished because the Nile perch preys on the smaller native species and 60 percent of the lake's endemic cichlids are feared extinct (EAC 2008).

Effective methods for identifying and monitoring invasive species early in the introduction lifecycle need to be instituted. As such, the regulatory and enforcements challenges need to be addressed and regional and international cooperation stepped up with regard to transboundary challenges such as the water hyacinth. Because invasive species could cause food insecurity and slow economic growth (Howard and Matindi 2003), their potential to derail attainment of the country's Vision 2030 targets should not be underestimated. In addition, there is need to explore and exploit the range of livelihood opportunities that invasive alien species such as *Prosopis juliflora* and the water hyacinth (*Eichhornia crassipes*) present.

Figure 4.8: Trends in elephant numbers, 1973-2010

Source: KWS 2010



The African lion is an endangered species in Kenya.

Poaching and overexploitation

Poaching, overfishing and uncontrolled harvesting of different plant and animal species are contributing to the decline of biodiversity. Some of the endangered animals species in Kenya are the African elephant, African lion, Black Rhino, Grevy's Zebra, Buffalo, Mangabey, Cheetah, Leopard, Hirola, Green sea turtle, Hawksbill turtle, Tana River Red Colobus, Sokoke scops Owl, Roan antelope and Gigasiphon (UNEP 2009). While biological diversity within the protected areas remains high, incidences of illegal extraction are common. Although the country's rhinos and elephants are kept under close surveillance, poaching remains a major threat to their survival. Thus, while Kenya was home to 20 000 black and white rhinos in the early 1970s, the number now stands at about 900. Elephant numbers also recorded an 85 percent decline over a 15-year period although these are now slowly recovering. Trends in the numbers of the black rhino and elephant are shown in Figures 4.7 and 4.8 respectively.

Poaching is driven by several factors including poverty, availability of lucrative markets and lack of institutional capacity to implement anti-poaching laws. Even though Kenya is a signatory to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) which bans the trade in wildlife trophies such as elephant tusks

and rhino horns, poaching continues in the country. KWS efforts to stem poaching by fitting rhinos with tracking devices and transmitters in order to monitor them, increased patrolling of protected areas as well as arresting and prosecuting poachers need to be scaled up, particularly in the national reserves which are managed by county councils.

Global climate change

Climate change is a challenge contributing to species population and biodiversity loss, especially with respect to the species with long gestation periods which don't have sufficient time to adapt to the changing weather conditions. Changes and variations in climate pose serious threats to biodiversity in Kenya both in aquatic and terrestrial ecosystems. For example, Amboseli and Tsavo National Parks were particularly hit by a long dry spell as they recorded the highest number of animal carcasses. Climate change also makes wildlife prone to new diseases. Yet, many of the mitigation mechanisms adopted, such as feeding wildlife with a high tourism value with hay, are unsustainable in the long run because of the associated costs and logistical challenges. As such, some of Kenya's plant and animal biodiversity species are on the verge of extinction although the degree of this threat has not been adequately documented. Climate change is discussed in greater detail in Chapter 3. Unless urgent measures are taken to address climate change and variability, any strides made towards alleviating poverty and improving human welfare under Vision 2030's flagship projects are likely to be quickly eroded.

Biosafety concerns

Biosafety is a concept that refers to measures to mitigate or protect human health and the environment from possible adverse effects of modern biotechnology. Modern biotechnology has made great innovations in agriculture—such as the development of drought tolerant and pest and disease resistant strains of Irish potato, cassava, sweet potato, macadamia, strawberry, pyrethrum, sugarcane, vanilla and flowers in Kenya (Olembo et al 2010)—possible. However, because of the uncertainty surrounding genetically modified organisms' (GMOs) long term impacts on human health, the environment and biodiversity, there is need to apply the precautionary principle. While the country's National Biotechnology and Biosafety Policy and the Biosafety Act (2009) are in place, their implementation has been weak and the Act does not yet have legal force. As such, the biosafety mandate continues to be fragmented among a number of institutions and there is growing public opposition to GMOs. Failure to address the biosafety concerns is likely to devastate the horticultural sector because 95 percent of the country's horticultural produce is destined for the EU which has stringent biosafety measures (KBC 2007).

Strategies to improve the state of Kenya's biodiversity

There are a number of strategies that Kenya is employing to address the challenges that the country's biological resources are facing. These include the use of international instruments, regional and national conservation instruments, Vision 2030, regional cooperation blocks, decentralized management of biodiversity, science and technology and initiatives to support community livelihoods.

International instruments

Kenya ratified the Convention on Biological Diversity (CBD) in 1994 and has put in place governance structures with strong policy and legal instruments. More than eight regulations and guidelines on environmental conservation and management including biodiversity have been gazetted and operationalized. The country has also instituted measures to link the CBD, the Ramsar convention on wetlands, the Bonn convention on migratory species, the World Heritage Convention, the United Nations Convention to Combat Desertification (UNCCD), CITES and the United Nations Framework Convention on Climate Change (UNFCCC).

In order to contribute to the global biodiversity conservation targets of 2020 and 2050 and to ensure constant supply of ecosystem goods and services from healthy habitats that benefit people (NEMA 2010), the government revised the old National Biodiversity Strategy and Action Plan of 2000 in 2010 in line with the Nagoya outcomes of the Conference of the Parties to the CBD. The revision seeks to ensure that the country's genetic resources are properly valued and sustainably used, to enhance information sharing and to build institutional capacities. The National Climate Change Response Strategy has also been finalized. KWS is, appropriately, the national focal point for the Ramsar Convention on Wetlands and Bonn Convention on Migratory Species of Animals as it is mandated with conserving Kenya's terrestrial and aquatic natural resources in the gazetted protected areas. In addition, KWS is the lead agency for the management of the country's wetlands and by 2010, five wetlands had been listed as wetlands of international importance (Ramsar Sites). The National Museums of Kenya (NMK) is the focal point for the Global Taxonomy Initiative (GTI), African Network for the International Pollinator Initiative (IPI), Global strategy on plant conservation (GSPC), and Ramsar Convention communication, education, and public awareness in Kenya and it represents the Africa region on the CBD Plants Committee.

In 2006, Kenya joined 22 other nations in signing the Agreement for the Establishment of the Global Crop Diversity Trust. The Global Crop Diversity Trust was established through a partnership between the United Nations Food and Agriculture Organization (FAO) and the Consultative Group on International Agricultural Research (CGIAR). The primary goal of the Global Crop Diversity Trust is the conservation of the agricultural diversity housed in a myriad of gene-banks across Africa and around the world. The mission of the Trust is to ensure the long-term conservation and availability of crop diversity for food security worldwide.

Regional developments

There is considerable on-going work to develop synergies among the existing multilateral environmental agreements, to harmonize reporting frameworks and to develop new legal agreements. Legal instruments and initiatives at the regional level include the African Convention on the Conservation of Nature and Natural Resources, the New Partnership for Africa's Development (NEPAD) Environmental Initiative, African Ministerial Conference on the Environment (AMCEN), and the Protocol on Protected Areas and Wild Fauna and Flora in Eastern Africa. Another important regional development was Kenya becoming a signatory, along with Uganda, Tanzania, Ethiopia and Rwanda, to the Nile River

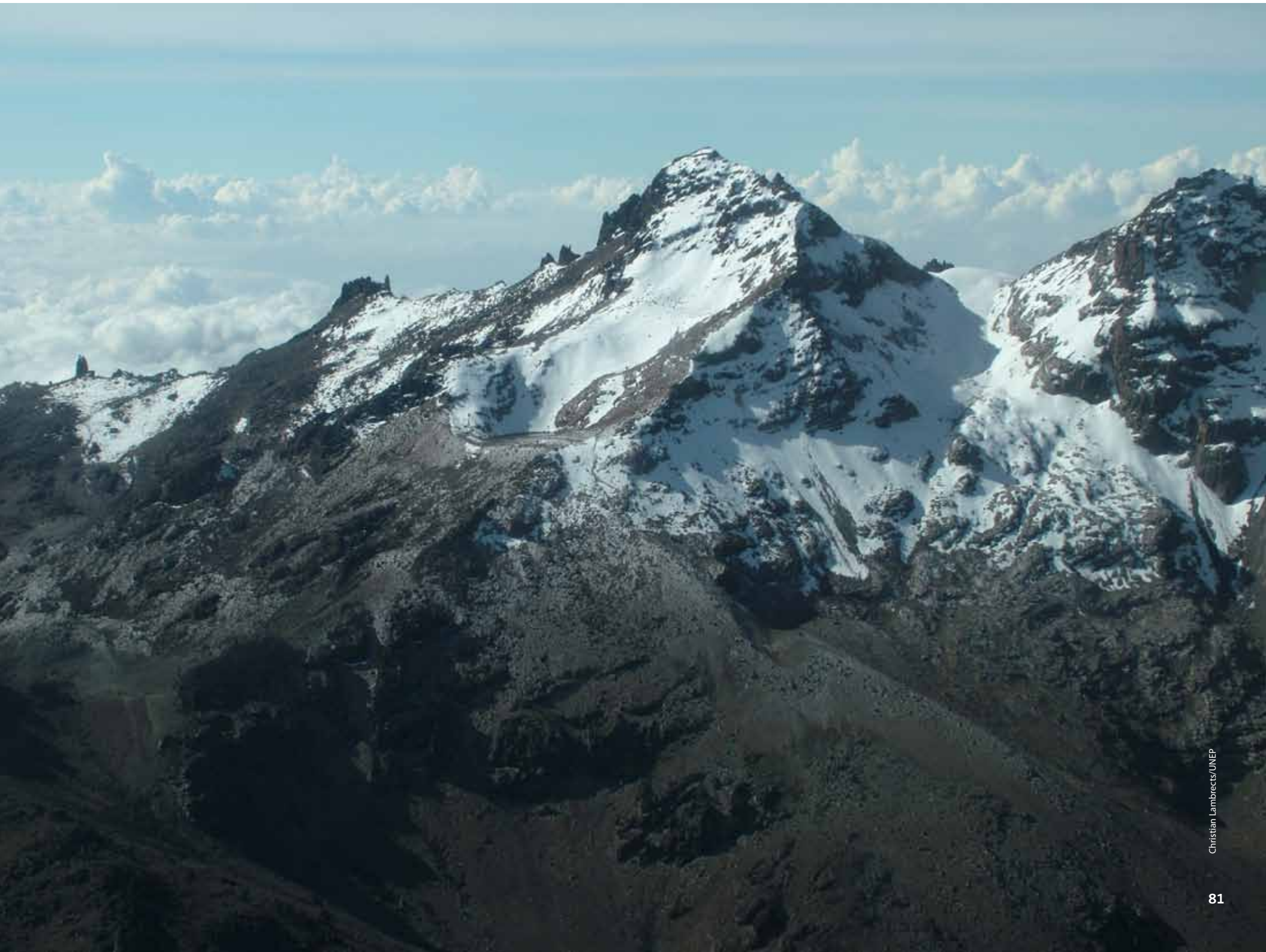
Basin Cooperative Framework. Besides providing for more equitable use of the waters of the world's longest river, the parties committed themselves to collectively working towards conserving the Nile and implicitly, the vast biodiversity wealth of the Nile basin.

National developments

The government set up the Centre for Biodiversity at the NMK whose primary role is to coordinate country biodiversity studies. In addition, a number of legal instruments (policies, rules, regulations, and acts) have been put in place to enhance conservation and regulate utilization of biodiversity resources. 2010's landmark development however, was the promulgation of the new Constitution which entrenches a range of environmental imperatives and provides an avenue for remedying the land tenure, land use and gender inequity issues that have negatively affected the country's biodiversity. The Constitution also devolves management of a range of natural resources to the nascent county governments. Policy instruments finalized in the course of 2010 include the Revised Kenya National Biodiversity Strategy and Action Plan (2010) and the Integrated Coastal Zone Management Policy (2010). These are expected to complement the growing body of biodiversity-related legal and policy instruments which include the Environment Management and Coordination Act (1999), National Water Policy (1999), Water Act (2002), Draft Forest Policy (2004), Draft ASALs Policy (2004), Forest Act (2005), Fisheries Policy (2008), Heritage Sites (2006), National Land Policy (2009), Energy Act (2006), Biodiversity regulation (2006), Draft Wildlife Policy (2007), and the draft Minerals and Mining Policy. While many of these instruments were not directly informed by the Vision 2030 objectives, it is clear that any initiative which directly or indirectly helps to conserve the country's biodiversity tacitly helps to meet the specific Vision 2030 poverty alleviation objectives as well as the overarching goal of improving the general welfare of the citizenry. It is also self-evident that a national biodiversity policy and law would be a useful complement to the above operative instruments.

A National Wetlands Standing Committee was established in 2010 to create public awareness, formulate and coordinate the creation of a national wetlands inventory, coordinate Environmental Impact Assessments (EIAs) and give technical advice on wetland issues. The committee is also tasked with drawing up a framework for a national policy on wetlands. It is envisaged that this policy will include policy strategies for securing and managing as well as assessing, inventorying and monitoring wetlands. It is also envisioned that the wetlands policy will also contain strategies for improving the knowledge base related to the protection of wetland functions, guidelines for identifying the

The glaciers on Mount Kenya are under threat due to climate change.



Christian Lambrects/UNEP

Elephant in the Mwaluganje Elephant Sanctuary.

Box 4.6: The Lumo Community Wildlife Sanctuary

The Lumo community wildlife sanctuary lies at the heart of the Tsavo ecosystem, surrounded by Tsavo East and Tsavo West National Parks and the Taita Game Sanctuary. It is composed of three group ranches namely; Lualenyi, Mramba and Oza all of which decided to pool their natural resources in the interest of sustaining their unique wilderness area that, in addition to its rich biodiversity, offers stunning views of Mount Kilimanjaro and some surrounding hills. The Sanctuary is an ancient elephant migratory route and also serves as an important wildlife corridor for the Tsavo East and Tsavo West National Parks wildlife.

most threatened wetlands and provide for a national platform to enhance communication among various stakeholders.

KWS supports the livelihoods of communities that interact with wildlife and bear the brunt of human-wildlife conflict through three programmes namely; Community Enterprise Development (CED); Corporate Social Responsibility programme (CSR) and protection of people's life and their property from wildlife destruction through a Problem Animal Management Unit (PAMU). The goal of the CED programme is to develop the capacity of communities and private landowners to establish and manage economically viable nature-based enterprises within targeted landscapes. Communities which interact with and host wildlife on their lands are key stakeholders in wildlife protection and are sensitized to wildlife-compatible land use practises. Examples of these are the Mwaluganje Elephant Sanctuary along the Mombasa South Coast and Lumo Community Wildlife Sanctuary, which is described in Box 4.6.

KWS' CSR programme encourages responsible corporate citizenship by encouraging the corporate world to improve the quality of life of impoverished wildlife stakeholders and to fund wildlife conservation. Public education, provision of health facilities and clean water to local communities, strengthening community-based wildlife conservation and promotion of eco-tourism are the cornerstones of this strategy. PAMU is a rapid response team that responds to distress calls about wildlife human predation and crop raids. Monitoring problem elephants has, for example, been eased by tagging them with special communications devices which transmit signals on their precise locations, making it easy to trace them and drive them back into the protected areas.

Conclusion and recommendations

Kenya is endowed with an enormous diversity of ecosystems and wildlife species. These natural resources are a source of livelihood to Kenyans, are central to the economy and are indispensable to achieving the aspirations outlined in Vision 2030's economic, social and political pillars. Important steps in recognizing the role of biodiversity have been made although a number of challenges remain. It is envisaged that the following interventions will enable sustainable use of the country's biodiversity resources:

- **A national biodiversity policy** should be formulated and a **biodiversity law** enacted in order to provide a robust regulatory framework that balances biodiversity conservation with the need to harness the country's enormous biodiversity wealth for the economic, social and political goals of Vision 2030.
- Mechanisms for sharing and exchanging biodiversity data among Kenyan institutions should be designed in order to ensure **strategic management and planning of all important biodiversity areas.**
- Ensure **centralized coordination of biodiversity conservation and management activities.** This could be achieved through establishing a National Biodiversity Steering Committee with specific mandates and terms of reference.
- **Strengthen national and regional partnerships in implementation of relevant conventions relating to technology transfer to better utilize the country's biological resources.** Issues that have hindered technology transfer since

the ratification of conventions that support technology transfer by Kenya should be identified and appropriate interventions instituted.

- There is need for **capacity building of the NEMA biodiversity focal point and establishment of a national biodiversity panel of experts** to synthesize outputs from lead agencies and the convention secretariat.

- **Strategies should be developed to shield biodiversity resources from biopiracy, negative impacts of global climate change and the impacts of liberalized of global tourism.** It is also important for Kenya to become a signatory to the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity and to domesticate its provisions.

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CHAPTER 5
FORESTS AND WOODLANDS

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Introduction

Forests and woodlands contribute significantly to Kenya's economy. They provide multiple environmental, economic, social and cultural benefits which can provide opportunities for the poverty alleviation and economic development envisaged in Vision 2030. For instance, forests create significant employment and livelihood prospects in the country's rural and urban areas. They also play an invaluable role in meeting the cultural and spiritual needs of adjacent communities. Forests' indirect but important benefits include acting as carbon sinks, reservoirs of biodiversity and critical habitats for wildlife. In addition, they keep the land productive by conserving soil and water. They also serve as water catchments that recharge rivers and dams which supply water for domestic use and hydro electric power generation. The latter two are especially vital to the attainment of Vision 2030 which aims to provide safe drinking water for larger proportions of the country's population. In addition, the manufacturing sector, which is identified by Vision 2030 as one of the areas that is expected to deliver the 10 percent annual growth rate, is heavily dependent on hydro power.

The country's forests and woodlands are increasingly under pressure from the growing human population and many are shrinking as a result of human-induced deforestation. The enactment of the 2005 Forests Act has admittedly helped to revitalize the sector by giving local communities a stake in the management of state and local authority forests. Despite the new law however, a number of challenges remain. The low penalties for offences compared to the value of the resources in question, inconsistencies with other sectoral policies and laws, and lack of security of tenure for people living on government and trust lands has resulted in opportunistic exploitation of forest resources both by the local communities and government. In 2001 for example, government excised 67 000 of state forests predominantly in the Mau Forest Complex, Kenya's largest closed canopy forest and the largest of the country's five water towers. Further, forests are currently undervalued in terms of the goods and services and the socio-economic benefits they provide. The government needs to institute mechanisms to ensure strict enforcement of the logging ban and ensure that the contribution of forests to the national economy is properly accounted for.

Current status of forests and woodlands

Forests in a regional and global context

Africa's forests and woodlands can be classified into nine general categories including tropical rain forests, tropical moist forests, tropical dry forests, tropical shrub lands, tropical mountain forests, subtropical humid forests, subtropical dry forests, subtropical mountain forests and plantations. Mangrove forests cover a total area of 3 390 107 ha. Only 32.5 million ha of forests and woodlands, or 5 percent of the total forest area, are formally protected. The forest sector in Africa plays an important role in the livelihoods of many communities and in the economic development of many countries. This is particularly so in Western, Central and Eastern Africa where there is considerable forest cover (UNEP 2006).

Africa has a high per capita forest cover of 0.8 ha per person compared to 0.6 ha globally. On average, forests account for 6 percent of GDP in Africa, which is the highest in the world. In Uganda, for example, forests and woodlands are now recognized as an important component of the nation's stock of economic assets and contribute in excess of US$ 546.6 million to the economy through forestry, tourism, agriculture and energy (NEMA 2008). The state of Rwanda's forests and woodlands and their importance to the national economy is also well documented. Forests are designated as protected areas which host game parks and forest reserves and make contributions to the national economy by supplying renewable sources of energy in the form of wood fuel and charcoal. They also make an indirect contribution to sustainable agriculture and are sources of medicines, fodder, honey, essential oils, as well as handicraft and construction materials. However, they are also threatened with mining, fires and poaching (REMA 2009).

Forests and woodlands are central to the long-term social and economic development goals of NEPAD and will play an important role in meeting the MDG targets. They provide energy, food, timber and non-timber forest products and are important contributors to wealth and health at the household, community, national, sub-regional, regional and even global levels. Forests and woodlands still remain key components of the environment that provide essential services to African countries where they play a critical role in combating land degradation and climate change as well as conserving wetlands, coastal areas and freshwater systems.

In the East African region, policy issues in management of montane forests are deliberated upon under the umbrella of the East Africa Community which oversees the East African Treaty of 1999 (Better Globe 2009). The rivers flowing from the Mau Forest Complex in Kenya drain into five lakes, three of which are international water bodies: Lake Victoria (shared by Kenya, Uganda and Tanzania), Lake Natron (shared by Kenya and Tanzania) and Lake Turkana (shared by Kenya and Ethiopia). All the five rivers, which flow into Lake Victoria, form part of the Nile Basin. Increased sediment influx from these five rivers

Figure 5.1: The Geographic distribution of Kenya's forests

Source: KFS 2010

and from the Kagera River annually costs farmers in excess of US$ 40 million worth of lost soil. Such a high sediment or nutrient load into the lake is a major contributor to the expansion of the areas covered by the water hyacinth, an invasive plant with a negative impact on fisheries and associated economic activities. The sediment load is particularly high during flash floods and can be mitigated by maintaining a good forest cover in the upper catchment areas (Better Globe 2009). In this regard, regional programmes such as the Nile Basin Initiative and others which focus on safeguarding common resources such as Lake Victoria should be facilitated to fulfil their mandates (UNEP 2007). On a broader level, the NEPAD programme on forests and woodlands is critical to the success of the other NEPAD programmes, including those on combating land degradation and climate change and on conserving wetlands, and coastal and freshwater resources.

The world's forests provide a range of ecosystem services. 80 percent of the planet's biodiversity is believed to depend on healthy ecosystems. Tropical forests, mostly found in developing countries, are especially vital for safeguarding global environmental goods and services. Nearly 2 000 indigenous cultures or more than one billion people depend on forests for their sustenance. Even though there is growing public recognition of the benefits of these ecosystems, they are increasingly under threat from deforestation and nearly 13 million ha are lost every year. Deforestation rates are particularly high in the tropical countries. It is estimated that some 1.8 billion m^3 of wood are harvested annually for wood fuel, with women typically doing most of the work (GEF 2009). Protected areas are considered one of the most efficient and cost-effective options for conserving forests. The world's forests are estimated to contain about 80 percent of above-ground and 40 percent of below ground terrestrial carbon. At present, there is more carbon stored in forests than in the earth's atmosphere.

International agreements which touch on the conservation and management of forest resources include the CBD and the United Nations Framework Convention on Climate Change (UNFCCC), both of which have been in force since 1992. Kenya is a signatory to these and a number of other multilateral environmental agreements (MEAs), including the 1971 Ramsar Convention.

Forests and land use in Kenya

The distribution of Kenya's population closely follows rainfall distribution patterns. Only 20 percent of the country's total area has high rain-fed agricultural potential and most farmers are dependent on small-scale commercial agriculture (WRI 2007). This, coupled with the rapid population growth rate of nearly 1 million people per year over the past decade, has placed increased pressure on existing settlements. As a result, there is great demand for arable land and the per capita holding is continually shrinking (UNEP 2009a). Protected forests that are located in high potential areas are valued for their agricultural and human settlement potential. State forests are also subjected to illegal logging and cultivation by people seeking alternative means of livelihood. This demonstrates the need to upscale farm forestry across all the country's ecological zones (GoK 2009a).

Categories of land use type	Areas ('000 ha) in Year		Remarks
	2005	2008	
Indigenous closed canopy forests	1 165	1 165	Decreased forest cover (25 000 ha) due to human interference in Cherangani, Samburu and Mau forests
Mangroves	54	54	Located in Kilifi, Malindi, Lamu (coastal areas).
Industrial plantation forests	134	107	This is in addition to 16000 ha of the unplanted designated areas
Private plantation forests	83	90	Increasing trend due to accelerated commercial planting by private sector and farmers
Subtotal closed canopy forests	**1 532**	**1 406**	**2.4 per cent of Kenya's total area**
Woodlands	2 075	2 050	Spread mainly in the ASALs
Subtotal of forest areas	**3 496**	**3 456**	**5.9 per cent of Kenya's total area**
Bush-lands	24 570	24 510	In ASALs and medium rainfall areas
Grasslands	10 350	10 350	Mainly in the savannah
Settlements	8 152	8 202	
Tree on farmlands	10 320	10 385	Mainly in high and medium rainfall areas
Inland water bodies	1 123	1 123	
Total area	**58 037**	**58 037**	

Table 5.1: Changes in various types of land use in Kenya from 2005-2008 Source: KFS 2010

The remaining 80 percent of Kenya's total land is classified as arid or semi-arid lands (ASALs). These ASALs support pastoralist and agro-pastoralist lifestyles but their woodlands are also a major source of charcoal which is a commodity with a ready market for domestic energy in rural and urban settlements all over Kenya (Better Globe 2009). The charcoal industry, though robust and capable of earning the government much needed revenue in taxes only came under formal regulation with the gazettement of the charcoal regulations in December 2009. A deeper analysis however reveals that not enough has been done so far to put in place the necessary structures to support the enforcement of these regulations in order to ensure sustainable use of the country's forests and woodlands. It is therefore important that charcoal producers and the relevant enforcement agencies such as the Kenya Forest Service (KFS), Kenya Wildlife Service (KWS), the Kenya Police, local provincial administrators and judicial officers are sensitized on these rules. The country's civil society is already helping to educate the public on this important development. More however needs to be done by key institutions which are mandated to register and monitor the charcoal producer associations. Table 5.1 contains details of forest-related land use changes in Kenya over the 2005-2008 period.

Kenya's forest cover stands at 1.7 percent as shown in Figure 5.1. This is much lower than the recommended threshold of 10 percent. Gazetted reserves are under the jurisdiction of the Kenya Forest Service (KFS). Some of the closed canopy forests are managed as national parks and national reserves by the Kenya Wildlife Service (KWS). About 100 000 ha of the forests are under the authority of local governments although these are generally poorly managed. Natural woody vegetation covers a combined area of approximately 37.1 million ha.

Kenya's montane forests: The five water towers

Kenya's five 'water towers' namely; Mount Kenya, the Aberdares Range, the Mau Forest Complex, Mount Elgon and the Cherangani Hills—are montane forests and the largest forests in the country. They form the upper catchments of all the main rivers in Kenya (except the Tsavo

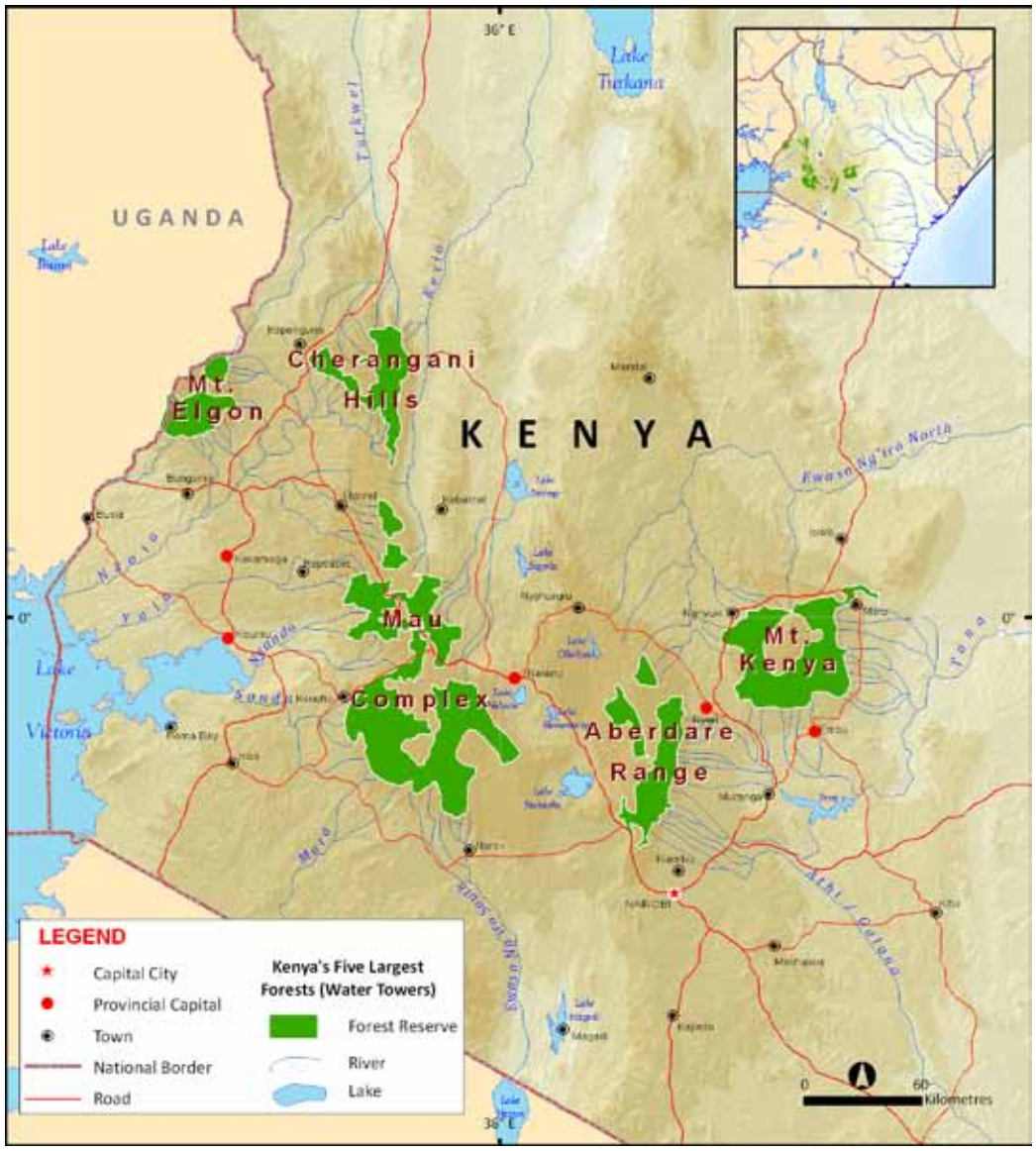


Figure 5.2: Location of the country's five largest forests which are also its water towers Source: KFS 2010

River that originates from Mount Kilimanjaro). They are sources of water for irrigation, agriculture, industrial processes and for the installed hydro-power plants. These montane forests are also surrounded by the most densely populated areas because they provide sufficient water for intensive agriculture and urban settlement (Akotsi et al 2006). They also provide timber and non-timber products to forest-adjacent communities. However, their rampant destruction through extensive, irregular and ill-planned settlements and illegal forest resource extraction is a matter of national concern.

The following sections are case studies presenting the state of the country's five water towers. They describe their changing physical conditions over time. Such assessments are important for safeguarding the livelihoods of millions of Kenyans and also for preserving the intrinsic beauty and richness of these landscapes. Figure 5.2 shows the location of these five forests.

The Mau Forest Complex

The Mau Forest Complex comprises 22 separate blocks and is the largest of the country's five water towers with a total forest cover of 403 775 ha. It feeds a range of the country's major water arteries that extend as far as Lakes Turkana, Natron and Victoria and supports critical economic activities including hydropower generation, tourism and agriculture. In spite of its national importance, many portions of the Mau Forest Complex have been deforested or degraded. Much of this damage has taken place in the past few decades. Excision of forest reserves and continuous widespread encroachment have led to the destruction of over 100 000 ha of forest since 2000, representing roughly one-quarter of the Mau Complex area (UNEP 2009a).

In 2001, a 61 023 ha parcel of the Mau Forest Complex was excised. This included over half of the Eastern Mau Forest Reserve, one quarter of South West Mau Forest Reserve as well as the Molo Forest Reserve. Between 1973 and 2005, Maasai Mau Forest lost over 8 214 ha of forest with almost 43 percent of that loss occurring in just two years (2003 to 2005). Just outside the gazetted boundaries of Maasai Mau Forest, nearly 32 000 ha were lost during the same time period. The eastern slopes of the Maasai Mau are a crucial catchment for the Ewaso Ng'iro River while the western slopes help to recharge the Mara River. Forest loss in critical catchment areas of the Sondu, Mara, Molo, Naishi, Makalia Nderit, and Njoro Rivers may result in ecological and hydrological changes which threaten the sustainable future of the downstream areas. In addition, people have encroached onto 43 700 ha of the Mau Forest Complex's remaining protected forests.

The suitability of many of these areas for agriculture attracts a rapidly growing population and has led to conversion of large areas

An aerial photo depicting the scale of the Mau Forest Complex's deforestation.

Christian Lambrechts/UNEP

BARINGO

COUNTY

Lariak Forest Reserve

LAIKIPIA

Ol Arabel Forest Reserve

Lake Bogoria

COUNTY

Rumuruti

Rumuruti Forest Reserve

Marmanet Forest Reserve

Uaso Narok Forest Reserve

Nyahururu

Solai

NAKURU

COUNTY

Olbolosat Forest Reserve

Aberdares Forest Reserve

Bahati Forest Reserve

NYANDARUA

Muruai Forest Reserve

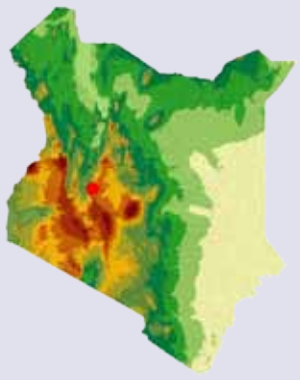
Lake Olbolosat

COUNTY

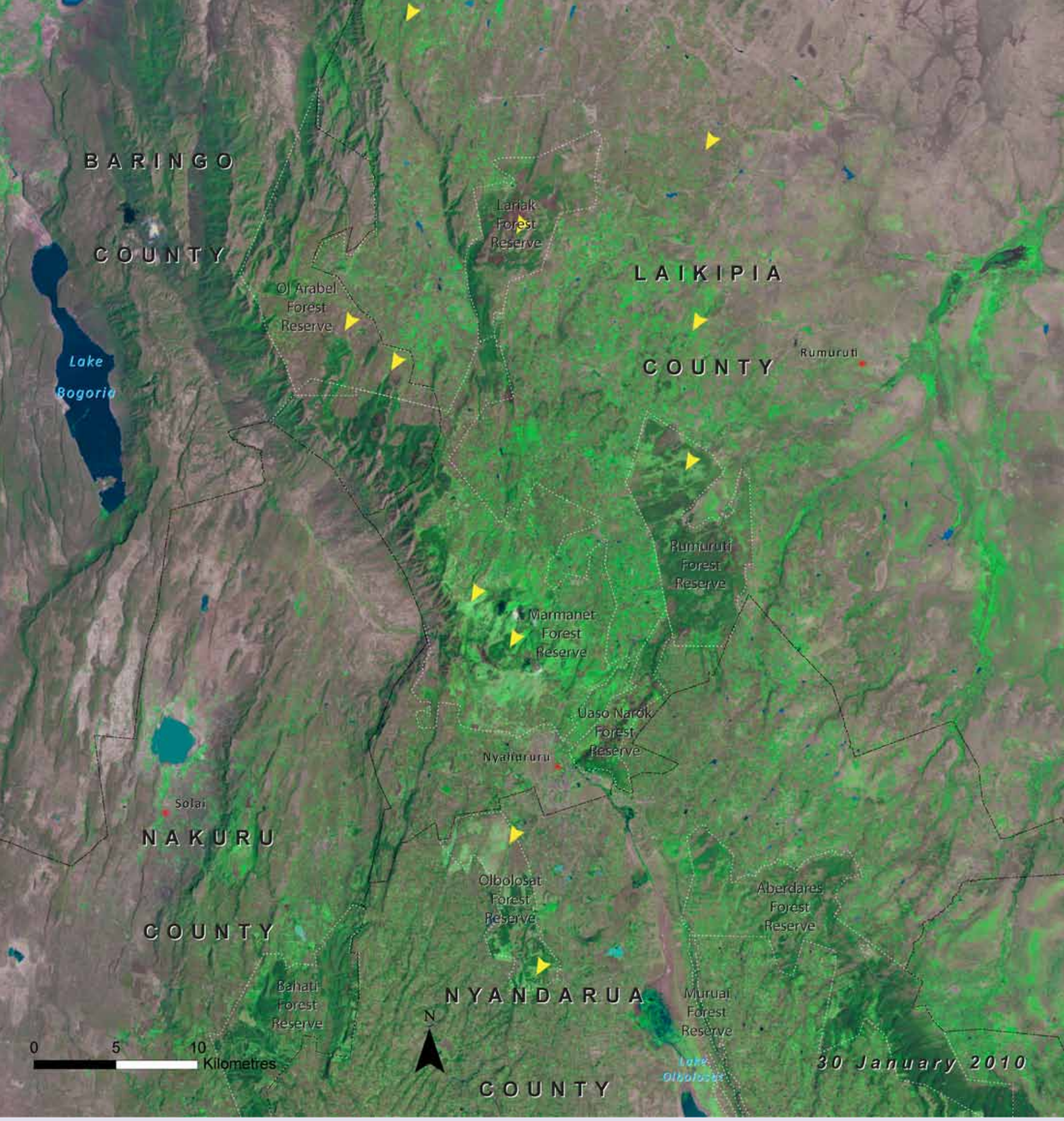
N

0 5 10 Kilometres

31 January 1973



Forest Loss – Conversion of forested land to agricultural and other land uses has been a common occurrence in Kenya over several decades. This worrisome state of affairs is not only restricted to private land, but also to gazetted forests. Deforestation in Kenya is therefore both attributable to illegal activities by private actors and government sanctioned forest excisions. In 1973, Ol Arabel, Lariak, Marmanet, Rumuruti, Aberdares, Olbolosat, Bahati, Uaso Narok, and Muruai forest reserves and their environs were covered with lush green forests



as depicted in the 1973 image. However, in the 2010 image, most of the forests have been cleared, leaving behind farms and barren land (yellow arrows). With Vision 2030 aiming to eventually raise the country's forest cover to 10 percent, policies need to be put in place to encourage afforestation and reforestation and to also discourage deforestation by making trees more valuable when standing than felled. Furthermore, there is need for enhanced protection of the existing forest resources.

of forest to farmland. This explains why people with claims of land ownership inside the forest resist eviction and raises questions about the legality of title deeds issued for gazetted forest land. Long term land adjudication plans are needed to resolve these issues. Poor land management inevitably leads to increased dependence by the population on forest products. Loss of forest cover at an unsustainable rate threatens the future development of Kenya. Realizing the goals of Vision 2030 will thus depend on sustainable management of Kenya's critical natural assets including the Mau Forest Complex which is the largest of the country's closed canopy forests.

However the situation is not all gloomy as the Mau complex witnessed a number of positive developments between 2005 and 2007. First, only 63.06 ha of the entire Mau Complex were cleared. Second, 5 970 ha of the forest complex showed signs of regeneration. Third, a public-private sector partnership under the auspices of the 'Save the Mau Trust' has stepped up efforts to rehabilitate the degraded portions of the forest. The progress made in reclaiming the forest is captured in reports by an Inter-Ministerial Conservation Secretariat in the Prime Minister's office. Four phases of the rehabilitation programme have so far been completed and the initiative is currently in its fifth phase (KFWG personal communication).

Mount Kenya forest

This was designated as a UNESCO World Heritage Site in 1997 because of its remarkable ecosystems and natural beauty. It covers an area of 232 047 ha and has exceptional biodiversity, scenic, social and cultural values which justify its protected area status. Its wide range of altitude and rainfall gives rise to eight ecological zones ranging from a cultivated zone below 1 800m to the Afro-alpine (areas above 3 800m) and the Nival zone, found above most vegetation. The attitudinal gradient of Mount Kenya leads to an unusually varied range of plant and animal species in a relatively small area. The areas under forest are critical water catchments for Kenya, delivering an estimated 40 percent of the country's water needs. From the forest belt growing between 3 000 and 4 000m to the glacial summit at 5 199m, Mount Kenya receives over 2 000mm of precipitation annually. This water feeds the Ewaso Ng'iro and the Tana, Kenya's longest rivers with Mount Kenya providing roughly half the water needed for Tana River's crucial hydro-power plants.

From the 1960s to the 1990s, there was intense population growth around Mount Kenya, and large areas of indigenous forest were cleared to establish tree plantations. Unsustainable exploitation of forest resources was followed by extensive illegal logging of valuable species and small-scale illegal charcoal production, growing of marijuana and unauthorized farming, which degraded many areas of natural forest.

It is unclear whether law enforcement has improved since the Forests Act of 2005 became operative and whether this legislation is effective in significantly reducing threats. To fill gaps that may exist, it is necessary to resolve related conflicts arising from the fact that the Mount Kenya Forest is regarded on one hand, as a National Park under the management of Kenya Wildlife Service while on the other, it is recognized as a Forest Reserve under the jurisdiction of Kenya Forest Service (KFS) according to a 1943 gazette notice that remains in force. The process of developing a management plan for the Mount Kenya ecosystem has been very slow as a result of this conflict. Both institutions mandated with its management administratively fall under the Ministry of Forestry and Wildlife making it easy to resolve the issue. The roles played by other partners with an interest in forest management should not be overlooked as it is through their efforts that resources have been mobilized for fencing of the forest and creation of wildlife corridors.

Between 2005 and 2007, probably as the result of the draft forest management plan that was put in place to conserve the Mount Kenya Forest, there were no significant changes reported in forest cover. This situation was confirmed in 2010 when the Department of Resource Surveys and Remote Sensing (DRSRS) of the Ministry of Environment and Mineral Resources made an aerial survey that produced no evidence of ongoing destruction in the forest and most of the forest sections are well stocked. Based on the survey, the South Imenti forest block which was depleted in 2000 appears to be firmly on the path to recovery with green vegetation dominating the whole forest. The forests of the southern, eastern and western sides of Mount Kenya also display a well vegetated condition. These are classified as moist highland forests of broadleaved tree species and show vigorous vegetative growth due to good rainfall. Ground surveys are nevertheless recommended to establish the current state of the forest. Indeed, KFWG's monthly reports indicate that selective destruction is still taking place in this region despite the logging ban.

Cultural and social values

Forests are traditionally important as sacred sites for cultural ceremonies by local communities. Specific tree species have distinct cultural values. The Mount Kenya forest plays an important religious role and is regarded as a sacred place by neighbouring communities. The Maasai who live in Ngare Ndare area ascribe significant cultural values to the forest while the Meru council of elders (Nchuri Ncheke) performs rites in it. A unique characteristic attributed to the forest by the Embu, Meru and Gikuyu people is that it is regarded as the traditional home of their God, Ngai Murungu, whose presence is strongly associated with the peaks of the mountain. In the past, these communities performed religious rituals while facing the mountain or in several sacred areas in the forest when faced with crises such as drought. The peaks were not visited except for traditional rituals and prayer (KWS 1996) which helped to conserve tree species such as the Mugumo tree (*Ficus natalensis*) and *Indigofera erecta*, which were considered sacred. Other species of cultural significance were those with medicinal qualities or food value.

Mount Kenya's biodiversity

Flora

Vegetation varies with altitude and rainfall with a rich alpine and sub-alpine flora. *Juniperus procera* and *Podocarpus sp.* are predominant in the drier parts of the lower zone (below 2 500 m) with rainfall ranging between 875 and 1 400 mm. *Cassipourea malosana* predominates in wetter areas in the south-west and north-east (where rainfall exceeds 2 200 mm per year). However, most of this lower altitude zone is not within the reserve and is now used for growing wheat. Higher altitudes (2 500-3 000 m) with rainfall ranging over 2 000 mm per year are dominated by bamboo *Arundinaria alpina* on south-eastern slopes; a mosaic of bamboo and *Podocarpus milanjianus* with bamboo at intermediate elevations (2 600-2 800 m); and *Podocarpus* at higher (2 800-3 000 m) and lower elevations (2 500-2 600 m). Towards the west and north of the mountain, the bamboo becomes progressively smaller

A view of the indigenous Mount Kenya forest.

and less dominant. *Hagenia abyssinica* and *H. revolutum* predominate in areas of maximum rainfall (2 000-3 500 m) with up to 2 400 mm of rainfall per year. Above 3 000 m, cold becomes an important factor, tree stature declines, and *Podocarpus* is replaced by *Hypericum sp*. A more open canopy results in a more developed understorey. Grassy glades are common especially on ridges. The lower alpine or moorland zone (3 400-3 800 m) is characterized by high rainfall, a thick humus layer, low topographic diversity, and low species richness. Tussock grasses *Festuca pilgeri*, and sedges *Carex sp.* predominate. Between the tussocks there are *Alchemilla cyclophylla*, *A. johnstonii,* and *Geranium vagans*. The upper alpine zone (3 800-4 500 m) is more topographically diverse, and contains more varied flora, including the giant rosette plants *Lobelia telekii* and *L. keniensis, Senecio keniodendron*. *Carduus sp. Senecio brassica* is found in both the lower and upper alpine zone. There are a variety of grasses on well-drained ground and along the streams and river banks such as the megaphytic *Senecio battescombei* and *Helichrysum kilimanjari*. Continuous vegetation stops at about 4 500 m although isolated vascular plants have been found at over 5 000 m. 13 species considered endemic to Mount Kenya were recorded by Hedberg in 1951 and largely confirmed in Mount Kenya's 2010 biodiversity report as well as questionnaires completed pursuant to the Mount Kenya Ecosystem Integrated Management Plan 2010-2020 (Birdlife International 2010).

Groundsel.

Fauna

In the lower forest and bamboo zone, mammals include the giant forest hog (*Hylochoerus meinertzhageni*), tree hyrax (*Dendrohyrax arboreus*), white-tailed mongoose (*Ichneumia albicauda*), elephant (*Loxodonta africana*), black rhinoceros (*Diceros bicornis*), suni (*Neotragus moschatus*), black-fronted duiker (*Cephalophus nigrifrons*) and leopard (*Panthera pardus*) which has also been seen in the alpine zone. Moorland mammals include localized Mount Kenya mouse shrew (*Myosorex polulus*), hyrax (P*rocavia johnstoni mackinderi*), and common duiker (*Sylvicapra grimmia altivallis*). There have also been reported sightings of the golden cat (*Felis aurata*). The endemic mole-rat (*Tachyoryctes splendens*) is common throughout the northern slopes and the Hinde Valley at elevations of up to 4 000 m.

Forest birds include the green ibis (*Mesembrinibis cayennensis*), Ayre's hawk eagle (*Hieraaetus dubius*), Abyssinian long-eared owl (*Asio abyssinicus*), scaly francolin (*Francolinus squamatus*), Ruppell's robin-chat (*Cossypha semirufa*), and numerous sunbirds (*Nectariniidae*). Other birds include scarlet-tufted malachite sunbird (*Nectarinia johnstoni*), montane francolin (*Francolinus psilolaemus*), Mackinder's eagle owl (*Bubo capensis mackinderi*), and the locally threatened scarce swift (*Schoutedenapus myioptilus*). The alpine swift (*Apus melba africanus*) and alpine meadow lizard (*Algyroides alleni*) are near endemic.

Birdlife International (2010), in its report on biodiversity, threat assessments, current investments, civil society stakeholders and policy review lists which of these mammals, reptiles, amphibians and insects are on the IUCN Red List.

Conservation management

The Mount Kenya National Park is managed by KWS on five-year management plan cycles. The main goal of such plans is to preserve:

- the afro-alpine ecosystem;
- the traditions, aesthetic and tourism values of a high mountain wilderness with this being especially important given the role tourism has been accorded in attaining Vision 2030;
- Mount Kenya's contribution to the country's environmental quality.

Rehabilitation efforts—roles played by community members in conservation

There are a number of groups contributing to the mountain's conservation efforts. The majority of them are formed on the basis of a common interest to conserve the Mount Kenya Biosphere Reserve as well as to improve the livelihoods of their members. They aim to do this by averting desertification through reforestation and establishing new forest lots within the Forest Reserve and also on their lands. Most of the communities living around the biosphere reserve act as

Box 5.1: Community Forest Associations (CFAs)

The 2005 Forests Act provides for community participation in forest management. The best opportunity to engage forest-adjacent communities in forest management in partnership with KFS lies in the formation of Community Forest Associations (CFAs). This provides an avenue for local communities to actively participate in the protection, conservation and management of particular forest areas. In return, they are entitled to a range of user rights such as collecting firewood, timber, herbal medicine, grass for roof thatching and grazing animals, recreational activities, scientific and educational activities. For the arrangement to make economic sense for the communities, CFAs should be entitled to broader business activities provided that these do not have adverse environmental effects. It may therefore be necessary to convert their registration as welfare entities into cooperatives and to strengthen the capacity of communities to engage in economic activities such as ecotourism and sustainable charcoal production.

watchdogs and report illegal activities such as charcoal burning, poaching and illegal grazing. In addition, they participate in conservation awareness campaigns mainly targeting community members and schools to make them conscious of a range of conservation issues. They have also contributed towards the construction of barriers, such as fencing (for example in Sagana) and moat digging (such as the 15km stretch in Kangaitha, Embu). Their contributions are made in kind by contributing labour during construction, donating poles or carrying out maintenance activities that include clearing of invasive species in the forest. A case in point is the activities of the Kiangondu community in Chuka where fire fighting is mainly done by those community members who live next to the forest.

Communities could benefit much more in return for the protection of catchment areas by having access to forest products and being involved in ecotourism initiatives. While these are provided for by the 2005 Forests Act, an analysis of its implementation in 2010 indicated that these commitments have not been adhered to. As such, community forest associations (CFAs) have began to lose faith in the institutions entrusted with approving forest management plans (Better Globe 2009). From the 351 CFAs registered countrywide, only 36 plans have been approved so far. Approval is followed by signing of Forest Management Agreements (FMAs) which are subject to availability of funds. The slow progress has caused a number of donor partners to despair and withdraw their financial support. Even with the gazettement of subsidiary rules in 2009, the FMA for Upper Imenti, for example, had not been signed by mid-2010, dampening CFA enthusiasm in jointly managing forests with government institutions. Moreover, few benefits have trickled down to the communities. The longstanding logging ban and the recent grazing ban in gazetted forests by NEMA have made it more difficult for communities to participate in management of forests as they do not derive any benefits from them. Box 5.1 describes community forest associations in greater detail.

The Aberdare forest range is characterized by a high diversity of forest types due to its wide altitudinal range.

Christian Lambrechts/UNEP

Some farmers have established their own woodlots on farms, thereby reducing pressure on forest products. In addition, farmers remain committed to wildlife conservation. A solution to crop raiding by wildlife may lie in fencing off vital protected areas that host wildlife. This is gradually gaining acceptance in many parts of the country where human-wildlife conflicts are prevalent. Further, access gates to the country's protected areas are not always located in places where they best serve the interests of local communities.

The Aberdare Range

The Aberdare range forests are made up of 15 protected blocks covering 256 515 ha and are located on the eastern edge of the Rift Valley. The Aberdare Range spans the Equator west of Nairobi rising to over 4 000 m at its highest peak. Its western escarpments drop dramatically toward the Rift Valley and to the east it slopes gradually, carrying water into the Tana River and to the Seven Forks hydropower plants where over half of Kenya's hydropower is generated. On their way into the Tana, the Chania River flows into Sasumua Dam, and the Thika River into Ndakaini Dam, from which more than three million people in Nairobi obtain most of their drinking water. The Aberdares also form part of the upper catchments of the Athi, Ewaso Ng'iro and Malewa Rivers. The forest belt of the Aberdare Range includes Aberdares, Kikuyu Escarpment, Kijabe Hill, Kipipiri and Nyamweru. An area of 760 km^2 of the forest falls within the Aberdare National Park. The range is characterized by a high diversity of forest types due to the wide altitudinal range (1 800-3 600 m) and climatic differences between slopes. The forests are threatened by large-scale, uncontrolled, irregular or illegal human activities particularly charcoal production, logging, encroachment and settlement, cultivation of crops and livestock grazing. These challenges pose a great threat to Kenya's water security, biodiversity conservation and economic development, all of which are indispensable to realizing the social pillar goals of Vision 2030. Between 2005 and 2007, the Aberdare range forests showed no significant changes in forest cover (Akotsi et al 2009). This may be due to the fact that Kenya's pilot fencing and rehabilitation activities were pioneered here. As one of the impacts of this has been improved forest cover, fencing off the country's main forests should be scaled up and plans to replicate this in Mount Kenya with the assistance of the Rhino Ark are in advanced stages.

Mount Elgon Forest

This forest covers 102 695 ha and forms the upper catchment of the Nzoia and Turkwel rivers. It also provides water to Malakisi River that crosses farming areas south of the mountain before entering Uganda. Mount Elgon lies on the Kenya-Uganda border where protected areas on the Kenyan side include Mount Elgon National Park, Chepkitale National Reserve and Mount Elgon Forest Reserve. The latter contains globally threatened species some of which are endemic to the Afro-montane region while others are endemic to Mount Elgon. These features make Mount Elgon a major tourist attraction and the conservation of the area should therefore be prioritized for species conservation. A rapidly growing population of around two million people around the mountain places immense pressure on this unique ecosystem.

Authorized logging has been practised in Mount Elgon since the 1930s. A 1986 Presidential Decree banned all logging in Kenya's natural forests but excluded Mount Elgon where legal logging continues. In the 1970s, land was excised from the Mount Elgon Forest around

A road through the Mount Elgon forest, which is a transboundary forest shared with Uganda.

Chebyuk where 600 families were settled. Agricultural encroachment and charcoal production are degrading the forest in many areas as well. In several cases, the forest has been cleared for crop farming on slopes that are not suitable, making them susceptible to erosion and landslides. Continued degradation and forest loss on Mount Elgon threatens to undermine the area's crucial role as a water catchment for the surrounding region. A recent survey of Mount Elgon forests showed no significant changes in forest cover between 2005 and 2007 (Akotsi et al 2009) but this could be misleading given anecdotal evidence of the resurgence of unlicensed logging in this forest. This is in spite of the fact that the 2005 Forests Act provides for participatory forest management with this being a clear indication that the approach has not yet taken root in the country. As such, it could take time for the management plans for Mount Elgon Forest to be completed.

Continued good performance of this transboundary ecosystem requires regular monitoring on both the Kenyan and Ugandan sides. It is therefore an ideal candidate for joint management planning through the Nile Basin Initiative (NBI), a partnership initiated and led by the riparian states of the Nile River. NBI seeks to develop the river in a cooperative manner, share substantial socioeconomic benefits, and promote regional peace and security. Cooperative water resources management is complex in any international river basin. It is particularly difficult in the Nile Basin which is characterized by water scarcity, poverty, a long history of dispute and insecurity, and rapidly growing populations and demand for water. NBI initiated a participatory process of dialogue among the riparian countries that resulted in agreeing on a shared vision to 'achieve sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources.' Efforts should be made to procure funding under the Nile Transboundary Environmental Action Project of the

A section of the Cherangani Hills forest that has been converted to farmland.

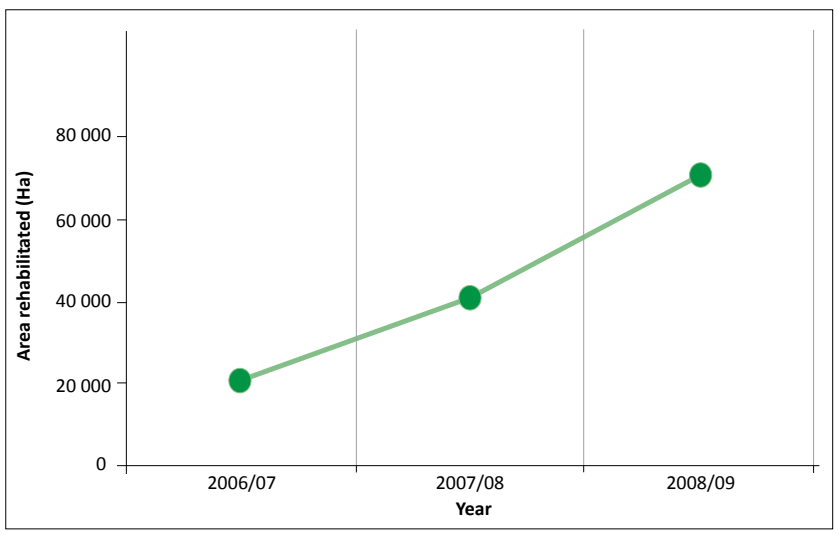


Figure 5.3: Natural forest rehabilitation trends Source: GoK 2008a

Shared Vision Programme for conservation of the Mount Elgon Forest so that it remains a pristine Nile Basin water catchment. At the national level, it is encouraging to note that squatters who hold claims to land in the gazetted Mount Elgon forest have received government assistance to resettle in the Chepyuk settlement scheme which entered its second and third phases in 2010.

The Cherangani Forest

The Cherangani Forest is composed of 14 forest blocks scattered along the Cherangani Hills that cover an area of 97 397 ha. It is located on the western ridge of the Great Rift Valley and forms the upper catchment of the Nzoia, Kerio, and Turkwel rivers. It is an ancient fault-block formation of non-volcanic origin with a series of gently rolling hills that form an undulating upland plateau on the western edge of Kenya's Rift Valley. These hills lie between the Elgeyo Escarpment to the east and Mount Elgon to the west, rising to 3 365 m above sea level at Cheptoket Peak in the north-central section. Located on the Cherangani escarpment, the hills are covered by a number of gazetted indigenous forest reserves. There has been active participation of local CFAs in the management of the forest with their vigilance helping to stem illegal logging activities. For example, a road expansion project that cleared swathes of the forest incurred the wrath of the local people who formally complained to the forest zonal manager. KFS should take note of such positive actions and use these to cement its relationship with CFAs. This could, for example, help KFS to keep pastoralists out of forests such as that in Marakwet.

A stand of mangroves in the Mikokoni area Lamu County.

Over the last 20 years, local inhabitants have encroached on forest land converting it into farmland. Cherangani Hills was however the least affected of the five forested water towers, with only 174.3 ha deforested. So far, a total of 29 352 ha of degraded natural forests have been rehabilitated out of which 2 752.2 ha were earmarked for enrichment planting. Another 26 600 ha were put under protection for natural regeneration. This brought the total area currently under restoration to 70 250 ha over the past three years. These trends are shown in Figure 5.3.

Mangrove forests

Mangrove forests located along the Indian Ocean coastline have traditionally supplied wood and non-wood products to places as far away as Arabia. A mangrove timber export ban imposed in 1982 in order to reduce over-exploitation and degradation of mangrove forests was revoked in 1993 (Better Globe 2009). The normal practise is that poles are selectively harvested, leaving behind crooked trees of poorer quality. There are many knowledge gaps that need to be filled in developing the most appropriate methods for sustainably managing this resource in future. Mangroves also deserve urgent attention as there are indications that rising sea levels caused by global warming will adversely affect them. The proposed construction of a deep sea port in Lamu is also likely to have far reaching implications on the 360 km^2 of mangroves growing in the archipelago.

The non-material benefits of forests relating to aesthetics and recreation, such as those provided by this Mount Kenya forest are often unappreciated.

Endowment value of forest and woodland resources

The contribution of forestry to the Kenyan economy is currently undervalued in terms of GDP contribution (GoK 2008c). Consequently it is poorly mainstreamed into macro and sectoral plans and its budgetary allocation is low. The total value of the resource is not fully quantified either as inventorying has only been carried out in the protected forest areas on an ad hoc basis. Moreover, resources falling outside these protected areas are not accounted for. It is therefore necessary to adopt an appropriate accounting and evaluation system for forests and woodlands that will reflect their true value.

Total environmental accounting for all goods and services provided by forest ecosystems continues to draw worldwide debate. The economic benefits contributed by the Mount Kenya forests, for example, are estimated at about Ksh. 2 billion per year (Emerton 1997). The bulk of this value comprised watershed catchment protection and domestic use benefits but excludes ecological, option and existence values.

Timber products

Sawn timber remains highly valued and in short supply in Kenya for a number of reasons. One is that the land available for forestry is diminishing in medium to high potential agro-ecological zones. Forests in such places face direct competition from land for agricultural production. Growing demand for land for agriculture, infrastructure and urban development—estimated at 5 000 ha per year—exerted by an increasing population on limited arable land is dramatically reducing forest acreage (World Bank 2007).

Apart from sawn timber, forests provide posts for construction as well as poles for fencing and power transmission. Other woody products that are derived from them include pulp as well as block and fibre boards. The sale of forest products is recorded to have increased from 423 400 to 503 700 m^3 from 2007 to 2008. Forests also play a direct role in supplying domestic energy requirements in the form of wood fuel and charcoal. This fact is not captured appropriately in national economic surveys since petroleum-based products are viewed as the key drivers of the economy (GoK 2010c). Redressing this disconnect would be useful in better appreciating forests' contribution to the economic and social pillars of Vision 2030.

Plantation forests which represent 0.3 percent of the country's forested area mostly comprise Cupressus lusitanica and Pinus patula. They are complemented by smaller areas planted with Eucalyptus species. Establishing and maintaining young plantations became a major challenge following the abolishment of the 'shamba' system in the country in 2003. In its place, non-residential cultivation was strongly recommended after studies showed that it could be equally effective if well regulated for the mutual benefit of the government and communities involved (Kagombe and Gitonga 2005). This arrangement is currently being undertaken through CFAs using the terms of the Plantation Establishment and Livelihood Improvement Scheme (PELIS). Under such terms, 3 519 ha of industrial forest plantations were established in 2008 (GoK 2008a). The 2005 Forests Act also provides for participation of communities and the private sector in forest management through licensing and concession agreements. Because of delays in signing these agreements, the relevant subsidiary regulations should be urgently finalized (World Bank 2007). Only 3 of 19 regulations have been finalized so far.

Demonstration of efficient wood processing at farm level.

The logging ban has had a range of negative outcomes for forest conservation even though it was intended to protect forests from over-exploitation. Trees worth more than Ksh. 10 billion are over-mature while silvi-cultural thinning operations have fallen behind schedule, leading to a loss of about Ksh. 3.5 billion in government revenue. A large amount of resources is also spent on enforcement of the ban which would have been available for alternative economic activities in the forestry sector. As a result, a black market is flourishing where timber fetches premium prices. Harmonization of tariffs within the East African Community could help to reduce smuggling of forest products within the region, enhancing forest conservation. This will also provide opportunities for the region to trade in timber products (World Bank 2007).

Demand and supply of forest and woodland products

Kenya has an annual per capita wood consumption of 1 m^3. A strategy is required to cover the total deficit of 7 million m^3 required for satisfying the huge national demand that stood at 37 million m^3 in 2009 (GoK 2009a). This makes Kenya a net importer of wood products as current supply does not satisfy demand. The logging ban in state forests continues to adversely affect all saw millers with the exception of three firms which were exempted from the ban. Much of the wood in the market is thus obtained from trust lands and farmlands.

Rising costs of petroleum-based fuel and high electricity tariffs have resulted in most of Kenya's population relying on wood fuel as the primary source of energy. This encourages further destruction of forests and woodlands. Charcoal production and trade have thus become a critical part of the economy in the country's drylands, providing domestic energy for 82 percent of urban and 34 percent of rural households. This industry represents an estimated annual value of over US $ 427 million (KSh. 32 billion). It employs over 700 000 people along the entire chain and indirectly supports over 2.8 million people. This is despite the unfavourable policy and legal environment that charcoal production operated under before the Charcoal regulations were gazetted in 2009. It is estimated that 1.6 to 2.4 million tonnes of charcoal are used in the country annually and this has negative environmental consequences since the trees that produce this charcoal are unsustainably harvested (GoK undated). In the ASALs, indigenous tree species such as Balanites, Acacia, Terminalia, Combretum, Dalbergia and Newtonia are preferred for charcoal-making even though they have a comparatively low regeneration capacity. Charcoal is also often produced as a by-product of other forms of land use change, for example, after clearing land for cultivation. Such traditional methods of land clearing destroy an equivalent of 121 061 ha of forests per year, or 12 km^2, accelerating desertification in the country.

Water supply

Forests serve as major reservoirs of water which they store up to 20m below ground and release slowly into the rivers. Evapo-transpiration within the forest contributes to formation of rain clouds. Forests also trap moisture in water-laden winds, convert it into water droplets and cause it to fall as rain on a frequent basis. The organic matter on the forest floor slows down water movement and mitigates flash floods. This in turn protects the human settlements, infrastructure and crops located downstream. The forest canopies intercept rain drops, dissipating their impact and preventing soil erosion.

Forests will therefore continue to play an important role in water catchment, especially given Kenya's status as a water scarce country. It is thus recommended that appropriate compensation schemes for suppliers of watershed ecosystem services are developed and implemented. This will ensure a steady flow of water for irrigation, intensive agriculture, urban settlements, industrial processes as well as hydro-power plants that traditionally produce most of Kenya's electricity output (UNEP 2009a). There is need to undertake all developments in a logical manner so that incidents such as construction of dams in gazetted forests as happened in South Nandi are avoided. This catchment service is particularly important given the prolonged drought that the country frequently experiences and which substantially depresses capacity to generate hydro electric power.

The potential of hydro-power generation from rivers whose upper catchments are in the Mau Forest such as the Sondu and Ewaso Ng'iro is considerable. The Sondu-Miriu hydropower scheme, whose catchment is the South West Mau Forest Reserve cost US$ 54 million to construct and has an installed capacity of 60 MW. In addition, the Sang'oro hydropower scheme will add 21.4 MW to the national grid when it is completed. Figure 1.8 (Chapter 1) shows the existing and planned power plants around the country.

Non-wood products

Non-timber products comprise mainly food and pharmaceutical raw materials that are mostly derived from woodlands. These are in such high demand that sometimes their sources become endangered, requiring legal protection. For example, because of over-exploitation in the wild, aloes are recorded on the IUCN red list.

Essential oils, gums, resins, herbal medicines, silk and honey, are among other commodities derived from the sector although their value has not been comprehensively assessed. It is clear however, that the annual consumption of gum arabica is on the increase in the domestic market and that prices are highly variable along the value chain (Better Globe 2009). Further, Kenya has 59 indigenous species of aloe, some of which are endemic. In order to tap the full potential of these aloes, their commercial production has been regularized. Relevant government agencies should also disseminate the economic opportunities that domestication of previously wild species present.

Inhabitants of the ASALs rely heavily on non-timber forest products. Indeed 90 percent of the livestock medicines they use are herbal-based. In arid areas, gums and resins are harvested from various trees and are a source of income. Acacia senegal var. kerensis grows widely in the drylands and produces gum arabica in commercial quantities. Two other varieties of this tree namely, Acacia senegal var. senegal and Acacia senegal var. leiorachis are also producers of gum arabica although the extent of their commercial potential has not been conclusively established. Northern Kenya is estimated to have the capacity to produce 10 000 tonnes of gum arabica per year of which only 30-50 tonnes are currently consumed by the domestic market in the adhesives, printing, food and pharmaceutical industries (Better Globe 2009).

Another important species is the East African sandalwood (*Osyris lanceolata*) which occurs in parts of Kenya as well as Algeria and Zimbabwe although it is not abundant in any one place. It is a hemi-parasitic plant that grows in the wild and is prized for its scented wood and essential oils. As such, it has attracted considerable interest in pharmaceutical and cosmetic industries in the Middle East, Europe and South Africa (CBK 2009). In Kenya however, it enjoys a protected plant status. The volume of impounded products is not well recorded so it is not possible to gauge the scale of illegal activities that are undermining its conservation.

Prunus africana is a classic example of how economic pressure can threaten the very existence of a species. As with other members of the Prunus genus, *Prunus africana* possesses extrafloral nectaries that provide anti-herbivore insects with a nutrient source in return for protecting the foliage. While the fruit is too bitter to be eaten by humans, it is consumed by many animals. In addition, it is a habitat for the rare Carruther's Mountain Squirrel which is currently protected under Appendix II of CITES. Further, a herbal remedy prepared from

A field of Aloe turkanensis on a farm in Baringo District.

KEFRI

Wood carvings are some of the wares on sale in many craft markets in Kenya.

the bark of *Prunus africana* is used to treat a benign prostatic hyperplasia. The over-harvesting of mature bark for this purpose threatens these species because stripping off too much bark kills off the trees. In the 1990s, it was estimated that 35 000 debarked trees were being processed annually. The current figure is estimated to be much higher.

Wood carvings

The wood carvings industry has good potential for wealth generation and provision of employment in line with the aspirations of Vision 2030. The industry earns an average of US$ 20-25 million annually in export revenue from carvings bought by tourists. The preferred indigenous tree species such as *Brachylaena huillensis* (Muhugu), *Combretum schumanii* (Mkongolo) and *Dalbergia melanoxylon* (African Blackwood or Mpingo) have already been exhausted in many of the original sources and there have been initiatives to move onto more sustainable sources (CBK 2009). These include fast growing tree species that can be introduced on farms. Wood carving is listed as one of the threats facing conservation of the Chyulu Hills ecosystem (KFWG 2011). An entity which aims to certify forest products as harvested using sustainable methods was registered in 2010. Such certification processes should help to support production of wood carvings on a sustainable basis.

Tourism

Forests are major habitats for wildlife and are major contributors to the tourism sector's foreign exchange earnings. In addition, montane forests supply water to biodiversity sanctuaries such as Lake Nakuru National Park which depends on the Molo River and the Maasai Mara National Reserve whose lifeblood is the Mara River. Both rivers originate from the Mau Forest Complex (CBK 2009) and are central to buttressing tourism's role in meeting the Vision 2030 aspirations. Rivers that originate from the Mau forests also flow through a number of conservation areas where the tourism potential is not fully developed. These include Kakamega, Kerio Valley and South Turkana, Lake Baringo and Lake Natron National Reserves. These conservation areas host a diversity of flora and fauna and closed canopy forests are major habitats for a large percentage of the country's wildlife and other biodiversity. In spite of their small area, they contain 50 percent of the country's tree species and it is estimated that they harbour 40 percent of larger mammal, 30 percent of bird and 35 percent of the nation's butterfly species. Indigenous forests are home to both endemic and threatened species.

Kenya's forests also provide great potential for ecotourism which

Sibiloi Petrified Forest near Lake Turkana in northern Kenya. Petrification is a natural process that occurs when all organic material in a tree dies and is replaced by a combination of minerals. Once complete, petrified wood is no longer considered wood and becomes classified as stone.

Box 5.2: Seven points to define ecotourism

1) **Involves travel to natural destinations:** These destinations are often remote areas, whether inhabited or uninhabited, and are usually under some kind of environmental protection at the national, international, community or private levels.

2) **Minimizes impact:** Ecotourism strives to minimize the adverse effects of hotels, trails, and other infrastructure by using either recycled materials or available local building materials, renewable sources of energy, recycling and safe disposal of waste and garbage, and environmentally and culturally sensitive architectural designs. Minimization of impacts also requires that the numbers and the behaviour of travellers is regulated to ensure limited damage to the ecosystem.

3) **Builds environmental awareness:** Ecotourism means education, for both travellers and residents of nearby communities. Well-trained, multilingual naturalist guides with skills in natural and cultural history, environmental interpretation, ethical principles and effective communication are essential to good ecotourism. Ecotourism projects should also help educate members of the surrounding communities, school children and the broader public in the host country about the importance of environmental conservation.

4) **Provides direct financial benefits for conservation:** Ecotourism helps to raise government funds for environmental protection, research and education through a variety of mechanisms, including park entrance fees, tour company operations, hotel, airline and airport taxes.

5) **Provides financial benefits and empowerment for local people:** National Parks and other conservation areas will only survive if there are 'happy people' around their perimetres. The local community must be involved and receive income and other tangible benefits (potable water, roads, health clinics, etc.) from the conservation area and its tourist facilities.

6) **Respects local culture:** Ecotourism is not only environment-friendly, it is less culturally intrusive and exploitative than conventional tourism. It strives to be culturally respectful and has a minimal effect on both the natural environment and the human population of the host country. Part of being a responsible ecotourist is learning beforehand about the local customs, respecting dress codes and other social norms and not intruding on the local community unless invited or when visiting as part of an organized tour.

7) **Supports human rights and democratic movements:** Ecotourism demands a more holistic approach to travel, one in which participants strive to respect, learn about and benefit both the local environment and local communities.

Source: Classic Escapes 2009

has the potential to significantly reduce poverty because it typically involves local communities in enterprise management and monetary benefit sharing. The fundamental characteristics of ecotourism are highlighted in Box 5.2.

Opportunities in the forest sector

Economic opportunities

The forestry sector contributes tangible and non-tangible benefits to the Kenyan economy worth more than KSh. 20 billion. More than one million households living within a radius of 5 km of forest reserves benefit in various ways from them through grazing, fishing, collection of firewood, water and herbal medicines. Other opportunities include butterfly farming and bee-keeping. Efforts should be made to ensure greater participation of women in forestry development since the 2005 Forests Act is gender neutral and does not take into account the gender-specific impacts of this and other legal and policy interventions.

The Forests Act also provides opportunities for joint management of state-owned plantation forests through concessions, licenses, contracts, joint agreements and other public private partnerships. This will promote tree planting and also stimulate the creation of a sustainable forest industry which will eventually result into increased forest cover and with it, greater welfare benefits to the poorer segments of society promised by Vision 2030.

For the country's forests to fulfil their full economic potential, KFS should intensify its surveillance and build partnerships with local communities. The latter can play an important watchdog role in stopping encroachment on the forests and illegal logging. It should also employ legal and voluntary mechanisms to rehabilitate degraded forests.

Women farmers here participate in tree planting activities that focus on farm forestry.

Carbon sinks and carbon trading

In 2005, Kenya ratified the Kyoto protocol and was the first African country to engage in carbon trading. This was after the Kenya Electricity Generating Company (KenGen) concluded an emissions reduction agreement with the World Bank. Three hydro power plants and one geothermal project have since been accepted by the World Bank Carbon Finance Unit. These projects are Olkaria II 3rd Unit at Eburru, Kipevu Combined Cycle at Kiambere, Sondu Miriu and the redevelopment of Tana Power Station. These projects are estimated to displace 2.4 million tonnes of carbon dioxide and generate revenues of about US$ 17.9m for KenGen.

Mumias Sugar Company has also entered into an agreement with Japan Carbon Finance to buy carbon emission reductions. This will see the company reduce its carbon and methane emissions by using bagasse to generate electricity. The money generated from these projects will be used to finance geothermal development and a number of community development projects (Mazingira News 2009).

Kenya's forests act as important carbon sinks. Healthy forests also increase the resistance of ecosystems to climate change by stemming land degradation. There is therefore need to encourage tree planting and to enhance forest cover by ensuring that many tree seedlings are planted for each tree that is harvested. The KFS has begun a project of planting 6 million trees around the country to help in reforestation. Kenya has also signed its first carbon deal under the Reducing Emissions from Deforestation and Forest Degradation (REDD) programme between Wildlife Works Carbon and KFS. The project aims to protect the 80 000 acre Rukinga Forest Reserve in south-eastern Kenya. This project will create a corridor that links the Tsavo East and Tsavo West national parks which together form Kenya's largest protected area. These parks have nevertheless been under threat from overgrazing, poaching and deforestation (GoK 2010e).

Charcoal burning releases 14.4-21.6 million tonnes of CO_2 emissions so degradation of the drylands (which are the main sources of charcoal in the country) contributes to global warming and climate change. Clean Development Mechanism (CDM) projects and mitigation measures have the potential to improve rural livelihoods in activities such as brick and charcoal making as well as agro-processing. Pioneers of CDM in Kenya include the Green Belt Movement which has spearheaded small-scale reforestation projects in the Aberdare and Mount Kenya regions that are funded by the World Bank. The projects bring together players such as KFS and a number of CFAs in activities related to climate change mitigation. The National Environment Management Authority (NEMA) website lists all the other licensed CDM projects. For them to succeed, it will be necessary for KFS to control illegal activities such as grazing in the forests as this poses a threat to the survival of the trees established in carbon projects.

Agroforestry

Croplands are spread out across Kenya, from the high rainfall areas in the highlands to more marginal cropping areas which are often classified as agro-pastoral. Due to scant and erratic rainfall, the major land use in the ASALs is a limited amount of cropping mixed with livestock keeping. Croplands and associated agro-ecosystems cover about 20 percent of Kenya (WRI 2007). For most of Kenya, rainfall alone is not sufficient to grow crops and in the ASALs that are not irrigated, a patchwork of grasses, shrubs and trees dominate the landscape with water availability and soil types determining the exact spatial patterns of plant communities.

Small scale charcoal production in Baringo: Charcoal is a commodity that is commonly offered for sale in the ASALs.

Livelihood strategies adopted by Kenyan families range from those that predominantly focus on livestock products in rangeland ecosystems to a combination of livestock, food and cash crops in areas with adequate rainfall and suitable soils. The six dominant livelihood classes are:

- Forests combined with fishing
- Pastoral or agro-pastoral
- Marginal mixed farming
- High potential mixed farming
- Cash cropping or irrigated cropping
- Wage labour or urban livelihoods

Pastoral livelihoods dominate the ASALs while cropping combined with pastoral livestock keeping (agro-pastoral) is practised in the margins of areas where rain-fed agriculture is possible (WRI 2007). This is also practised in areas around permanent water sources such as on mountainous areas and along river courses in the dry belts of Kenya. High potential agricultural lands in central and western Kenya are dominated by a combination of dairy, food and cash crop farming. Farmers in areas with less fertile soils and erratic rainfall such as along the coast of the Indian Ocean prefer a blend of livestock and food crops. Fishing is sometimes combined with pastoral livestock keeping or food crop cultivation but this is a localized occupation.

Farms are now recognized as a source of 30-50 percent of Kenya's wood supply. Agroforestry is the primary source of wood fuel while private lands (farms or range lands) are the major source of wood for charcoal. The proportion of croplands covered by woodlots is highest along the foothills of the Aberdare Range and Mount Kenya, in Central Kisii, as well as Nyamira and Buret Districts. In some instances, woodlots cover more than 12 percent of the land. Spatial patterns are determined by factors such as proximity to densely settled rural and urban areas, as well as other pockets of high wood demand (for example, the tea growing areas).

Even in places where tree planting efforts are limited by climatic factors, farmers still plant some trees to demarcate boundaries and meet their energy requirements. This calls for greater allocation of funds for drylands forestry research in order to provide farmers with a wider choice of options for tree growing in the country's drylands. Charcoal production and firewood collection are important economic activities and contribute significantly to income generation in all areas except the remotest locations or those with very little woody vegetation. Besides improving livelihoods, tree planting in drylands is an effective way to control desertification.

A young Cedar forest in Aberdare National Park.

Threats to harnessing the opportunities provided by forests and woodlands

Population pressure

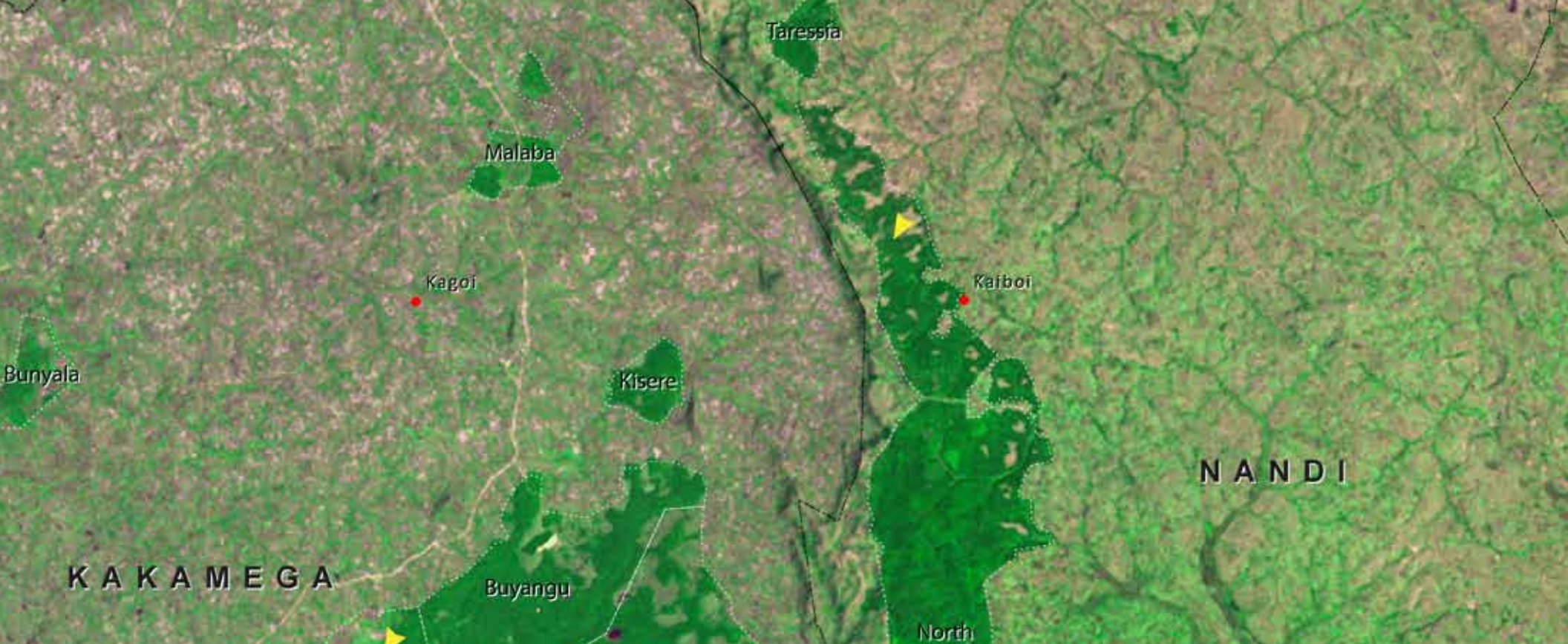
Loss of forests and woodland resources in Kenya is closely related to population dynamics and over-exploitation of wood products, conversion into agricultural land and other land uses. The greatest threat to our environment (forests and woodlands included) is however posed by poverty whereby people's basic needs for adequate food, shelter and health are not met. Efforts to obtain basic needs under such circumstances generally lead to destruction of forests and woodlands. Unsustainable land use is also driving land degradation which has negative impacts on the economy and livelihoods, exposing more than 23 percent of vulnerable rural communities to desertification in Kenya.

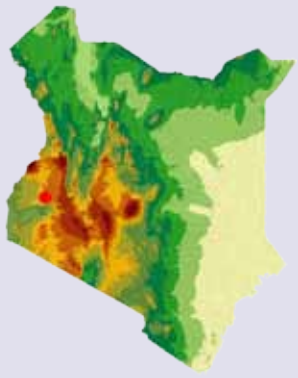
Kenya's population is on the rise and stood at stood at 38.6 million in 2009 (GoK 2010d) and at the 2.9 percent growth rate, it is estimated to stand at 40.9 million in 2011. The resulting high demand for forest and woodland products by a rising population creates land use conflicts and environmental degradation as forests are cleared to make way for human settlements and agriculture. Frequent droughts in Narok, for instance, are attributed to the rapid growth of settlements and the increased rate of deforestation by conversion of bushlands into smallholder farms, charcoal burning and illegal logging upstream in the Mau forest (UNEP 2009a).

Encroachment and illegal logging

On average, 5 000 ha of forest cover are lost every year through illegal logging, encroachment, excision for settlement of people and cultivation (GoK 2010f). In 2001, the excision of 67 000 ha of forest was justified as needed to settle landless Kenyans and those internally displaced by political turmoil. This excision however resulted in a major disruption of the functions of Kenya's water towers (Wamahiu 2009). Illegal timber harvesting is also rampant since the logging ban is not adequately enforced, highlighting the need to raise the capacity of KFS to do so. The Maasai Mau Strategic Plan 2010-2020 showcases what can be

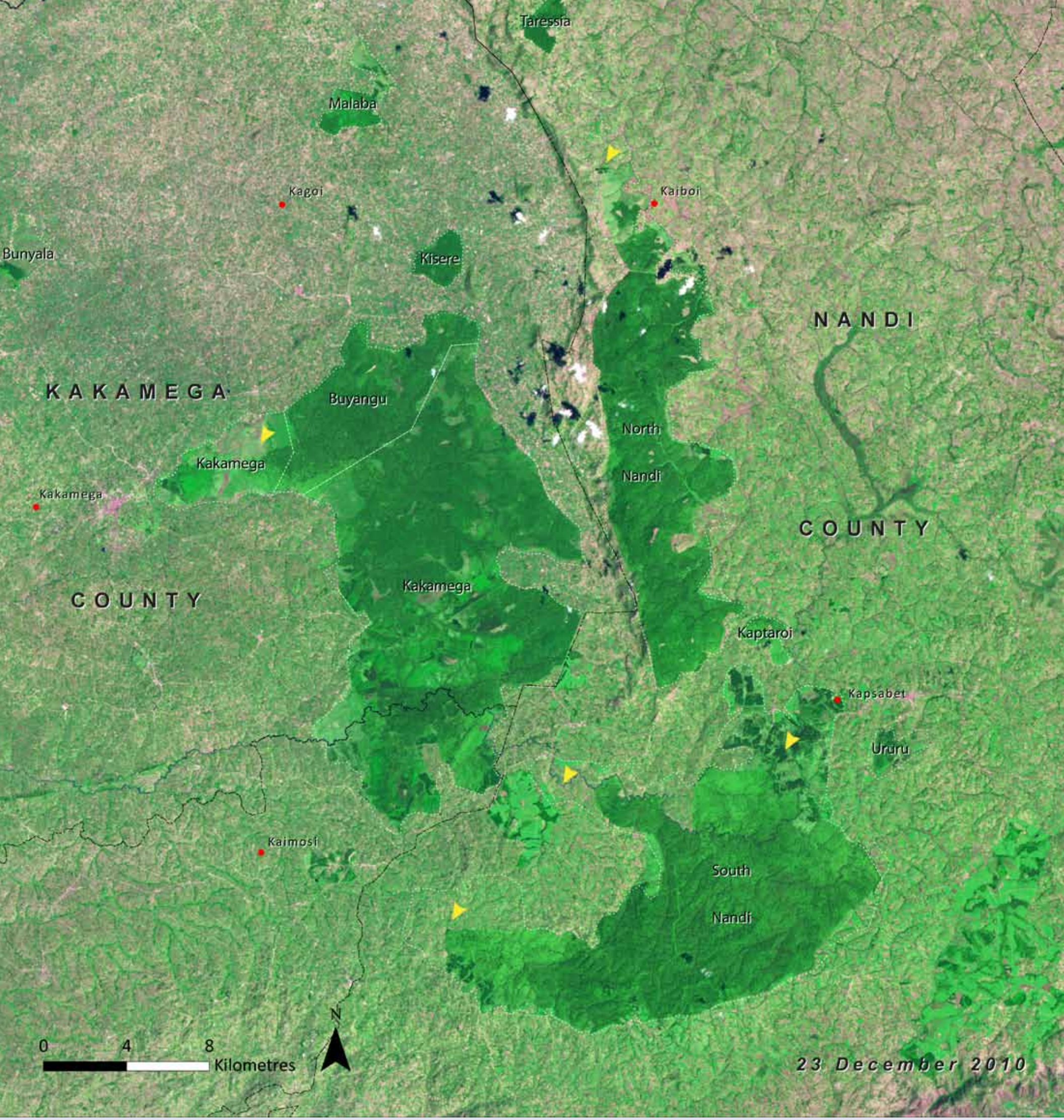
Encroachment and illegal cultivation in Maasai Mau Block of the Mau Forest Complex.





Kakamega Forest – Kakamega forest, the only surviving rain forest in Kenya is a remnant of the Guineo-Congolian rainforest presently scattered across Uganda, Democratic Republic of the Congo and Kenya. This forest harbors dominantly central African flora that distinguishes it from other forests of Kenya. It is a precious remnant of the once vast Trans-Africa ecosystem that provides a unique sanctuary for a remarkable diversity of endemic plants, birds and insects. Between 10-20% of the total number of animal species are endemic to the forest.

Changes in land use of the forest ecosystem, aggravated by the increase in human population around the forest ecosystem have occurred within the past three decades. This population depends on the forest for their livelihood from which they obtain a variety of products



such as food, herbal medicines, woodfuel and building materials. As a result parts of the forest have been converted to agricultural activities and settlements.

A 1991 survey which compared standing timber volumes with those from similar surveys 26 years before showed that in the short period, the forest had lost 50% of its volume. The study further predicted that it would take about 60 years to establish complete protection of the forest and restore it to its 1965 condition assuming no other interventions are adopted. These two Landsat images (1973 and 2010) clearly capture this trend.

Category	Total Area (ha) 1970s and 2000s		% change (1970s-2000s)	% change 2030 (ha)
Woodland	444 079	49 231	-88.9	Substantial
Shrub land	374 202	785 890	52.4	53.0
Bare land	59 242	804	-98.6	-
Cropland	42 388	328 104	87.1	94.0
Close natural forest	390 871	189 050	-51.6	-60.2
Open natural forest	-	103 174	100.0	100.0
Grassland	201 223	55 752	-72.3	-74.3
Total (Ha)	1 512 005	1 512 005		

Table 5.2: Land-cover change in Narok district Source: NEMA 2010

achieved through cooperation between the private sector, and central and local governments. Such plans are important reference points that can motivate stakeholders to withstand political pressure and act rationally to save the country's environment in order to secure ecological services for the present and future generations.

Overexploitation

Deforestation in all of Kenya's five waters towers is mainly due to poor environmental governance. The consequences include loss of forest cover, increased soil erosion, drying of rivers and streams, siltation in dams and increased costs of forest-related products such as timber (NEMA 2005). The statistics of land cover/land use change in Narok District between 1970 and 2000 is detailed in Table 5.2. The projected scenario by 2030 depicts substantial change in the area under woodlands, closed natural forests and grasslands.

Vulnerability to climate change, pests and diseases and fires

Forests and woodlands are particularly vulnerable to climate change. This is because the impacts of climate change and variability lead to changes in land cover and land use, increase the incidence of pests, diseases and fire outbreaks and foment loss of livelihoods (Ojwang et al 2010). Monoculture forest plantations are especially prone to pest attacks and an exotic pest known as blue gum chalcid is currently threatening eucalyptus trees in Kenya. First reported in western Kenya in 2002, it has now spread to most parts of the country. This pest is native to Australia and research to develop integrated management approaches (including biological measures) that can bring it under control is underway.

An estimated 3 000 ha of state forests are lost to fires annually. These fires are either spread accidentally from neighbouring private farms or are started deliberately as an act of sabotage. It is therefore recommended that a participatory approach to formulating and implementing forest policies and projects is adopted in order to ensure local community support.

A section of the Maasai Mau forest that has largely been cleared for human settlement.

Christian Lambrects/UNEP

Manual clearing works well in bringing thickets of Prosopis juliflora under control.

Tree diseases can occur on seed, seedlings and planted trees. Seeds mostly suffer from *Fusarium*, *Penicilium* and *Aspergillus* fungal infections which are best prevented by using only certified seed that is free of infection. Seedling diseases include damping off caused by Fusarium fungus, mildew on young seedlings caused by *Oedium* sp. (powdery) and shot holes on indigenous seedlings. These challenges can be adequately addressed in the tree nursery by reducing sowing density to overcome damping off, applying fungicides and avoiding excessive watering. Seedlings that have been exposed to sufficient sunshine are also generally less susceptible to diseases.

Rhizomorphs under the bark, a symptom of Armillaria root rot disease.

Invasive alien plant species

The current and most well-known case of an alien plant becoming invasive in Kenya is that of Prosopis juliflora that has colonized the ASALs. This exotic tree was originally introduced for fodder, and wood fuel production. It is now considered a weed that competes with indigenous vegetation. A number of technologies which promote utilization of its timber and non-timber products in order to control it have been advanced by Kenya Forestry Research Institute (KEFRI). KEFRI has also imported a biological control agent that could help to tame *Prosopis*.

Harnessing the opportunities in forests and woodlands

The Forests Act 2005

For many years, forest legislation and practise in Kenya has been criticized for failing to protect the country's indigenous forests or to ensure sustainable use of plantations and other areas of forest and woodland (World Bank 2007). Prior to the enactment of the 2005 Forests Act, most forest-adjacent communities were alienated by exclusion from forest management. The 2005 Forests Act was a timely piece of legislation that instituted the necessary legal mechanisms to comprehensively address the challenge of sustainable forest management. The law contains many innovative provisions to correct previous shortcomings and creates an enabling environment for developing the institutional capacity of the relevant agencies. It also promotes community participation in forest management and benefit-sharing, nurtures transparency and accountability and encourages the formation of public-private partnerships. In addition, it takes cognizance of the role of farm forestry and dry land forests.

The Forests Act also enables members of forest-dependent communities to enter into partnership with KFS through registered CFAs. So far, 351 CFAs have been registered. Out of these, 36 have had their management plans approved as already indicated. More active involvement of local communities is currently hampered by lack of information on potential benefits as well as lack of awareness on the mechanisms for benefit sharing. Any further delays in the process of drawing up forest management agreements should be avoided in order to sustain the interest of local communities and potential donors (KFWG 2010).

Conservation efforts by a Community Forest Association in Narok District.

The Forests Act 2005 in 2011 and beyond

Implementing the Forests Act of 2005 was already causing conflict with other national legislation under the old constitutional dispensation. It is however now due for review in order to align it with the new Constitution. This could be the perfect opportunity to address the thorny issues it contains. For example, the Water Act of 2002 provides for the formation of committees to manage catchment areas gazetted under the Act. The Forests Act also provides for the formation of committees at the conservancy level for managing forests. There are no clear linkages in the operations of the two committee categories, each of which is constituted by different individuals. There is also conflict between the 2005 Forests Act and the Wildlife (Conservation and Management) Act (Cap 376), especially where forests are double-gazetted. The wildlife law does not allow consumptive utilization of natural resources within national wildlife parks while the former does. Besides, the Environmental Management and Coordination Act (EMCA) mandates NEMA to conserve the biological diversity which has a direct bearing on forest resources. Management of forests and woodlands also has to take into account the National Environment Action Plan (NEAP) of 2009 which recommends a range of actions to address environmental issues in Kenya. The Trust Lands Act, Local Authorities Act and Chiefs' Authority Act all pose potential risks of conflict of interest or of power relations. There is therefore need to urgently harmonize all these policies and laws (World Bank 2007).

Strengthening policy and legal frameworks

There are various laws and policies governing the management of forests and woodlands in Kenya. These include the Constitution, forestry master plans, laws and policies dealing with land tenure as well as sectoral laws on wildlife, water and agriculture. In the past, Presidential decrees were also issued on matters concerning forests and woodlands even though they were often not backed by legislation and were difficult to implement. Whereas from a legal perspective, land tenure is governed by various policies and laws that have a direct impact on the conservation or excision of forests, access to land is governed by various cultural practises at the community level. Customary laws most often determine overall ownership of property as well as succession and inheritance of productive assets. In most cases, males are the owners, beneficiaries and successors of these productive assets. In contrast, women are subjected to systematic discrimination that is associated with legal pluralism, where enacted laws are often superseded by customary and religious laws (NALEP 2010). It is therefore vital to carry out educational programmes that elicit attitudinal shifts with regard to the status of women.

Actualizing constitutional provisions could be effected by ensuring that implementation of relevant provisions of the new Constitution features in annual performance contracts from the 2011/12 financial year. The Fifth Schedule of the new Constitution provides timelines for enacting land and environment legislation. Emphasis should be placed on making the process participatory and ensuring that government operations are informed by the bill of rights stipulations on land and the environment as well as devolution (MFW 2010).

Vision 2030

In the social pillar of Vision 2030, special attention is paid to the conservation and restoration of Kenya's forests, especially the five water towers. These forests supply environmental goods and services that support the other sectors of the economy (GoK 2008b) and undergird the attainment of the goals of the economic, social and political pillars of Vision 2030. The Vision's first medium-term plan also sets out a number of flagship projects through which Kenya will endeavour to achieve the MDGs by 2015 (GoK 2008c). It is also important to note that Kenya's new Constitution upholds the objective of achieving and maintaining a tree cover of at least 10 percent of the country's total land area (GoK 2010b), which would help the country to attain its conservation objectives and in turn deliver improved livelihoods for Kenyans in line with the aspirations of the country's long term development blueprint.

Conclusion and recommendations

Forests and woodlands resources make considerable contributions to Kenya's economy and human development. However, they are under severe pressure from the growing population. There have been attempts by the government to address these pressures. However, despite the enactment of the 2005 Forests Act, there are still challenges afflicting the sector. These are compounded by the fact that forests are currently undervalued in terms of the goods and services they provide to local and national economies.

In light of the above, the following recommendations are proposed:

- Forests and woodlands are currently undervalued in terms of the goods and services they provide and the socio-economic benefits derived from them. Using the total economic value (TEV) approach to conducting inventories, **comprehensive data should be gathered by relevant authorities in order to ensure that informed decisions on the country's forest and woodlands resources are made.**
- The Forests Act of 2005 is in conflict with a number of other laws. There is need to harmonize all of these laws amongst themselves and with the new Constitution. **There is also need to adopt a multi-sectoral implementation strategy in order to support forest conservation and environmental management** in the country.
- **The future of forestry lies in the expansion of tree planting** within and outside gazetted forests.

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CHAPTER 6
LAND, AGRICULTURE AND LIVESTOCK

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Introduction

In Kenya, land means different things to different categories of owners. To farmers and pastoralists, land is a prized asset and a source of livelihood and therefore issues of access and control are key concerns. The elite consider land as a marketable commodity from which to make windfall profits through market speculation. The public, politicians and administrators view land as a sovereign imperative whose boundaries reflect a social, cultural and political identity. To development agencies, land provides goods and services required for people's welfare and prosperity. Conservationists perceive land as a fragile, ecological entity whose integrity is determined by the constant interactions of living and non-living things on the earth's surface. These perceptions translate into different, often competing interests and land was identified as one of the underlying causes of the 2008 post-election violence that rocked several densely populated regions of the country. This is because land is an important resource base that supports a number of natural resources and the site upon which economic, social and political aspirations find expression (Sifuna 2009). Its sustainable use, an enabling regulatory framework, efficient dispute resolution mechanisms and a modern land information system are therefore vital to attaining Vision 2030's economic and social pillar targets and to maintaining political stability which is a prerequisite to meeting all the goals set out in the country's long term development blueprint.

Kenya covers an area of 591 958 km^2, which comprises 98.1 percent land and 1.9 percent water (GoK 2010b). Of the total land surface, 20 percent can be classified as medium to high potential arable land with the rest being classified as arid and semi-arid lands (ASALs). However, the arable land supports 80 percent of the human population while the ASALs support the remaining 20 percent in addition to 50 percent of the livestock and 80-90 percent of the wildlife resources in the country. Figure 6.1 shows the country's broad land classification.

Land is a critical resource for the survival of the Kenyan people and the contribution of agriculture to the economy is enormous (GoK 2007). About 67.7 percent of the country's population lives in rural areas and most derive their livelihood from agriculture. A lot of pressure is exerted by the fast growing population on the areas with high and medium productive potential.

Agricultural land use in Mau.

Christian Lambrechts/UNEP

Figure 6.1: Land classification in Kenya

Source: KNBS 2010

Over the last 30 years, human settlement has taken a complex pattern manifested by encroachment on water catchment areas and forests, rapid rural-urban migration and rising occupation of the arid and semi-arid lands (ASALs). The rapid rural-urban migration has led to unplanned informal settlements (slums) in the major urban centers and compounded waste management problems. The drift to the marginal areas has led to degradation of the fragile ASAL ecosystems, increased human-wildlife conflicts as well as land use conflicts between agriculturalists and pastoralists, with the latter two partly attributable to the prolonged absence of a national land use policy which would usher in the land reforms envisioned by Vision 2030 and the new Constitution.

Status of land resources in Kenya

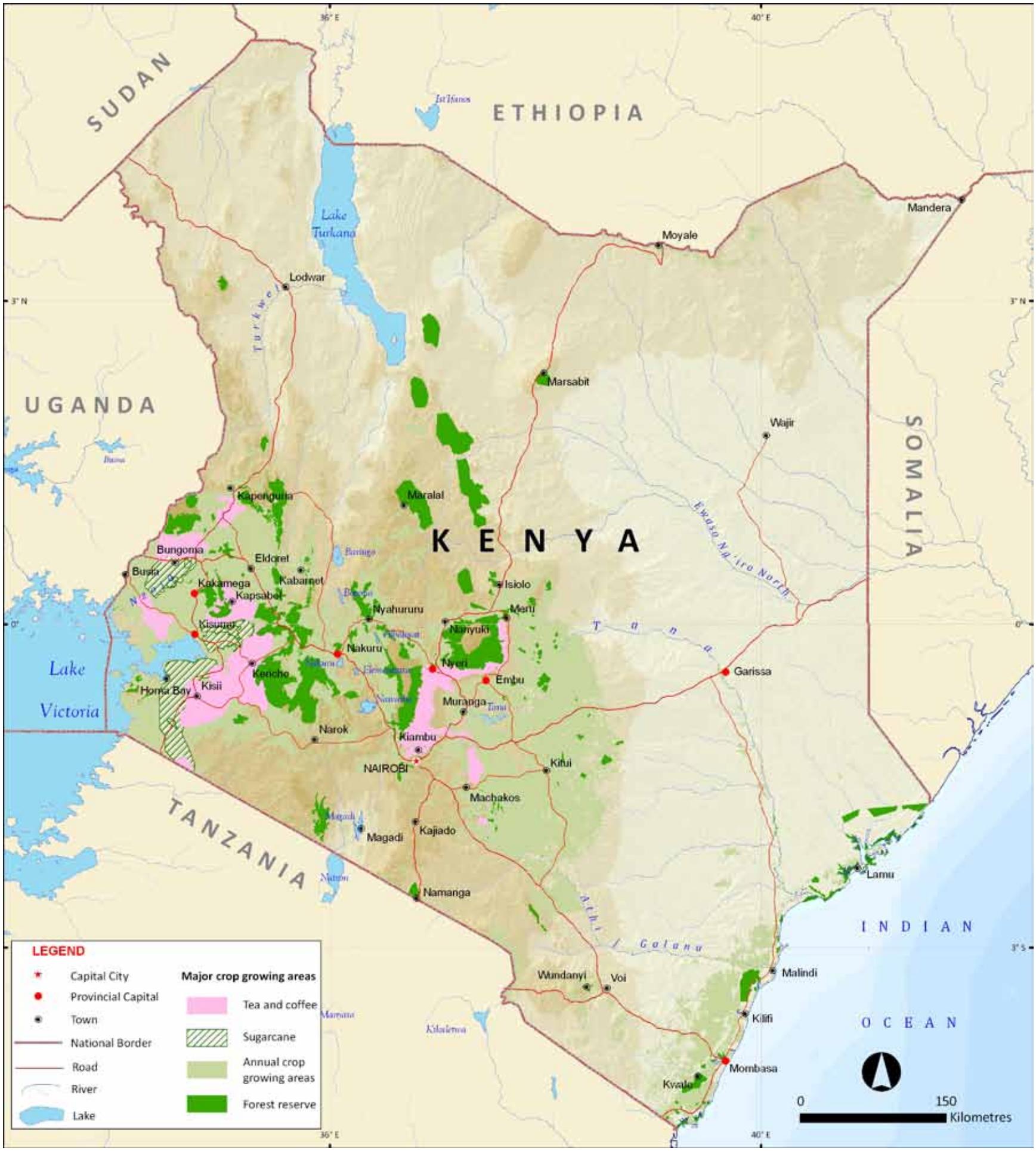
Land is a fundamental natural resource whose productivity directly impacts the country's economic growth and development. Most Kenyans derive their livelihood from land-based resources particularly through farming. The country's annual and major crop growing areas are highlighted in Figure 6.2.

Land use

Kenya's land use is largely pastoral in the semi-humid and semi-arid zones; and agricultural in the moist and humid zones. About 17 to 20 percent of the land has medium to high agricultural potential. Forests,

Figure 6.2: Annual and major crop growing areas

Source: DRSRS



Christian Lambrects/UNEP

A tea plantation in Nandi Hills.

woodlands, national reserves and game parks together cover 10 percent of the total land mass (UNEP 2009). Land continues to be degraded with the situation projected to worsen in future. Droughts are also more frequent and severe, reducing per capita food production.

Agro-ecological zones

Kenya's agricultural productivity is determined by factors such as climate, hydrology and terrain (Jaetzold et al 2009). These agro-ecological factors also determine the suitability of an area for a particular land use and these should ultimately inform the zoning processes that the land use law entrenched in Article 66 of the Constitution would provide for. Land's agricultural potential can be classified as high, medium or low. The high to medium potential land comprises about 20 percent of the country's total land area. Because these areas consistently receive more than 1 200 mm of rainfall annually and the soils are fertile, they are used for the intensive cultivation of a large variety of crops such as tea, coffee, sugarcane, maize and wheat.

Table 6.1: General characteristics and crop suitability of the agro-ecological zones

Source: Jaetzold et al 2009

AEZ No.	Ratio of rainfall to potential evaporation (r/Eo)	Agro-ecological zone	Possible crops & cropping systems
0	> 1.20	Per humid	Forest zone
I	0.80-1.20	Humid	Tea-Dairy
II	0.65- 0.79	Sub-humid	Wheat, Maize, Beans, Irish Potatoes
III	0.50-0.64	Semi humid	Beans and other pulses, Maize, Wheat, Cotton , Cassava
IV	0.40-0.49	Transitional	Barley, Cotton, Maize Groundnut, Sorghum
V	0.25-0.39	Semi-arid	Livestock, beans pigeon peas, S. Potatoes Sorghum, Millet
VI	0.10-0.24	Arid	Ranching and cropping only under irrigation
VII	<0.10	Per arid	Range land

Nevertheless, agricultural productivity is curtailed by a shortage of rainfall with only 17 percent of the country receiving average rainfall of more than 800 mm per annum, the minimum required for rain-fed agriculture. Figure 6.3 shows the country's agro-ecological zones while Table 6.1 highlights crop suitability for each of these zones.

The ASALs largely occupy northern and eastern Kenya as well as the southern margins of the central Kenya highlands. The semi-arid area covers about 20 percent of the entire land area while the arid area, which is characterized by true desert conditions, covers around 60 percent of the total landmass. Because incidences of crop failure in the ASALs are high, the predominant land-use systems are ranching, wildlife conservation and pastoralism although some perennial cash crops are cultivated.

Agriculture

The agricultural sector, which consists of industrial and food crop growing, horticulture, livestock, fisheries and the forestry subsectors, is the mainstay of Kenya's economy. Growths in the economic and

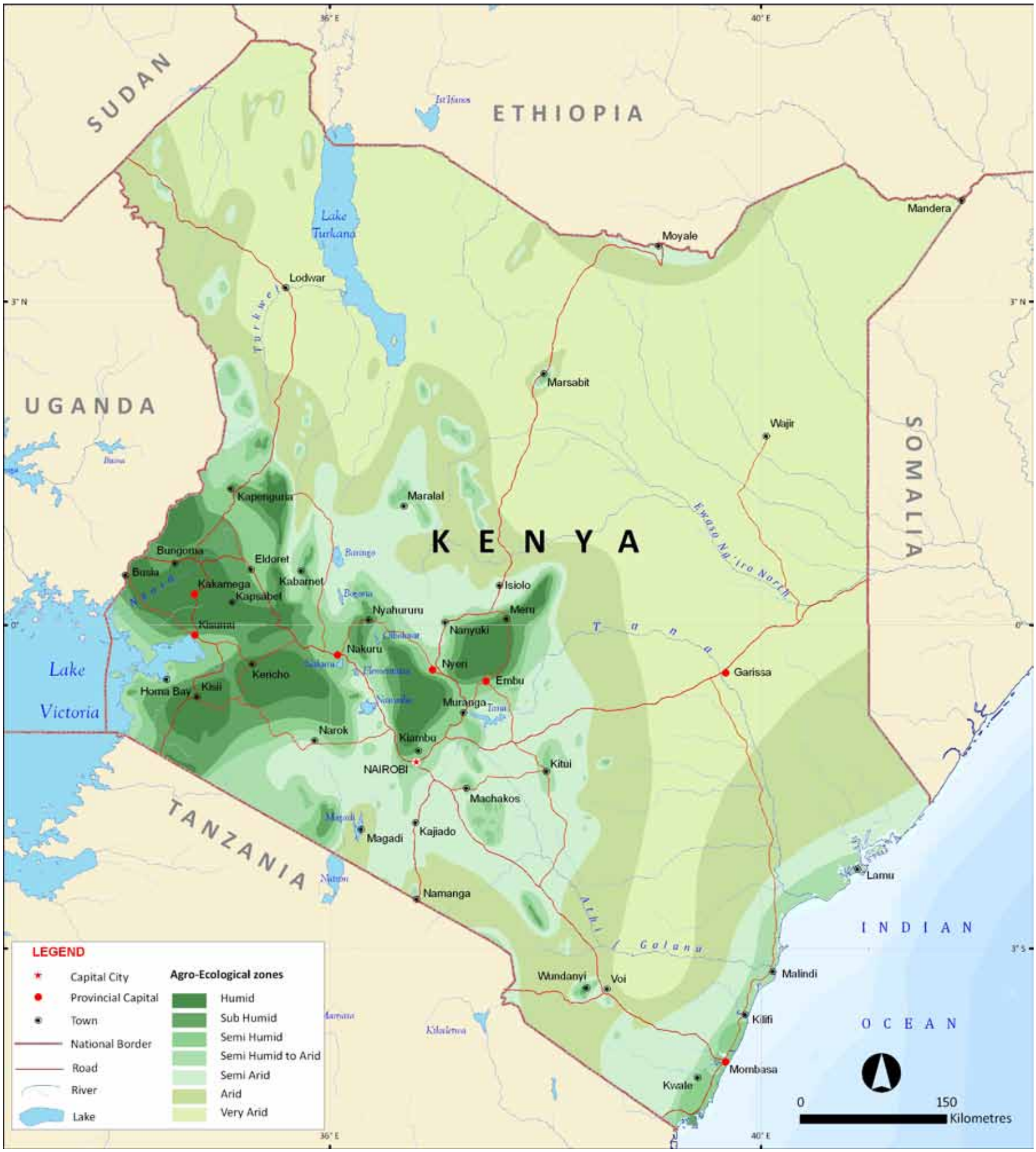


Figure 6.3: Agro-ecological zones

Source: NEMA 2010

agricultural sectors are therefore closely related. These trends are shown in Figure 6.4. This implies that agriculture, will, in the medium term at least, continue to determine whether the 10 percent annual economic growth rate anticipated by Vision 2030 is achieved.

Kenya has two agricultural production systems; rain-fed and irrigated. Rain-fed agriculture is entirely dependent on the bimodal rainfall in most of the country. There are two cropping seasons except in the very high-altitude areas. The performance of rain-fed agriculture varies spatially due to the country's diverse agro-climatic zones. In the humid, high-altitude areas, agricultural productivity and predictability are high. However, the population density in these areas is rising and

Maize crop failure in the Maasai Mara area due to lack of rain.

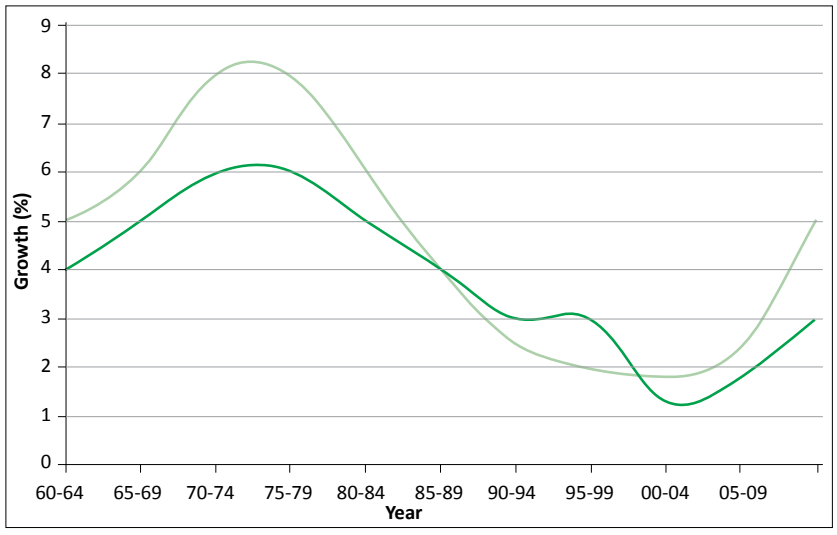


Figure 6.4: Trends in agricultural and economic growth, 1960-2008 Source: GoK 2010b

land is increasingly subdivided into small parcels that are uneconomical for farm enterprises.

In the medium altitude and moderate-rainfall areas, arable rain-fed farming is moderately suitable. However, there is a relatively high risk of crop failure due to the increased frequency of dry spells, and uneven rainfall distribution. Increasing productivity in these areas as envisaged by Vision 2030 will require better selection of crops, adoption of improved technologies, and better crop husbandry.

The ASALs have an average annual rainfall of 400 mm. Droughts are frequent and crops fail in one out of every three seasons. Most of the area is rangeland and is suitable for ranching and pastoralism. Farm enterprises comprise mixed crops and livestock. While there is ample land, farmers tend to grow crops that are not suitable for either this rainfall regime or the soils (ASDS 2010, Jäger et al 2005 and Gachimbi et al 2006). For it to be successful, agriculture in the ASALs therefore calls for better planning, careful selection of farm enterprises and greater investment in infrastructure.

Water and agriculture

Smallholder farmers account for 42 percent, large commercial farms 40 percent and government-managed schemes 18 percent (ASDS 2010) of the irrigated land in the country. Smallholder farmers often rely on low-cost, water-efficient irrigation technology to predominantly produce horticultural crops as these have a high export potential. The Mwea, Ahero, Pekerra, Bunyala and West Kano national irrigation schemes largely produce water-dependent crops such as rice.

Given the low national average rainfall of 400 mm, the government should encourage efforts to harvest and store adequate water for agriculture and other uses. Groundwater resources that can be exploited for agriculture also need to be assessed and quantified. More land can be utilized for crop cultivation by developing irrigation infrastructure in the ASALs.

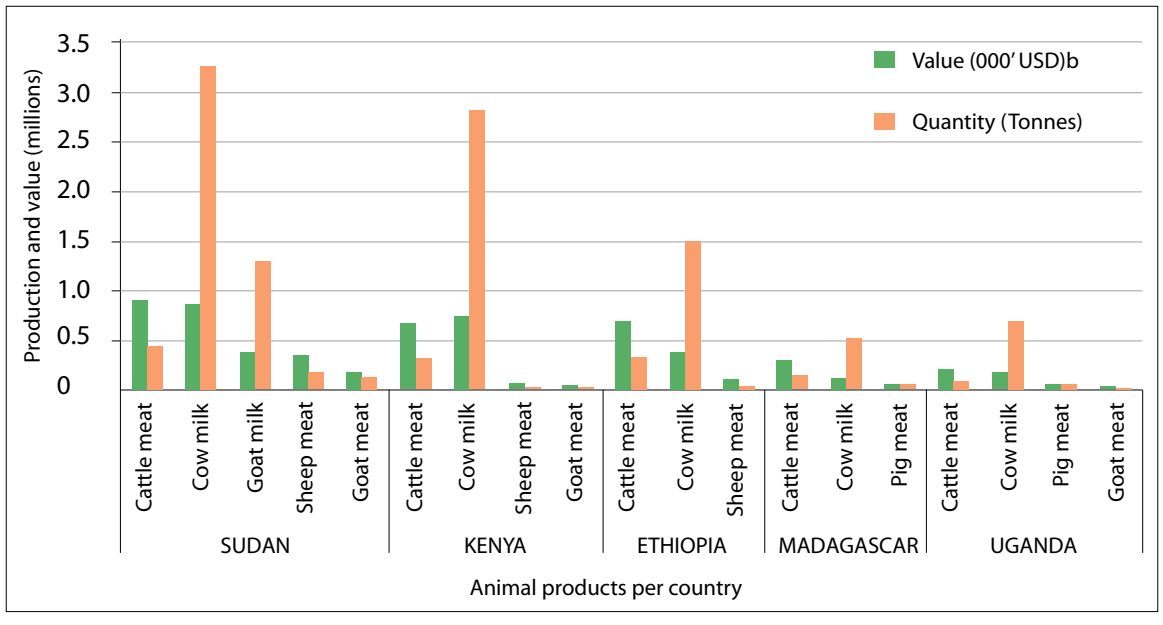
A pastoralist herding cattle in Marsabit, northern Kenya.

Livestock production

Livestock production plays an important economic and socio-cultural role among many communities in Kenya. The key livestock subsectors are beef and dairy cattle, sheep, goats, camels, pigs and poultry. The country's dairy cattle are estimated at 3.5 million heads. Dairy cattle are mainly kept in the medium to high-rainfall areas. The common dairy breeds are Ayrshire, Friesian, Guernsey, Jersey and cross-breeds. In 2008, milk production was estimated at 5.1 billion litres worth KSh 100 billion. At current effective demand, the country is self-sufficient in milk production.

The population of beef cattle is estimated at 9 million (KNBS 2010, MOLD 2009). The main beef species are East African Zebu, Boran, Sahiwal and cross-breeds. Although most of the country's beef is produced from rangelands, dairy cattle culls contribute substantially to the national supply. Even though beef production is affected by climate variability and animal diseases, the country produces about 320,000 tonnes of beef worth KSh 62.1 billion annually. In the East African sub-region, Kenya ranks second after Sudan in both animal product yields and value, followed by Ethiopia and Uganda. Figure 6.5 shows the production of animal products across the Eastern Africa region.

Figure 6.5: Regional animal production Source: Ackello-Ogutre and Sikei 2008



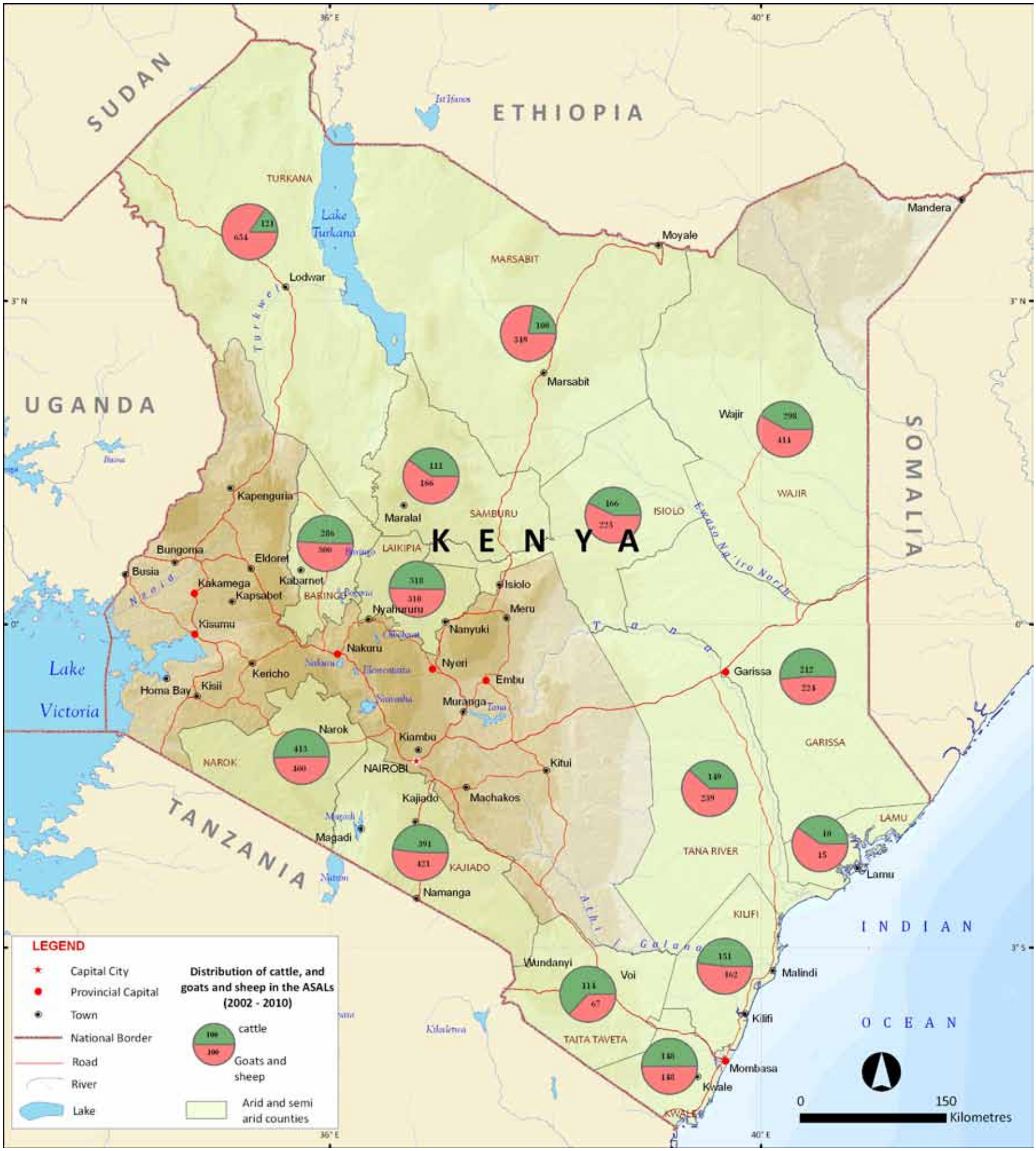
Cattle, camels, and goats at a watering hole.

Sheep and goats play a key role in the food security and incomes of pastoral households owing to their short-generation intervals, high adaptability and versatile feeding habits. The country is home to an estimated 27.7 million goats and 17.1 million sheep (GoK 2010a). Annual mutton and chevon production is estimated at 84 000 tonnes valued at about KSh 14 billion.

Kenya has an estimated 31.8 million chickens, 80.2 percent of which are indigenous while 19.8 percent are commercial layers and broilers (GoK 2010a). Other poultry types such as duck, turkey, pigeon, ostrich, guinea fowl and quail are becoming increasingly important. Annually, the country produces about 20 tonnes of poultry meat worth KSh 3.5 billion and 1.3 billion eggs worth KSh 9.7 billion.

Figure 6.6: Distribution of cattle, goats and sheep in Kenya's ASALs

Source: DRSRS



A small-scale piggery in Limuru.

Pig rearing has withstood periodic fluctuations and is now relatively well-established in Kenya. It is estimated that the country produces 12 000 tonnes of pork worth KSh 1.2 billion annually. The country's distribution of goats and sheep (shoats), and cattle in the ASALs is presented in Figure 6.6.

Beekeeping (apiculture) is practised in most parts of Kenya, particularly in the ASALs. In addition to directly contributing to household incomes, bees play an important role in plant pollination that is central to crop production. The country produces an estimated 14 600 tonnes of honey and 140 tonnes of beeswax annually which are collectively valued at KSh 4.4 billion. Due to the low investment and variable costs involved, beekeeping is becoming increasingly popular in rural areas.

Camel keeping is mainly practised in northern Kenya. Camels produce milk, meat, are a source of income and serve as pack animals. The country is home to a camel population of 2.9 million (GoK 2010a) which produce 7 000 tonnes of meat worth KSh 1 billion, and 200 million litres of milk worth KSh 2 billion annually. Because camels are probably the most versatile of the domestic animals, camel keeping is gradually extending to the South Rift region and is expected to expand to other parts of the country in the coming decades.

While livestock production is associated with positive livelihood outcomes that are indispensible to meeting the economic aspirations set out in Vision 2030, excessive pressure on vegetation by livestock has adversely affected the production potential and carrying capacity of land in Kenya. Indeed, the high livestock population, especially in the fragile ASALs, has been associated with increased land degradation.

The growth of the pastoralist population in Kenya and the increase in livestock population density have led to the extension of grazing activity into semi-arid marginal lands and forests, causing severe degradation in these areas. Heavy losses of livestock due to diseases, pests and drought have also continued to adversely affect animal production and also pose a threat to human health.

Scale of production

Agriculture is predominantly carried out on a small-scale and mainly in the high-potential areas. Production is carried out on farms averaging 0.2-3 ha, mostly on a commercial basis. This small-scale production accounts for 75 percent of the total agricultural output and 70 percent of the marketed agricultural produce. Small-scale farmers account for over 70 percent of maize, 65 percent of coffee, 50 percent of tea, 80

Ranching and pastoralism are the predominant land use systems in the ASALs such as Kalama Group Ranch in Samburu shown here.

Christian Lambrects/UNEP

percent of milk and 70 percent of beef production. However, adoption of improved techniques such as the use of hybrid seed, concentrate feeds, fertilizer, pesticides and machinery by small-scale farmers is relatively low. Adoption of modern farming practises therefore has the potential to substantially increase the productivity of these farmers and to improve their welfare, enabling the Vision 2030 poverty alleviation goals to be met faster.

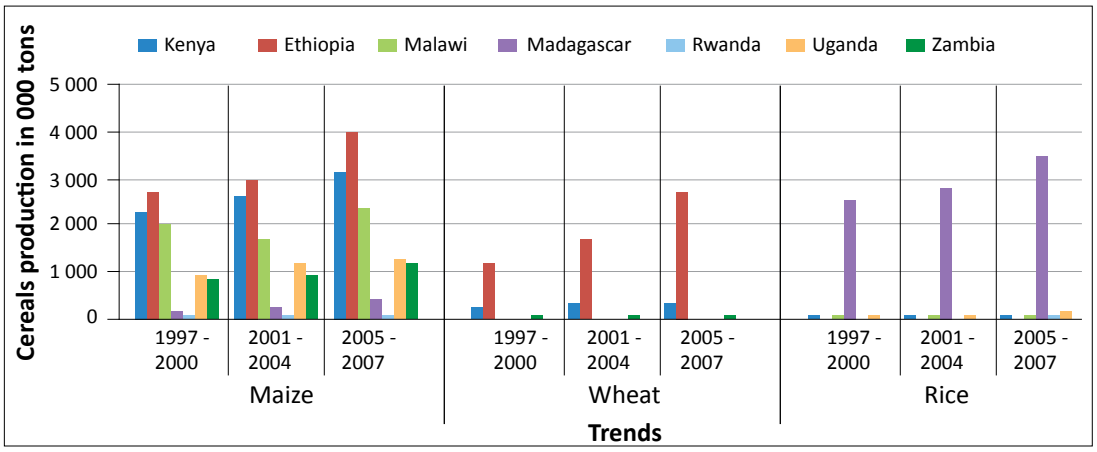
The rangelands' small-scale livestock production system predominantly consists of pastoralists. Livestock herds are typically large because of communal grazing and there is a low use of purchased inputs like feed, drugs and artificial insemination. Rather than being market-oriented, production is mainly for subsistence but improving market access for pastoralists, encouraging value addition, infrastructural development and streamlining the institutional and fiscal framework in line with the Vision 2030 aspirations would go a long way in integrating this sector into the mainstream economy. Providing extension services, encouraging investment in livestock processing facilities, encouraging regional, national and local initiatives to end cattle rustling and planning and enforcing disease free zones would also address the security, disease and nutrition constraints to increased livestock productivity.

Medium-scale farms range from 3 to 49 ha in size. Farmers in this category are more receptive to technology use and practise more viable commercial agriculture by investing in inputs, marketing their produce and taking loans for farm development.

In Kenya, large-scale farming is practised on farms averaging about 50 ha for crops and 30 000 ha for livestock ranches. The large-scale farming subsector, which accounts for 30 percent of marketed agricultural produce, mainly involves growing crops such as tea, coffee, maize and wheat in addition to keeping livestock for commercial purposes. In keeping with the objectives set out in Vision 2030, there is need to reduce input costs and increase the acreage of land under irrigation, inculcate good farming and farm management practices and to encourage the use of improved technologies in order to increase productivity per land unit. This is because these factors have been held responsible for the declining cereal yields in Kenya, especially in comparison with countries like Ethiopia and Madagascar. Regional trends in the production of cereals are depicted in Figure 6.7.

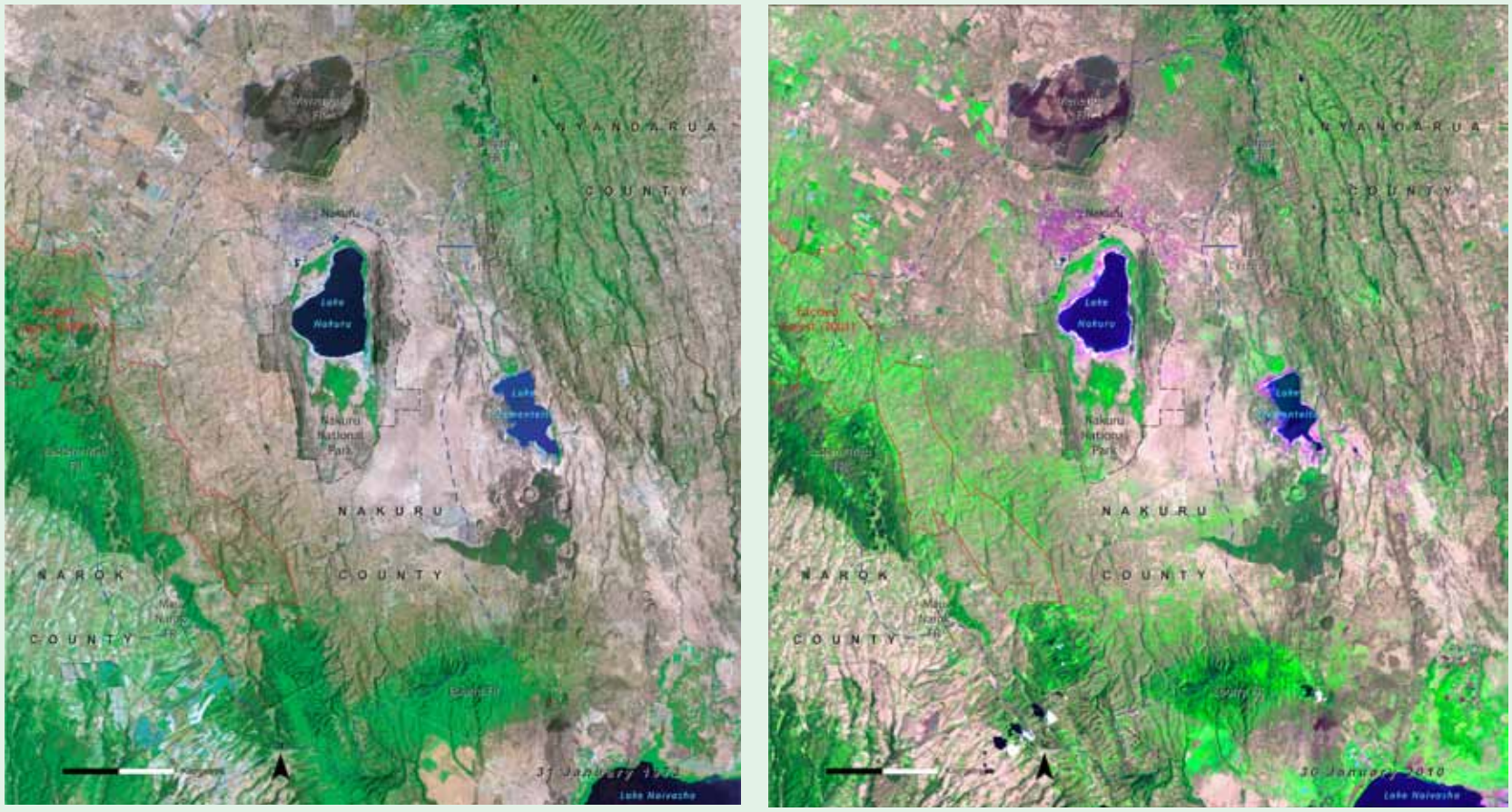
Figure 6.7: Regional trends in cereals production

Source: ASDS 2010

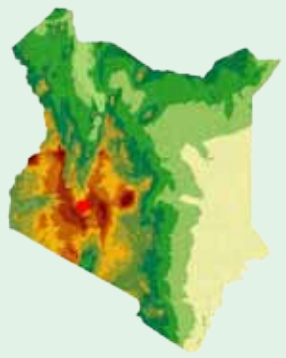


Land degradation is a common feature in the Eastern and North Eastern parts of Kenya.

Christian Lambrects/UNEP



Land cover degradation in the Lake Nakuru catchment in 1973 and 2010



Box 6.1: The degradation of Lake Nakuru catchment area

Lake Nakuru has a total area of 188 km^2. The park is a habitat for over 450 bird and 56 mammalian species and hosts the world's largest concentration of the Lesser flamingo as well as lions, leopards, rhinoceros, and buffaloes which make Kenya a highly valued tourist destination.

The loss of natural vegetation, particularly forests, in Lake Nakuru's watershed threatens the lake's water quality and water balance. Between 1986 and 2003, roughly one-fifth of the forested area in the upper reaches of the River Njoro catchment was lost. Another analysis found that just under half of the dense vegetation cover in the Lake Nakuru basin was lost between 1973 and 2003. The images show the land cover in the lake's catchment in 1973 and 2010.

Source: UNEP 2009

Threats to land, agriculture and livestock

The threats to the land resource include land degradation from soil erosion, declining soil fertility, pollution, land cover change, low agricultural productivity because of the low adoption of appropriate technologies, excessive pressure from livestock as a result of overstocking and an outdated policy and legal framework.

Land degradation

The important land degradation issues Kenya is grappling with range from escalating soil erosion, declining soil fertility, agrochemical pollution, salinization of land and land cover conversions. Although in 1997, 64 percent of Kenya's landmass was subject to moderate land degradation and about 23 percent to very severe degradation problems, the later had increased to nearly 30 percent in the early 2000s with the cultivated areas and grasslands being particularly affected (Muchena 2008, Bai et al 2008). This degradation manifests itself as gully erosion with the problem appearing to be most pronounced in the Eastern and North Eastern parts of Kenya where 12.3 percent of land suffers from severe degradation, 52 percent from moderate degradation and 33 percent is vulnerable to land degradation. The expansion of cropping into fragile areas such as forests is responsible for much of this degradation. A case study of Lake Nakuru, which is contained in Box 6.1, demonstrates this point well.

An estimated 12 million people (UNEP 2009) or just under one-third of the country's population depends directly on land and as the country's population continues to grow, the resource is expected to become increasingly degraded unless urgent remedial measures are taken. And, the steady decline in per capita land holding, rising land degradation as well as the fragmented, complex and pluralistic land tenure regimes pose serious food security and environmental concerns. These considerable challenges are likely to threaten the economic, social and political stability of the country and to concomitantly negatively impact the delivery of Vision 2030.

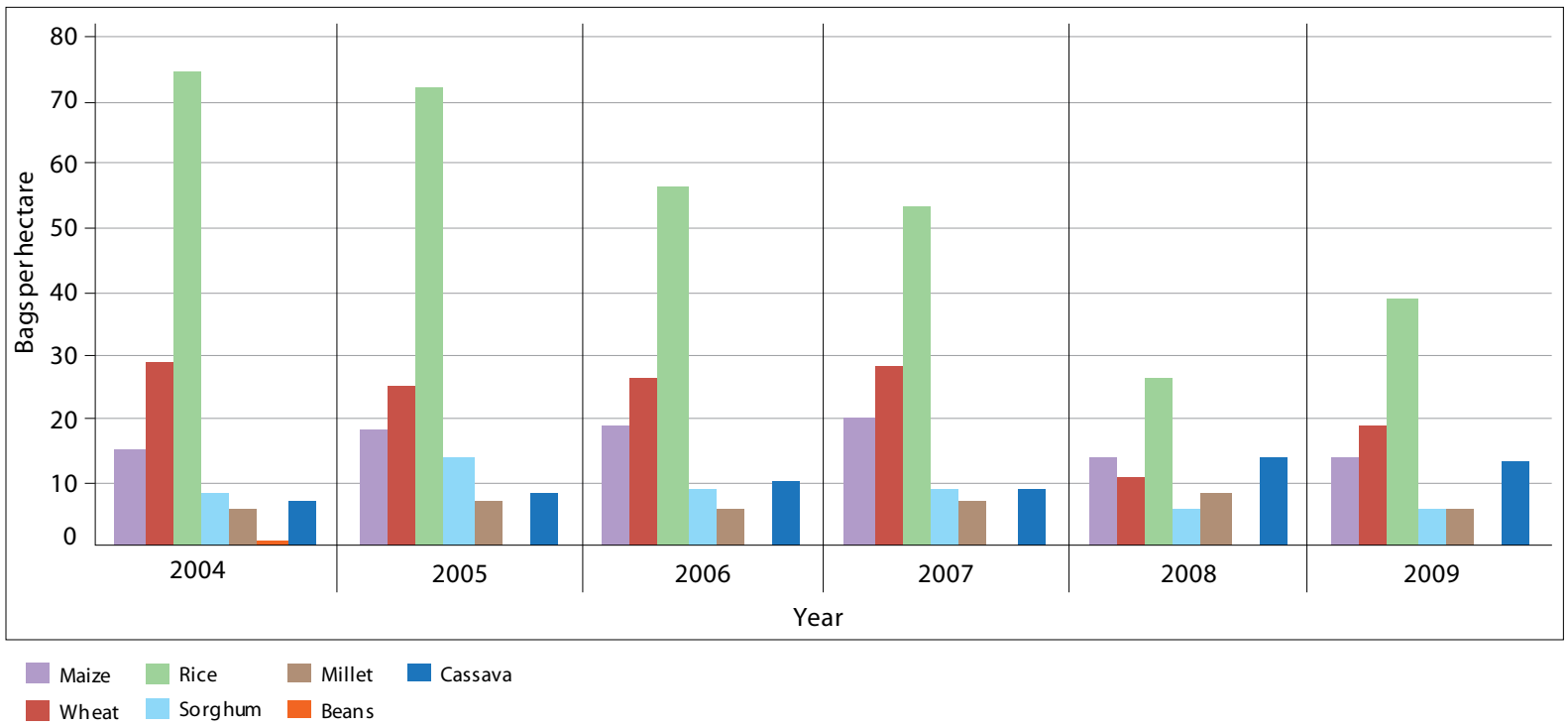


Figure 6.8: Average crop production per hectare, 2004-2009

Low agricultural output

Agricultural output continues to be impeded by various challenges such as soil erosion, loss of agro-biodiversity, soil nutrient depletion, low agricultural output and productivity, an inappropriate legal and regulatory framework and overreliance on rain-fed agriculture (GoK 2007 and GoK 2009). The productivity levels for most crops are significantly below potential as these have either remained constant or are in decline. Figure 6.8 shows the average crop production per hectare over the 2004 to 2009 period. The low agricultural output and productivity results from unsustainable land use practices and the low adoption of appropriate technologies such as high-yielding crop varieties, adequate application of fertilizer and manure and use of efficient tillage and cultivation methods. These have been exacerbated by the high cost of inputs and productive resources such fertilizer, pesticides and irrigation infrastructure.

Outdated legal and regulatory framework

An outdated and fragmented legal and regulatory framework still remains a challenge to the development of the agricultural sector yet, because this is the foundation of the economy, it is indispensable to the attainment of the objectives of Vision 2030's economic pillar. In particular, the existing regulatory framework—of which the antiquated Agriculture Act (Cap. 318) is an integral part— is not fully supportive of private sector-led agricultural development in the liberalized economic environment. Further, inappropriate land-use practices and disjointed sectoral environmental policies have encouraged land fragmentation, extension of residential developments into agricultural land, an abundance of idle land, deforestation, encroachment into fragile ecosystems such as wetlands and forests as well as cultivation on river banks. The finalization of the National Land Policy in 2009 and the inclusion of comprehensive land provisions in the new Constitution are important first steps. The challenge will be for the executive arm of government and the National Assembly to enact and operationalize the land laws specified in the Constitution's Fifth Schedule within the stipulated timeframes.

Unsustainable increases in livestock population

Excessive pressure on the vegetation by livestock is a considerable problem that has adversely affected the production potential and carrying capacity of Kenya's ASALs. The growth of the pastoralist population and subsequent increase of the livestock population have led to the extension of grazing activity into semi-arid marginal lands and forests, causing severe degradation and reduced livestock yields. The impact of grazing in the drier areas is most evident around watering points and settlement areas which are grazed until they are bare leading to malnourished animals and even livestock deaths in arid areas such as Baringo. The cumulative effect of extensive land degradation has reduced the carrying capacity in all the country's agro-ecological zones leading to soil erosion and depletion of the natural seed banks in the soil such that even with adequate rainfall, little grass or other palatable vegetative material regenerates.

Livestock diseases and pests affect animal production and marketing and also pose a threat to human health. Specifically, they cause heavy losses through livestock deaths, reduced livestock and human productivity and a loss of markets for products. The incidence of transboundary diseases such as foot and mouth, contagious bovine pleuropneumonia, lumpy skin disease, trypanosomiasis, East Coast fever, brucellosis, pestes des petits ruminants (PPR), contagious caprine pleuropneumonia, rabies, Newcastle disease and Gumburo disease continues to be high, adding some urgency to the need to establish the disease free zones alluded to in Vision 2030. Emerging and re-emerging zoonotic diseases like Rift Valley fever, avian flu and bovine TB also need sustained surveillance so there is need to upscale capacity building in the relevant areas.

Recent severe droughts—many of which are climate change-related—have accelerated the degradation of land in Kenya and reduced per capita food production. As a largely human-induced phenomenon, climate change calls for multi-sectoral partnerships in tackling its varied negative impacts that include energy, water and food scarcity which in turn fuel natural resource conflicts. The scarcities and attendant conflicts cyclically aggravate poverty and environmental degradation, making the poverty alleviation goals set out in Vision 2030 more elusive.

Watering livestock in Marsabit.

Endowment value of the land, agriculture and livestock resources

Land

Because land provides humans with a habitat and livelihood means, it is a principal asset for both survival and development. This is because people's livelihoods, culture and the economy depend on a flow of multiple ecosystem services which result from the complex interactions among the physical, biological and chemical environments of which land is an inalienable part. The effective management of land is therefore critical to attaining the aspirations set out in the social, economic and political pillars of Vision 2030.

Agriculture

The agricultural sector, including livestock production, directly accounted for between 21.5 to 23.5 percent of GDP in the period 2006 to 2010 (GoK 2011). In addition, the sector contributes approximately 65 percent of total export earnings, 18 percent of formal employment and 62 percent of informal employment and supplies 70 percent of the raw materials to the agro-based industries (GoK 2010). Despite the various challenges that bedevil the sector, agriculture is the mainstay of the Kenyan economy. This implies that addressing these challenges will enable the sector to contribute to the 10 percent annual economic growth rate specified in Vision 2030.

Livestock

Livestock is a source of livelihood for Kenyans in virtually all the regions of the country. Because 80 percent of the country is too dry to support cultivation agriculture, the households which inhabit the ASALs rely extensively on livestock which, in addition to meeting their food needs, accounts for about 90 percent of the total employment and over 95 percent of household incomes. At the national level, the subsector provides employment to about 10 million people and accounts for 4.4 to 5.4 percent of the GDP. In addition, the subsector supports the feeds, drugs, vaccines and equipment manufacturing industries and provides raw materials to the agro-processing industries (GoK 2010). And, because the subsector's enormous potential has not been fully tapped, it has the ability to considerably bolster the agricultural sector with the benefits trickling through to the economic, social and political pillars of Vision 2030.

Opportunities for land, agriculture and livestock to deliver Vision 2030

In spite of the many challenges and constraints limiting land, agricultural and livestock growth in Kenya, many opportunities for both building dynamic land-based resources' management systems and delivering Vision 2030 exist.

Sustainable land management

Sustainable land use can be attained and enforced using a robust national land use regulatory framework while land degradation can be tackled through a range of mechanisms. These include appropriate soil and water management strategies, reclamation of drylands, protection of forests and other critical ecosystems, agroforestry and promotion of conservation agriculture and water-harvesting technologies.

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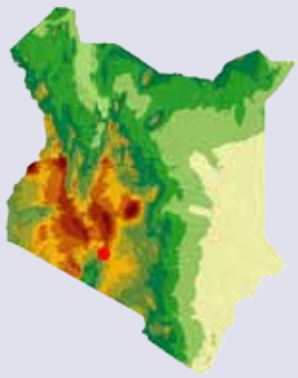

Greening Kajiado – In the past, Kajiado County, located to the south of Nairobi City, formed one of the largest contiguous pastoral lands occupied mainly by the Maasai community. The area's vegetation primarily consisted of grassland, shrubs, and thickets. Nomadic pastoralism—the traditional way of life of the Maasai—was the dominant land use. Currently though, subdivision of this land and eventual change

of ownership has resulted in a change in the vegetation characteristics and land use. As is evident from the above two images, within a span of 16 years (1984-2010), the vegetation changed from a brownish to a more lush, greener tone. This is because the new land owners are aggressively promoting tree farming. The yellow arrows show those areas that have changed from barren to green.

A dam in Kenya's ASALs provides water throughout the dry season.

Increasing agricultural and livestock yields

Yields of crops and livestock are far below their optimum with those of maize, sugar cane and dairy being a mere one-tenth of the global average. Tripling national average yields of major crops and livestock is therefore easily achievable through the adoption of appropriate technologies such as crop and livestock biotechnology and integrated soil fertility management. Other initiatives that can spur agricultural and livestock productivity are value addition and improving access to agricultural inputs and extension services.

Increasing irrigated agriculture

Irrigation, particularly in the high- and medium-potential agricultural areas and ASALs should be substantially scaled up by developing the largely untapped potential of the Tana and Athi river basins and the country's 253 km Lake Victoria shoreline. Further, communities and households should be encouraged to harvest and store sufficient water for domestic and agricultural use. Groundwater resources, that can be used to supplement surface water and rain water-harvesting, need to be urgently assessed and harnessed. These initiatives should be complemented by developing irrigation infrastructure in the ASALs and adopting low cost, water efficient drip irrigation systems. Because intensified irrigation can increase agricultural productivity fourfold and, depending on the crops grown, increase incomes tenfold (ASDS 2010), the benefits would far outstrip the costs and, the positive outcomes of this for Vision 2030 would be enormous.

Value addition

Value addition in this context consists of enhancements to a product early on in the supply chain. It includes farm-level quality improvements, processing, branding, quality certification and accreditation that fetch a higher price for the product. It is estimated that 91 percent of Kenya's total agricultural exports are in raw or semi-processed forms. Thus, by not adding value to its produce, the country loses out on billions of potential earnings. The potential for adding value to products such as tea, coffee, pyrethrum, milk, beef, hides and skins, fruits and vegetables —and for transforming Kenya into a rapidly industrializing middle-income nation by 2030 and the positive knock on effect this would have on impoverished Kenyans' welfare—remains largely untapped.

Promotion of forest conservation and farm forestry

Forestry contributes to improved agricultural productivity through conserving soil and water and improving soil fertility. The destruction and degradation of the country's forests has resulted in increased rates of flooding, landslides and siltation of rivers. Because of the positive correlation between forest cover and agricultural productivity, it is important to step up efforts to raise the country's forest cover from the current 1.7 percent to the desired 10 percent level by intensifying reforestation efforts in Kenya's gazetted forests and promoting the benefits of small- and large-scale tree farming and agroforestry. Initiatives aimed at introducing indigenous and commercial tree species in the ASALs in order to control desertification and improve livelihoods also need to be urgently undertaken. Chapter 5 contains a detailed discussion of these issues.

Conclusion and recommendations

Agriculture is the largest sector of Kenya's economy and is one of the key sectors that have been earmarked to deliver the 10 percent annual economic growth rate envisaged under Vision 2030's economic pillar.

The following recommendations would help to actualize this goal and to prevent land conflicts in the country:

- **Overhaul the legal and regulatory framework**. In particular, there is need to enact a land use law within the timeframes stipulated by the Fifth Schedule of the new Constitution and to overhaul the operative Agriculture Act (Cap 318) which does not reflect the realities of the liberalized environment within which agricultural enterprises operate. The new agriculture law should, of course, be preceded by participatory formulation of a national agricultural policy aimed at reviving the fledgling but crucial agricultural sector.

- **Sustainable land management in the high and medium potential areas should be encouraged.** Policies geared towards reversing land degradation in the high and medium potential agricultural areas should be tackled through appropriate soil and water management strategies, reclamation of drylands through irrigation, protection of forests and other critical ecosystems, agroforestry, promotion of water-harvesting technologies and of conservation agriculture as the latter is associated with higher crop yields, reduced soil erosion and sustainable land management. Conservation agriculture is also increasingly promoted as one of the ways of tackling climate change.

- **Promotion of farm forestry is a priority** and efforts in forestry development should focus on expanding tree cover in industrial plantations, on farms and in urban and local authority and national forests in order to restore environmental integrity. A formal policy on farm forestry and conservation of the natural environment needs to be finalized. Initiatives aimed at introducing commercial tree species into the country's vast ASALs to control desertification and improve livelihoods need to be fast-tracked in order to reverse environmental degradation and provide the pastoralist communities with alternative livelihood sources.

- **Policies geared towards efficient and effective natural resource management in the ASALs needs to be promoted** as the communities are at risk of becoming trapped in a downward poverty spiral. Unless this is urgently instituted, this may force them to eventually migrate out of these marginal areas to other already densely populated rural and urban areas, increasing the pressure on these. Specific policy measures should be formulated to thwart this risk and should include:

  - **Local and national policy makers should initiate and support development of production chains for a number of products with considerable commercial potential**. These would encourage intensification of livestock production with emphasis on beef, milk and milk processing, development of mixed crop-livestock production systems (zero-grazing, optimizing manure management as well as utilization and intensification of fodder production) and the use of low cost irrigation systems for high value crop production and diversification.

  - **Private sector agricultural investment should be stimulated through the development of basic infrastructure** including a rehabilitated road network and encouraging appropriate water harvesting and other modern technologies through fiscal incentives. This is expected to lead to more sustainable natural resource management practices and improved livelihoods which will in turn facilitate the attainment of Vision 2030's economic, social and political pillar goals.

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CHAPTER 7
FRESH WATER, COASTAL AND MARINE RESOURCES

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Introduction

Kenya's economy is dominated by the agricultural sector; although only 20 percent of the country's total land area has sufficient fertility and rainfall to be farmed. Kenya's principal cash crops include tea, horticultural produce and coffee while maize is the staple food. The production of maize however, is subject to sharp rainfall-related fluctuations, with production down-turns periodically necessitating food aid. In 2004 for instance, more than 1.8 million Kenyans required food aid due to drought and water stress.

Lately water availability has worsened due to climate change and variability, rising population pressure and destruction of wetlands and the wider catchment areas. This chapter therefore reviews Kenya's freshwater resources including the country's fresh water per capita endowment, Kenya's coastal and marine resources, the key policy issues and opportunities that can be harnessed to help meet the Vision 2030 goals before proposing strategies for the improved management of these resources.

Status of freshwater resources and coastal ecosystems

Kenya has a total area of about 582 646 km^2. Water occupies about 1.9 percent or 11 230 km^2. The rest, equivalent to 571 416 km^2 is covered by land. 80 percent of Kenya's land area is arid or semi-arid (ASALs), implying that only 114 283 km^2 of Kenyan land can be profitably used for rain fed agriculture. There is however, a large potential for agriculture in the ASALs if the required investments in irrigation, water storage and water harvesting infrastructure are made.

Kenya's freshwater resources are represented by lakes, rivers, swamps, springs as well as dams, water pans and groundwater. Kenya's annual freshwater resources endowment is estimated to be 20.2 BCM (billion cubic metres) or 548 m^3 per capita per year. This is much lower than the comparative figures for Uganda (1 273 m^3) and Tanzania (2 035 m^3) (World Bank 2010) and the UN recommended threshold of 1 000 m^3 per capita per year. Figure 7.1 illustrates the global renewable water resources per capita. This has serious implications for tourism, agriculture and industry which are Vision 2030's flagship projects because raising their contribution to Kenya's economic growth will require these sectors to consume substantially more water.

Surface water resources

Kenya's surface water resources are distributed within five drainage basins: the Tana, Athi, Ewaso Ng'iro north, Rift Valley and Lake Victoria Basin. Figure 7.2 shows these drainage basins while Table 7.1 provides

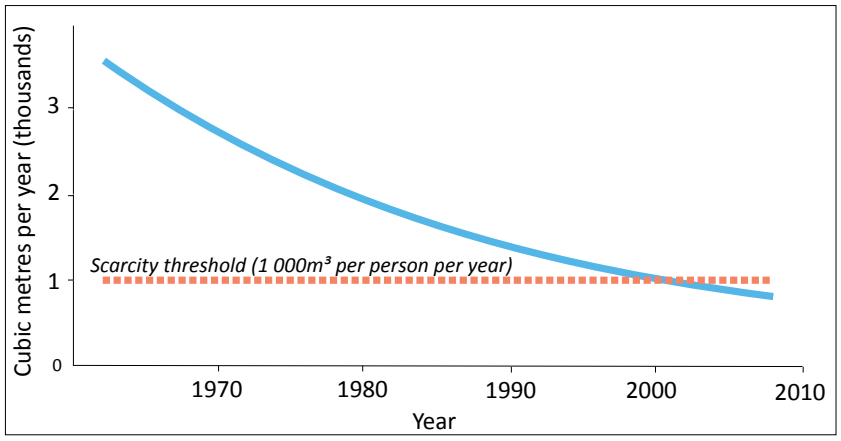


Figure 7.1: Global renewable water resources per person Source: FAO 2010

A group of Hippopotami cooling off in Lake Naivasha: Kenya's water bodies are habitats to a myriad of plants and animals.

Christian Lambrects/UNEP

Figure 7.2: Kenya's main drainage basins

Source: WRI 2007

Drainage basin	Area (km²)	Annual rainfall (mm)	Surface Water (10^6 m³)	Surface water abstraction		Ground water (10^6 m³)	Total water (10^6m³)	% of total water resources potential
				10^6 m³	%			
L. Victoria	46 229	1 368	11 672	254.3	2.2	116	11 788	54.1
Rift Valley	130 452	562	2 784	46.8	1.7	126	2 910	3.4
Athi River	66 837	739	1 152	133.1	11.6	87	1 239	4.3
Tana River	126 026	697	3 744	595.4	15.9	147	3 891	32.3
Ewaso Ng'iro North	210 226	411	339	42.1	12.4	142	481	5.8
Total	579 770	621	19 691	1 071.7	5.44	618	20 309	99.9

Table 7.1: Average annual water availability and utilization per drainage basin

Sources: GoK 1992, GoK 1998

an overview of the renewable water resources. The table also indicates Kenya's surface and groundwater resources' distribution and water abstraction levels for each of the five drainage basins.

Lake Victoria Basin

The Lake Victoria basin covers about 8 percent of the total area of Kenya but accounts for over 54 percent of the national freshwater resources. The quantity of water in Lake Victoria is regulated by rainfall, evaporation and inflows and outflows from the lake basin. The main outflow is through the Nile River to the north. The main inflows from the Kenyan catchment include the Sio, Nzoia, Yala, Nyando, Sondu-Miriu, North Awach, South Awach and Gucha-Migori rivers. The other inflow is from the Akagera River whose source is in Rwanda. Table 7.2 shows the balance between the lake's water inflows and outflows.

Average 1950-2000	Flow (m^3s^{-1})	Percentage
Inflows		
Rain over the lake	3 631	82
Basin discharge	778	18
Outflows		
Evaporation from the lake	-3 330	76
Victoria Nile outflow	-1 046	24
Balance	33	

Table 7.2: Balance between water inflows and outflows of Lake Victoria

Source: NEMA 2007

Data on the levels of Lake Victoria have been collected consistently since 1896. The key factors influencing lake levels are natural and are mostly related to inflows and outflows. Three striking water level regimes have however been observed in the last 104 years. They are

Table 7.3: Historical water levels of Lake Victoria

Year	Month	Level in m.a.m.s.l*	Height above 1923 level (m)
1923	March	1133.19	0.00
2006	January (10th)	1133.46	0.27
2005	October	1133.66	0.47
1961 (before the flood)	January	1133.70	0.51
2004	September	1133.99	0.80
1994	February	1134.18	0.99
1994	October	1134.21	1.02
1986	September	1134.26	1.07

* m.a.m.s.l. stands for metres above mean sea level

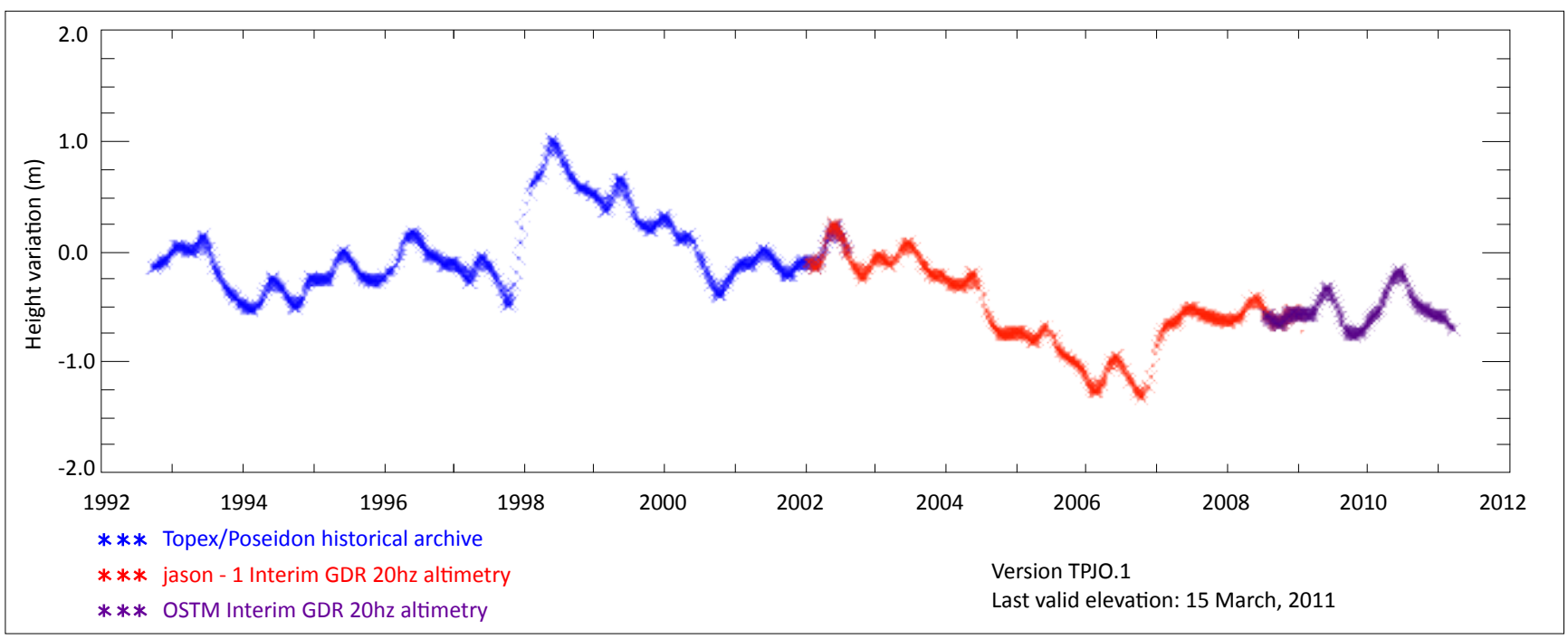
1900-1961 when water levels were low, 1961-2002 when levels were high following the 1961 floods, and the post-2002 regime which has tended towards the pre-1961 regime. The 2005/06 levels were the lowest experienced since the floods of 1961/62 and the lowest level recorded in January 2006 was slightly above the lowest ever level recorded in March 1923. Table 7.3 and Figure 7.3 highlight the trends.

The Rift Valley Basin

This basin consists of a number of closed basins and covers an area of about 130 452 km². It encompasses the basins discharging into Lake Turkana in the North through the Turkwel and Kerio rivers and those draining into Lake Natron in the south through the Ewaso Ng'iro South River. The smaller lakes such as Baringo, Bogoria, Nakuru, Elementeita, Naivasha and Magadi also form individual basins. The Kerio River is the main river in the Rift Valley basin with a total length of 354 km. It has an average width of about 5.7 m, mean depth of 0.21 m and the mean flow is 4.47m³/second.

Figure 7.3: Fluctuation in the water level of Lake Victoria. Height Variations from TOPEX POSEIDON Jason-1 and Jason-2 OSTM Altimetry

Source: USDA 2011



Lake Baringo at night.

Nearly all the major lakes in Kenya are found in the Rift Valley. Their water quality varies from fresh (Lakes Naivasha and Baringo), through brackish (Lake Turkana) to saline (Lake Magadi). Lake Naivasha is a Ramsar site and supports a significant flower-based horticultural industry and some fisheries. It also provides water for domestic and livestock use. The source of water for the steam used by the Ol Karia geothermal power plant is thought to originate from this lake through subterranean seepage. The environs of Lake Naivasha, including its rich biodiversity, are highly attractive for tourism. Unfortunately, the use of the lake's resources, notably its water and riparian lands, are largely uncontrolled and have led to its pollution and declining water levels as shown in Figure 7.4.

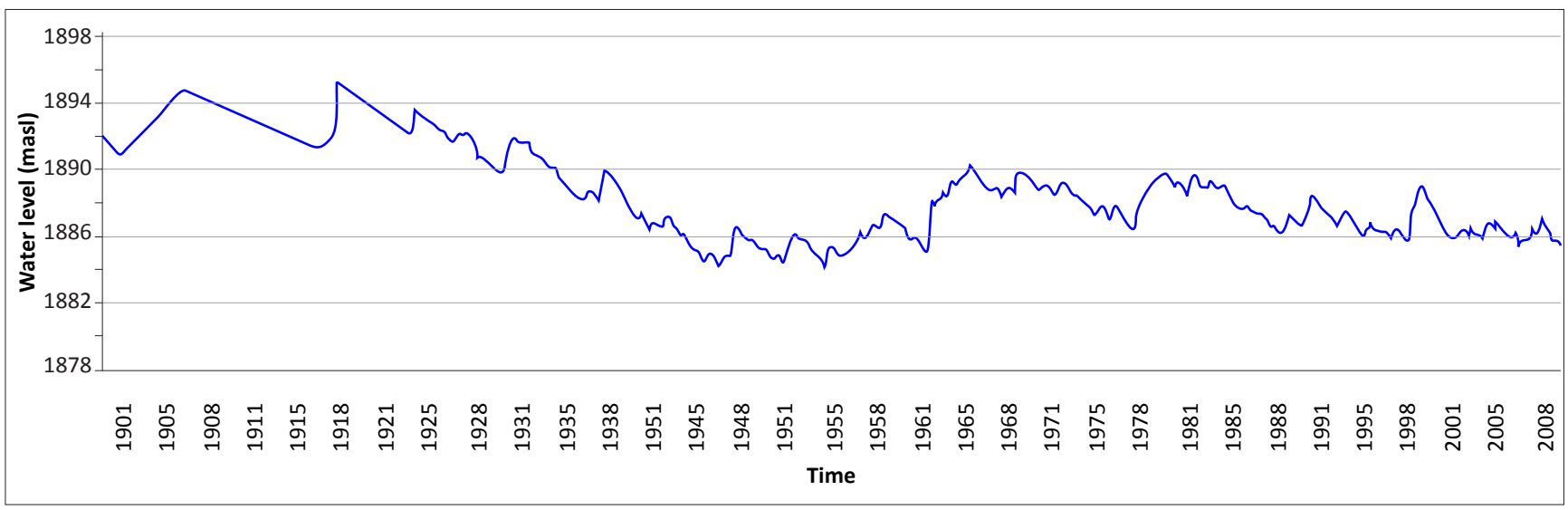
Athi River Basin

The Athi River Basin measures approximately 67 000 km^2. The basin comprises the southern part of Kenya east of the Rift Valley and drains the southern slopes of the Aberdares Range and the flanks of the Rift Valley, as well as the North Eastern slopes of Mount Kilimanjaro before draining into the Indian Ocean through the Athi River. The

Lake Magadi—a saline lake in the Rift Valley basin.

Figure 7.4: Long term water levels of Lake Naivasha. It can be noted that the water levels have been declining and the lowest levels were recorded between 1945 and 1955. As from 1987, there has been a gradual decrease with a spike in 1997/98 due to the El Niño phenomenon

Source: WRMA 2009



Mount Kenya's Lake Alice.

upper portion of the Athi river basin is a high potential agricultural and industrial area and covers major urban centres like Nairobi and Mombasa. The Athi River measures approximately 591 km, and has an average width of 44.76 m, average depth of 0.29 m and average flow rate of 6.76 m^3/second.

Tana River basin

The Tana River basin measures approximately 127 000 km^2. The basin drains the eastern slopes of the Aberdares range, the southern slopes of Mount Kenya and the Nyambene hills before discharging into the Indian Ocean through the Tana River. Like the Athi River Basin, the River Tana basin drains an area that is highly populated and urbanized. Portions of the basin include agriculturally high potential areas despite the fact that about 80 percent of the basin is located in the ASALs. The Tana River is a major source of hydropower and currently has an estimated installed capacity of 480 MW out of its total estimated potential of 960 MW.

River Tana measures approximately 1 050 km in length and has an average width of 39.3 m, a mean depth of 2.5 m and an average flow rate of 41.98 m^3/sec. Its mean annual discharge at Garissa is 5 BCM. Minimum levels were recorded in 2000 and 2009, correlating with the severe droughts experienced then. Figure 7.5 shows the trend in water levels over a 20-year period.

Some of the problems afflicting this river basin are water shortfalls arising from excessive abstraction, pollution and water conflicts between upstream and downstream users.

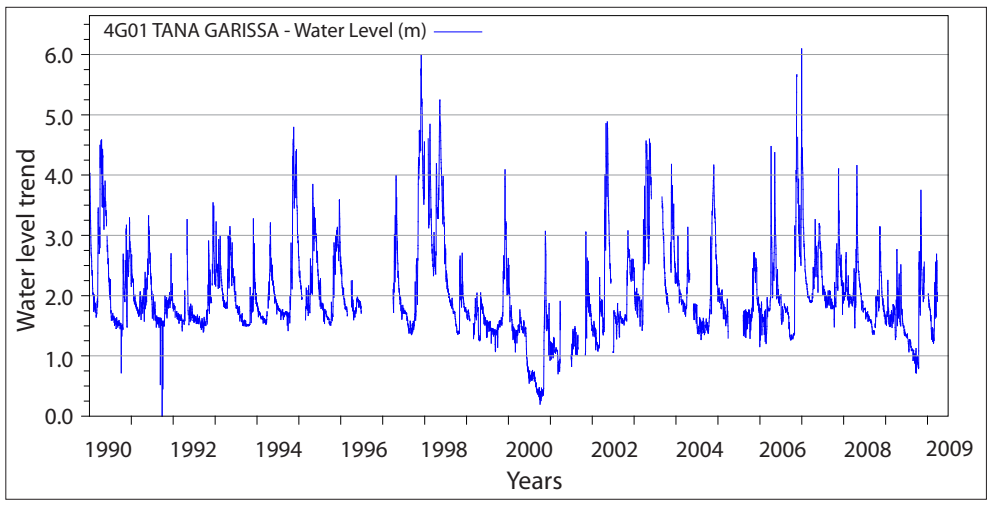


Figure 7.5: Water level trend over 20 years for River Tana measured at Garissa. Note the low levels in 2000 and 2009

Source: WRMA 2009

Ewaso Ng'iro North River Basin

The Ewaso Ng'iro North river basin covers an area of 209 000 km^2. It is found in the Northern part of Kenya, and drains the northern slopes of the Aberdares Range and Mount Kenya. Even during the flood season, the river's waters are absorbed into the Lorian swamp, though in some years, its flow continues into Somalia. In this basin, there is increasing demand for irrigation water, which in turn raises the prospect of water conflicts.

Groundwater resources

Besides surface water, Kenya is also endowed with groundwater resources. As indicated earlier, the annual quantity of renewable groundwater is about 10 percent of the renewable surface water. Areas that receive low rainfall and runoff such as Ewaso Ng'iro basin are largely dependent on groundwater as a reliable source of water. Groundwater is also an important supplementary source in urban centres such as Nairobi, Mombasa and Nakuru.

Main groundwater aquifers in Kenya

The main groundwater aquifers in Kenya are closely linked with four major rock systems. These are the volcanic rocks; the basement metamorphic rocks; intrusive igneous rocks; and the quaternary sedimentary rocks. The volcanic and quaternary geological formations are particularly rich in groundwater.

Kenya's groundwater potential is extremely variable, both spatially and temporally, in quality and quantity and in terms of the level of the water table and depth. Recharge varies from less than 5 percent of the annual rainfall in the arid and semi-arid lands where evapotranspiration losses are high, to 30 percent in areas of deep sandy soils, coral limestones and unconsolidated rocks where evapotranspiration losses are low. In humid and semi-humid regions, recharge rates may be higher.

Classification of aquifers

The various aquifers in the country have been classified into broad categories with respect to their perceived importance. The classification helps in determining the quality and quantity of each aquifer in light of its value and vulnerability to different management regimes. The classification is shown in Table 7.4.

Class	Description	Examples
Strategic aquifer	Aquifer used to supply significant amount/proportions of water in a given area and for which there are no alternative resources, where such resources would take time and money to develop, significant transboundary aquifers	Sabaki, Tiwi, Nairobi, Central Merti, Nakuru, Kabatini, Lake Naivasha, Lamu Island
Major aquifer	High-yields aquifer systems with good quality water	Daua and Elgon volcanics
Minor aquifer	Moderate-yield aquifer systems with variable water quality	Mandera Jurassics
Poor aquifer	Low to-negligible yield aquifer systems with moderate to poor water quality	Aquifers in Basement rocks
Special aquifer	Aquifer systems designated as such by WRMA	Isinya

Table 7.4: Classification of Kenya's aquifers

Source: National Water Master Plan report 1992

Estimated groundwater potential in BCM/year safe yield *	Estimated abstracted groundwater in Mm^3 per year	Per cent of available exploitable groundwater that is abstracted
1.04	0.18	17

* Safe yield is the amount of water that can be abstracted without causing undesirable effects to the aquifer

Table 7.5: Estimated potential compared with amount abstracted

Source: GoK 1992

Groundwater development and use

It is estimated that the country's hydrogeology allows for an economic exploitation of the groundwater resources at an annual safe yield of 1.04 BCM of which only 0.18 billion BCM per annum is currently being extracted (Table 7.5). For sustainable utilization of groundwater resources, it is important that studies are conducted to determine the current abstraction levels for aquifers in different parts of the country and to encourage such exploitation where quality and quantity allow.

Wetlands resources

According to the Environmental Management and Coordination Act (Wetlands, Riverbanks, Lakeshores and Seashores Management) Regulations 2009, wetlands are: 'areas permanently or seasonally flooded by water where plants and animals have become adapted; and include swamps, areas of marsh, peat land, mountain bogs, banks of rivers, vegetation, areas of impeded drainage or brackish, salt or alkaline; including areas of marine water the depth of which at low tide does not exceed 6 metres. It also incorporates riparian and coastal zones adjacent to the wetlands'. This is similar to the definition contained in the Ramsar Convention (1971) which defines wetlands as 'areas of marshes, peat lands, floodplains, rivers and lakes, and coastal areas such as salt marshes, mangroves, and seagrass beds, but also coral reefs and other marine areas no deeper than six metres at low tide, as well as human-made wetlands such as waste-water treatment ponds and reservoirs'. Based on the Ramsar convention, wetlands are classified into three main types:

- Inland wetlands including permanent and seasonal rivers, inland deltas and floodplains, lakes, ponds and marshes
- Marine/coastal wetlands including open coast, coral reefs, estuaries, deltas, mangrove forests, and lagoons.
- Artificial or man-made wetlands including reservoirs, aquaculture ponds, excavations, waste water treatment ponds, irrigation canals and rice fields.

The source of the Mzima Springs is a natural reservoir under the Chyulu Hills. Rainwater percolates through the volcanic lava rock and spends many years underground before emerging at Mzima.

Christian Lambrects/UNEP

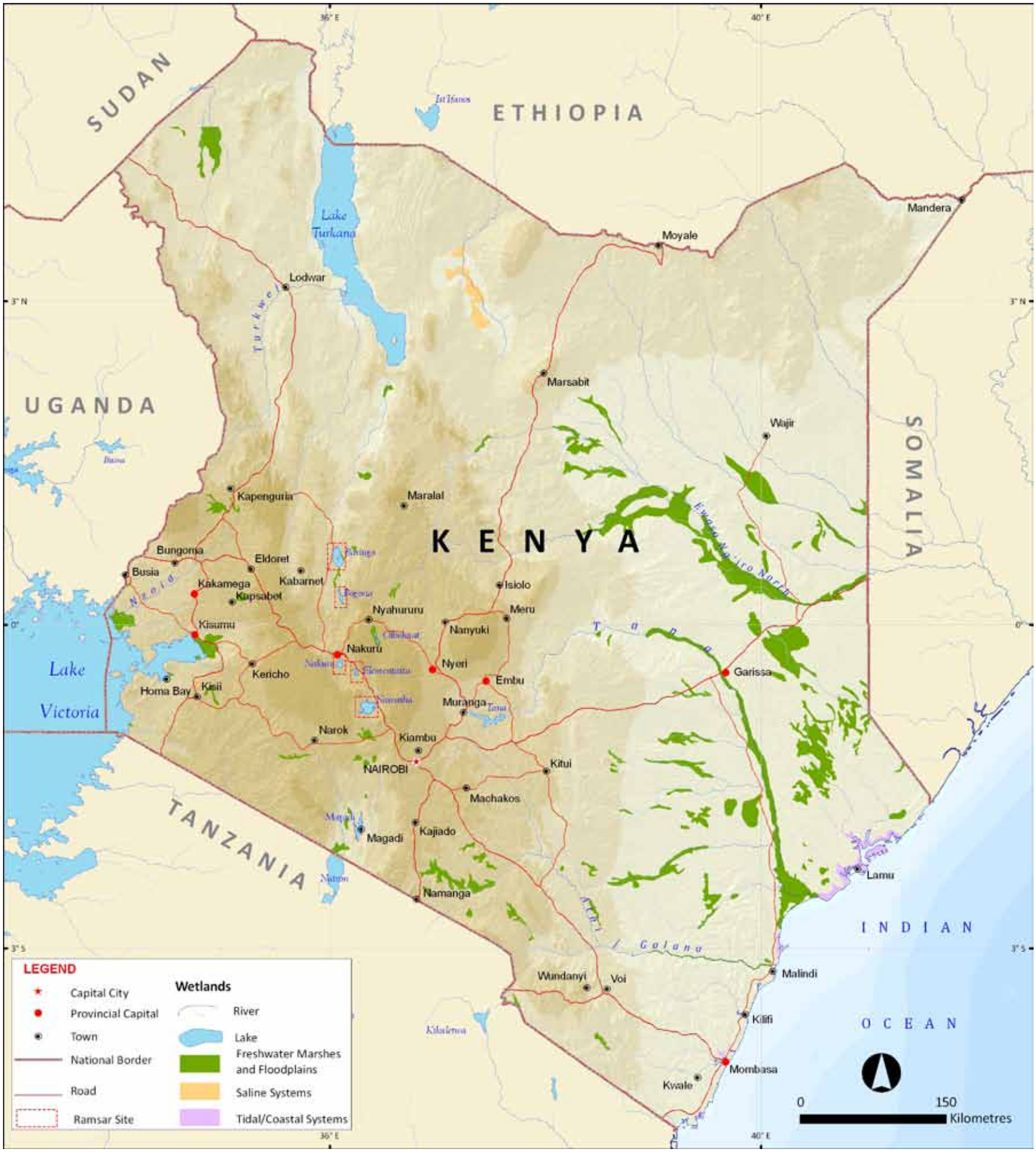


Figure 7.6: Location of wetlands in Kenya

Source: KWS 2010

From this classification, Kenya has been found to have six classes of wetlands: marine, estuarine, lacustrine, palustrine, riverine and human made wetlands. A general location of these is shown in Figure 7.6.

In terms of the water sector, wetlands play a fundamental role in maintaining climatic and hydrological stability. Natural wetlands also provide life-supporting services by moderating local climate, regulating stream flow, improving water quality through sediment filtration and absorbing heavy metals and other toxic pollutants and reducing flood risk downstream. They also help to recharge ground water and augment stream flows. Recharges in major wetlands occur through rainfall precipitation. These services make clean water available to people. Thus, wetlands are important sources of water for human consumption, agriculture and watering of livestock and wildlife. They recharge aquifers thereby raising the water table and making groundwater easily available for domestic and industrial use as well as for agricultural activities.

Coastal resources

Kenya's 608 km coastline extends from Somalia's border at Ishakani in the north, to Vanga at the Tanzanian border in the south. The coastal region is endowed with rich natural resources that play a critical role in fostering economic development. Such resources include beaches for recreation, fisheries resources, mangrove forests and cultural diversity.

Attribute	Quantity
Length of coastline	608 km
Exclusive Economic Zone	118 sq km
Number of marine Protected Areas (MPAs)	10
Average annual marine fish catch (wild catch and mariculture)	7 000 tonnes

Table 7.6: Kenya's coastline at a glance Source: NEMA 2009

Table 7.6 contains an overview of Kenya's coastline. A number of ecosystems occur along the coastline. These include mangroves and other coastal forests, seagrass beds, sand dunes and sandy beaches and coral reefs.

Coastal forests and mangroves

The mangroves and coastal forests of Kenya characterize the low lying inter-tidal areas and system of low ridges between 100 and 300 m in altitude respectively. The coastal forests in particular, thrive on complex, mostly infertile soils inland. Coastal forests characteristically occur where humidity is high throughout the dry season. The forests have a canopy span of up to 7 m, covering about 139 000 ha and with lowland forest patches, woodlands, bushlands and thickets. The main forests in the coastal area include Arabuko Sokoke (41 000 ha) and the Shimba Hills system (19 260 ha). Others are smaller patches ranging from 10 to 2 000 ha and mainly consist of the 'Kaya,' sacred forests of the Mijikenda communities. These forests exhibit high levels of diversity and endemism. Arabuko Sokoke forest, for example, is home to six rare and endemic bird species.

Riverine forests on the other hand, depend on flooding from coastal rivers, including the Tana River. They are a unique forest type in the coastal zone, providing habitats for rare species of primates, such as Red colobus monkeys. Their extent, however, has been reduced by extensive damming and over-abstraction of the coastal river's waters for farming, which has reduced flooding. This is threatening both the forests and the species they harbour.

Mangrove forests occur along the coast in the intertidal area between the land and the sea. Landward, mangroves are found adjacent to coastal terrestrial forests, while seaward, they coexist with seagrass beds and coral reefs. Kenya's mangrove forests and coastal wetlands are concentrated on the northern coast around the Lamu archipelago and the permanent Tana/Sabaki River estuaries, with smaller wetlands in the mouths of semi-perennial and seasonal coastal rivers on the South Coast, at Shimoni-Vanga, Funzi and Gazi Bays, and Port-Reitz, Tudor, Mtwapa, Kilifi and Mida Creeks.

The total area of mangroves in Kenya has been estimated at between 53 000-61 000 ha, with 67 percent occurring in Lamu district, and 10 percent each in Kilifi and Kwale districts. It is estimated that 10 310 ha of mangrove forest have been lost due to conversion to other land uses, overexploitation and pollution. There are 9 mangrove species found along the East African coast. All these occur in Kenya although the dominant ones are *Rhizophora mucronata* and *Ceriops tagal*. Other rarer species include *Heritiera littoralis* and *Xylocarpus moluccensis*.

Mangrove forests are nutrient-rich environments which promote a variety of food chains and function as nursery and feeding grounds for fish and invertebrates. Many of these species spend part of their lifecycle in coral reefs, seagrasses and open waters. The mangrove trees are also important for shoreline stabilization and provide wood fuel and building materials for both rural and urban coastal populations.

Mangrove forests in the Manda Bay, Lamu.

Eugene Apindi Ochieng

Seagrass beds

Seagrasses occur in extensive beds that cover the largest proportion of shallow reef slopes, and form an important habitat for many species living in them and adjacent systems. Twelve seagrass species are found in Kenya. *Thallasondendron ciliatum*, which forms monospecific stands, is the dominant one. Its canopy structure provides habitats for small and juvenile fish and invertebrates. Other common seagrass species found in the country are *Halophila ovalis, Halophila minor, Halophila stipulacea, Halodule uninervis, Halodule wrightii, Syringodium isoetifolium, Cymodocea rotundata, C. serrulata, Thalassia hemprichii, Zostera capensis* and *Enhalus acoroides*.

Seagrasses show clear zonal patterns with water depth, sediment structure and exposure to air and sunlight during low tide. Species that are tolerant to exposure are found higher up on the intertidal, while those that cannot withstand exposure occur submerged in pools of water. Seagrass beds are important foraging grounds for endangered species such as dugongs and marine turtles. They are also important habitats for fish species like rabbit fish, surgeon fish and parrot fish. Various species of shellfish and sea cucumbers are also found in seagrass beds.

Sand dunes and sandy beaches

Sandy beaches are found all along the coast and most notably along parts of the coastline dominated by terrigenous sediment and without fringing reefs, near the Tana and Sabaki rivers and northwards towards Lamu. These areas have high dunes generated by wind-blown sand from the beach. The largest dunes occur within the Tana River delta, reaching 50 m above sea level, covering an area of 1 300 km^2. Sand dunes support a rich diversity of wildlife and other natural resources. Their sand is generally of terrestrial origin and is deposited by the river.


Fagasan/Flickr.com

A star fish in seagrass during low tide in Tiwi beach, Mombasa.

Beaches are important habitats for species such as sea turtles, which lay their eggs in upper-beach environments, as well as shorebirds and migratory birds. However, because they are at the fringe of land and sea and offer easy access to the sea, they have become areas of intense economic activity, habitat modification and user conflicts. These have negative impacts on vulnerable species like sea turtles, which spend a critical part of their lifecycle on the beaches.

The Kipini Conservancy located in Lamu and Tana River districts forms a continuous mosaic of highly diverse habitats including sand beaches, dunes, bush land thickets, grassland, woodland, and forest.


Christian Lambrects

Coral reefs

Coral reefs are among the most productive of all marine ecosystems. They provide a habitat for numerous species, including turtles, dugong, whale sharks and others. Their essential ecosystem services, such as protecting the coastline from ocean waves and hosting many biodiversity species, exposes them to numerous threats. Coral reefs support coastal artisanal fishing which is dominated by local and migrant fishermen using hand- or wind-powered boats (such as local dhows and dugout canoes) and fishing gear adapted from traditional gears, including basket traps, spears (both hand and powered), nets and hand lines. As a result of extensive exploitation due to little or no regulation, and the use of destructive fishing techniques, the reefs in Kenya have been generally over-fished and are suffering degradation.

Opportunities for sustainable management

Water is central to the economic development of Kenya. Government should therefore put in place measures to increase supply and ensure more efficient management of Kenya's scarce freshwater resources. Kenya's safe yield of surface water resources has been assessed at 7.4 BCM per annum while that of groundwater is estimated at 1.04 BCM per annum. In 1998 water extractions were estimated at about 13-19 percent of the assessed safe yield potential, amounting to between 1.1 to 1.6 BCM per annum.

In 2005, surface and ground water extractions were estimated to be 1.6 BCM per annum, indicating an extremely low level of development of the available water resources. Although Kenya is classified as a water scarce country, there is still scope for extensive water development. Water development may include non-consumptive uses like hydroelectric power generation.

Coastal and marine resources also contribute immensely towards the economic development of Kenya through tourism, fisheries, shipping and port activities which have positive outcomes for the delivery of Vision 2030, the country's long-term development blueprint. Tourism and shipping are the highest contributors to the coastal economy, contributing 45 and 15 percent respectively. Artisanal fishing lands 95 percent of the total marine catch, contributes 6 percent to the coastal economy, and is the main source of livelihood for more than 60 000 households. The proportion of the contributions of different activities' to the coastal economy is shown in Figure 7.7.

Development of hydropower and irrigation potential

In Kenya, access to electricity is normally associated with a rising quality of life. The current hydroelectric power potential of Kenya's waters has not yet been fully exploited. Currently, only 719 MW has been developed against a potential of 6 000 MW. This latent potential will need to be harnessed if Kenya is to deliver the 10 percent annual economic growth rate promised by Vision 2030.

Expansion of irrigated land has the potential to increase cropland substantially and to boost agriculture that was previously wholly dependent on rainfall. The National Water Master Plan identifies an irrigation potential of almost 540 000 ha based on 80 percent dependable flow. In spite of the increase in the area under irrigated

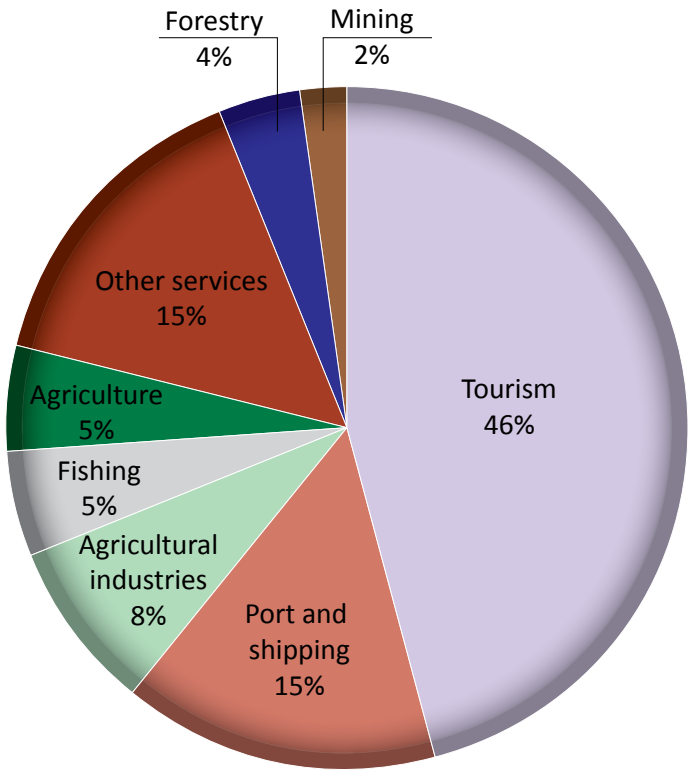


Figure 7.7: Principal economic activities and their contribution to livelihood and income for coastal populations

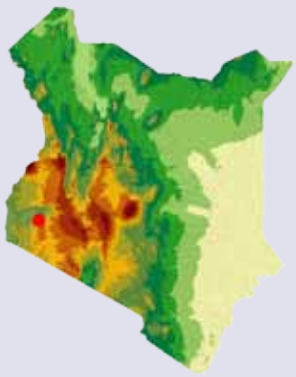
Source: NEMA 2009

agriculture from 52 000 ha in 1985 to 105 000 ha in 2003, the potential has not been fully developed due to the high cost of infrastructure. The target was to bring 192 640 ha of potential irrigable land under irrigation by 2009 and to subsequently increase it by 10 000 ha annually to a maximum of 1.2 million hectares including drained lands.

To meet the diverse demands for clean energy and water, the government, in Vision 2030, has proposed the development of several large and medium-sized multipurpose dams. The latter can be put to varied uses such as hydroelectric power generation, irrigated agriculture, water supply, flood control, recreation, inland navigation and fish breeding. For instance one of the flagship projects of Vision 2030 is the Magwagwa Dam Multipurpose Development Project on the Sondu River. It has a hydroelectric power generation potential of 120MW, the potential to provide irrigation for 15 000 ha of land and to supply adequate water to a population of approximately 600 000.

Basin approach to water resources management

The country has adopted a basin-based approach to water resources management. This is a holistic methodology that provides for regulated use of the water resources for the benefit of communities while preserving the integrity of ecosystems. Under this approach, restoration and rehabilitation of river basins is key to addressing water pollution and ensuring delivery of clean water to users. The Water Resources Management Authority (WRMA) uses the river basin as its focus, and is charged with the responsibility of integrating the management of such basins, and including stakeholder groups in the management structure. The sector intends to increase regular monitoring of water resources from the current 30-40 percent to 70 percent in order to identify areas that need attention before serious deterioration occurs. The Catchment Management Strategies for all the water basins in the country were gazetted in 2009.



Electricity generation—Sondu Miriu River, one of the six major rivers in the Lake Victoria basin, drains a total area of 3 470 km^2 in the Western part of Kenya. The river originates from the western slopes of the Mau Escarpment and flows through a narrow gorge, penetrating the Nyakach Escarpment. It then meanders into the Odino falls before entering the flood plains of Nyakwere where it drains into the Winam Gulf of Lake Victoria. The Sondu Miriu Hydro Power Project is a 60MW power project based on a run-of-river diversion from a

weir structure on the Sondu Miriu River above the Nyakach Escarpment. The water from the intake weir is conveyed via a 6.2 km underground tunnel before dropping to the power station via a 1.2 km penstock. The tail water then passes through an open channel for about 5 km to the 20MW Sang'oro power plant before discharging back to the Sondu Miriu River.

Unlike other hydropower projects in Kenya, Sondu Miriu Hydro Power Project does not have a major dam and associated large reservoir but relies on the flow of the river with only a small storage capacity at the intake, thus reducing its environmental impacts.

At the regional level, in 2010, the Nile Cooperative Framework Agreement was signed by six of the ten Nile Basin Countries namely; Kenya, Uganda, Tanzania, Rwanda, Burundi and Ethiopia. Such cooperative approaches provide a mechanism for coordinated management of the water resources and help to integrate the diversity of interests in shared basins.

A supportive legal and policy framework

Government has put in place a supportive legal and policy framework that will ensure the sustainable development of water resources. The vision for the water and sanitation sector is '*to ensure water and improved sanitation availability and access to all by 2030*.' To achieve this, Vision 2030 spells out measures to be undertaken to enable universal access to water and improved sanitation by 2030. Some of the specific strategies include improving the management of water resources, enhancing storage and harvesting capacity, constructing multipurpose dams as well as water and sanitation facilities in order to cater for the growing population. It has also defined flagship projects that will enhance the achievement of the water-related MDGs.

The new Constitution provides for the right to water and sanitation and recognizes environmental management as critical to achieving sustainable development. The Constitution also underscores the need for sustainable utilization, exploitation, management and conservation of the environment and natural resources as well as ensuring ecologically sustainable development including the protection of ecologically sensitive areas.

A number of other laws also provide for good water resources management. The Water Act 2002 has specified relatively clear roles at different levels for water resources management and development. Sections 42 and 55 EMCA (1999), which is the framework environmental law, provide for the sustainable management and utilization of wetlands and aquatic resources. There are also several sectoral statutes that have provisions on land use relevant to this sector. These include the Local Government Act, Physical Planning Act, Agriculture Act, Forests Act, Wildlife (Conservation and Management) Act, Mining Act and the Heritage Act (Monuments and Antiquities Act). In addition to addressing other issues, these laws provide for environmental protection and conservation within the relevant sector, with several subsidiary pieces of legislation prescribing land use standards to control environmental exploitation.

Coastal tourism

The main tourist attractions at the coast are its sandy beaches, marine parks and reserves, terrestrial game parks and reserves and an intriguing cultural setting which blends African, Arab, Portuguese and Western ways of life.

Tourism is the leading foreign exchange earner in Kenya and is expected to be a major contributor to attaining Vision 2030's economic pillar goals. In addition, income from tourism-related economic activities is an important and reliable source of revenue for the central government and local authorities. Between 2005 and 2007, tourism contributed an average of 9.2 percent to the GDP annually. However,

Fishing nets on Watamu Beach.

John & Mel Kots/Flickr.com

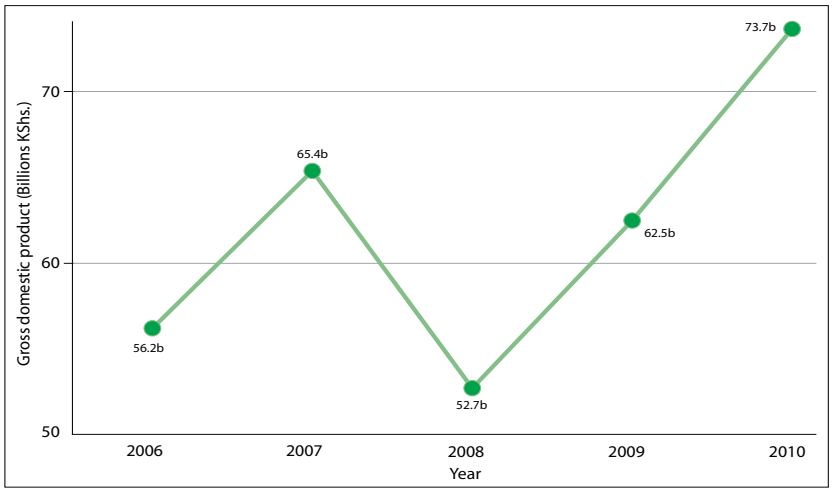


Figure 7.8: Overall tourism earnings, 2006 to 2010

Source: GoK 2011

in 2008, the sector witnessed one of its worst performances in recent history. This was mainly as a result of the political violence that erupted in the country in the wake of the disputed 2007 general elections. As a consequence, tourism earnings decreased from KSh 65.4 billion in 2007 to KSh 52.7 billion in 2008, representing a 19.2 percent drop. The volume of international arrivals also dropped sharply by 33.8 percent from 1.8 million in 2007 to 1.2 million in 2008. This was attributed to cancellations of reservations and termination of ongoing holidays as a result of the ensuing political uncertainty. Figure 7.8 shows the contribution of the tourism sector to the GDP from 2006 to 2010.

Coastal tourism contributes up to 68 percent of the total tourism earnings in Kenya. In most cases, half of the tourists to Kenya (47.6 percent of all bed-nights occupied in 2008) visit the coast with the country's north coast being the preferred destination. The sustainable use of the country's coastal and marine resources will therefore be crucial to meeting the economic and improved welfare goals enumerated in Vision 2030.

Coastal fisheries

There are two main types of fisheries: capture and culture fisheries. Traditionally, coastal communities have depended on capture fisheries and mangrove exploitation. Kenya is endowed with rich inshore marine fisheries and the most productive fishing areas are the North coast including Lamu, Kiunga, Kizingitini, Faza, the Sabaki Estuary and Tana River Delta, and the south coast especially the Funzi-Vanga complex.

Artisanal fishing that is undertaken in the inshore waters is labour-intensive and thus provides employment and livelihood sources to thousands of fishermen and their families. Estimates indicate that over 10 000 fishermen are directly engaged in artisanal fishing that accounts for about 95 percent of the total marine catch.

Mariculture, which is the culture of marine organisms, is increasingly being taken up by the residents of the coastal region as an income generating activity. There are three types of mariculture which can be undertaken along the coast; pond culture on land behind mangroves, suspension culture (cage and raft) in sheltered waterways that are of sufficient depth, and rack culture in the shallow intertidal areas. However, hydrologic conditions and other factors make large areas of mangroves in Kenya unsuitable for pond culture. For instance, only 3 950 out of 54 000 ha (7.3 percent) of the total mangrove area is considered suitable for the development of brackish-water shrimp farming. The common mariculture systems used in Kenya include small earthen ponds, drive-in mud crab cages, pen culture, Acadja Net Enclosures and down ponds.

Ports and shipping

Maritime transport of goods and passengers accounts for 15 percent of the coastal economy. The Mombasa Port at Kilindini is one of the largest and most important ports along the entire East African coast. The port serves Kenya and the landlocked neighbouring countries such as Uganda, Rwanda, Democratic Republic of Congo and South Sudan. The total number of ships that docked at the Mombasa Port averaged at 1 772.8 during 2004-2008. Cargo traffic handled in the port increased steadily from 12.92 million to 16.42 million deadweight tonnes over the same period. The volume of traffic handled at the port of Mombasa in 2008 was 16.4 million tonnes compared to 16.0 million tonnes in 2007, a 2.8 percent increase. 19.1 million tonnes were handled in 2009 and 19 million tonnes in 2010. The trend in the amount of cargo handled at Mombasa port from 2006-2010 is shown in Figure 7.9.

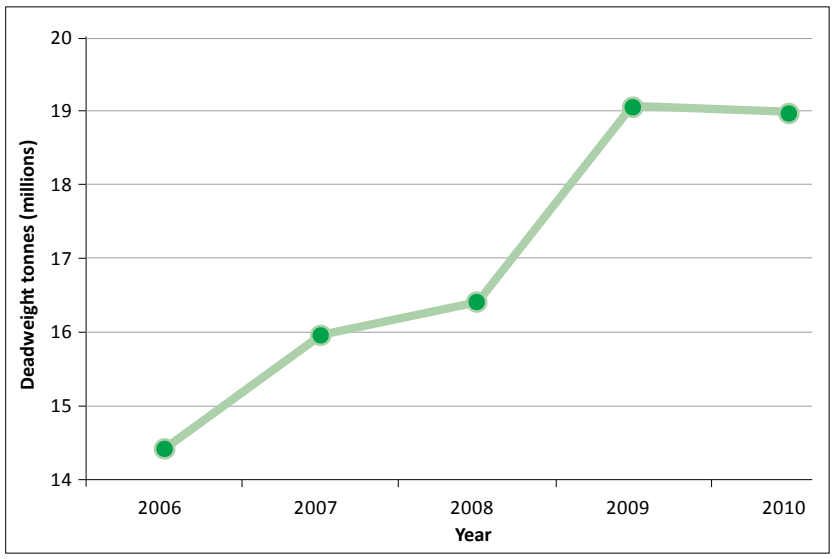


Figure 7.9: Trend in the amount of cargo handled at the Port of Mombasa

Source: GoK 2011

Challenges facing freshwater and marine resources

A number of factors are impeding the sustainable development of the country's freshwater and marine resources. These include the ever increasing population and attendant water demand, overexploitation, wetlands and the wider catchment degradation, climate change and variability, marine pollution, shoreline changes and erosion, and emerging economic considerations.

Water scarcity

While the 2.9 percent annual growth in the country's population has led to a corresponding increase in water demand, the water supply has largely remained static. This calls for appropriate measures to meet the growing water demand for domestic and agricultural use. The renewable freshwater availability per capita has been declining over time and although it stands at an already low 548m^3, it is projected to fall to 235m^3 by 2020 (GoK 2010b). Acute water scarcity is often associated with a range of water-borne diseases such as diarrhoea and cholera. Because an unhealthy population cannot be productive, water scarcity is likely to adversely affect the attainment of the Vision 2030 economic, social and political goals.

The country's water resources are not evenly distributed in time and space primarily because 80 percent of the country is classified as ASALs. In addition, floods and droughts occur more frequently. As a result, poor Kenyans are seldom concerned about protecting the natural environment leading to water resource and catchment degradation.

There is therefore a clear link between water resources management and community livelihoods. Unless poverty and population issues are incorporated in water management, any attempts to achieve sustainable water resources management are doomed to failure. Appropriate interventions are therefore called for in order to make Kenya more water secure.

Wetlands degradation

The demands placed on wetlands are contributing to their deterioration. The contributory factors are poverty, rapid population growth, unsustainable agricultural practises, urban development, pollution, catchment degradation and climate change-induced stressors.

Wetlands are nutrient-rich ecosystems with high productivity, thus making them suitable for agriculture. During the dry season, wetlands are the only distinct areas with quality pasture and provide fall-back for livestock dependent populations. The pressures on the water resources and quality extend well beyond the administrative boundaries. Indirect impacts can result in downstream eutrophication and sedimentation and changes in geomorphology and flow regimes.

Wetlands are habitats to many different species including some that are endemic, endangered, and threatened such as haplochromines, Sitatunga antelope and papyrus. Most of the wetlands' species are cherished and valued by local communities and are therefore vulnerable to overexploitation, with some being on the brink of extinction.

The relatively flat terrain associated with river floodplains and estuarine wetlands make them easier to urbanize and 'develop' than upland areas, resulting in a concentration of human developments there. This has resulted in a progressive direct loss and indirect degradation of coastal and floodplain wetlands. Impacts are not just limited to lowland wetlands. Often the ecological footprint of unsustainable developments can extend over a considerably large area. Encroachment into wetlands has, for instance, been known to influence local and regional climates through the creation of urban heat islands. Impervious surfaces can alter sensible and latent heat fluxes and recent research findings have suggested that cities may also significantly affect local and regional precipitation regimes. Progressive urban sprawl, therefore, has the potential to impact the natural environment, and wetlands in particular, far beyond formal municipal boundaries. However, it is important that the increased urbanization that is expected to accompany the devolution envisaged by the Constitution does not accelerate the degradation of the country's wetlands, otherwise this will imperil the actualization of the Vision 2030 goals.

Urban wetlands for instance are threatened in two principal ways. The first is through the direct conversion of wetlands to planned and unplanned built up areas. This is leading to acute problems associated with pollution, drainage issues, direct biodiversity habitat loss, overexploitation of wetland plant and animal species by urban and peri-urban residents and the increased prevalence of invasive alien species. The second threat is from watershed-related impacts of urban development, including increased demands for water, increasing diffuse and point source pollution and the need for greater agricultural production to support the burgeoning urban population. These all comprise the 'ecological footprint' of cities and adversely impact

Waste materials pollute the Nairobi River as it flows past the Dandora municipal dumpsite in Nairobi.

Christian Lambrects

wetlands even though these may be far from the urban centres. As agriculture is the backbone of the Kenyan economy, its strong growth is crucial to the delivery of Vision 2030, particularly its economic pillar goals. However, it is important that wetlands' integrity is not compromised while seeking to improve agricultural productivity in line with the Vision 2030 targets.

Water quality and pollution

Pollution of the water resources is a major problem. It creates health hazards, destroys ecosystems, adversely affects biodiversity and reduces industrial capacity through costs arising from the removal of pollutants. Industrial effluent, agricultural chemicals, municipal sewage and sediment load from soil erosion are some of the sources of pollution. Soil erosion arises from unsustainable land and water use practises. Physical-chemical analyses of surface waters show a high concentration of dissolved and suspended matter particularly at the beginning of rainy seasons. Table 7.7 highlights pollution discharge load into surface water by sector from domestic, industry and agricultural sources.

Table 7.7: Pollutant discharge load into surface water by sector Source: NEMA

Pollution source	Typical BOD* level of raw effluent, mg/l	Typical COD level of raw effluent, mg/l
Industry		
Coffee pulping	3 000 - 9 000	3 000 - 28 000
Textile	1 500	3 300
Leather tanning	1 500	
Paper and pulp	1 500	
Slaughter house	1 400	2 100
Fruit canning	2 000	
Milk processing	1 000	1 900
Domestic		
Domestic waste	500	
Agriculture		
Cattle pen washings	1 500	
Pig sty slurry	15 000	
Poultry manure	30 000	

*BOD stands for biochemical oxygen demand.

Catchment degradation

Catchment degradation is a major problem which is undermining the sustainability of water resources because it results in increased runoff, flash flooding, reduced infiltration, erosion and siltation. Degradation of the environment in the drainage basin results in the decline of springs, streams and rivers with catastrophic consequences for human wellbeing and environmental integrity. The main causes of catchment degradation include population pressure and deforestation resulting from destruction of natural vegetation through such activities as poor farming practises (over-cultivation and over-grazing), poorly assessed developments like infrastructure, forest excision for settlement, wood fuel, illegal logging and human encroachment. Other issues that contribute to catchment degradation include excessive abstraction of surface and groundwater, soil erosion causing turbidity and siltation, high nutrient levels causing eutrophication of lakes, dams and pans and pollution from toxic chemicals, including agricultural pesticides and heavy metals.

The degradation of catchment areas leads to chronic and long term problems. These are not always apparent because of the incremental nature of the degradation and the fact that the effects are often felt at a distance (in time and space) from the time and source of degradation. Table 7.8 summarizes the water quality situation for the different drainage basins in Kenya.

Costs of freshwater resources degradation

The costs associated with degradation of water resources include those for maintenance of infrastructure, health impacts, treatment of urban water supply and reduced fisheries production. According to Mogaka et al (2002), estimating the costs of water resources degradation is not easy due to inadequate monitoring data and lack of a scientifically validated understanding of the processes that link pollution and the impacts. The authors however present some guidelines for costing

Table 7.8: Water quality for the different drainage basins Source: Ministry of Water and Irrigation, Water Quality and Pollution Control Division

Basin	Surface water quality	Groundwater quality
Lake Victoria	The lake has fresh water. Rivers exhibit variable seasonal quality—the water in the rivers is turbid, coloured and silt laden during the rainy seasons. In the upper reaches, water is of good quality.	Over 90 percent of boreholes drilled have good water quality, which is fresh and free from high levels of dissolved salts.
Rift Valley	Only L. Naivasha has fresh water. The other lakes in the basin have brackish to saline waters. In the upper parts of the rivers, water is of good quality but in lower parts there is high siltation and agricultural pollutants affect water quality.	Mostly fresh, neutral, soft and free from colour and turbidity. 50 per cent of tested borehole waters have fluoride levels above 1.5ppm.
Athi	In the upper reaches, water is of good quality during the dry periods, but gets very turbid during the rainy season. Water quality deteriorates downstream due to pollution from municipal waste, domestic sewage, industrial effluents and agricultural activities.	Over 50 percent of boreholes contain hard and saline water. Along the coastal area, sewage pollution and seawater intrusion affect water quality. High local variations occur in quality. Parts of the basin have high fluoride levels, hardness and high iron and manganese contents.
Tana	Generally of good quality. Pollution from municipal sewage, agrochemicals and siltation affects some rivers in this basin. Quality deteriorates gradually downstream.	Generally fresh and free from colour and turbidity. Hardness varies from soft to moderately soft. High fluoride levels in parts of the basin.
Ewaso Ng'iro	River water has high turbidity due to agricultural activities.	Water often hard with variable salinity levels. Nitrate contamination has been detected and is due to accumulation of livestock waste at watering points.

Issue	Effects	Associated costs	Estimated annual costs (Ksh millions)
Soil erosion	Siltation	Increased maintenance cost for minor dams/ pans	62.0
		Reduced life of pumps leading to abandonment of water supplies	20.0
Catchment degradation	Increased flooding downstream	Health effects (for instance Kano, Budalangi)	3.5
Water quantity	Crop production	Reduction in crop production	165.0
	Lowered water table	Increased pumping costs for groundwater	
Water quality	Water treatment	Cost of urban water treatment	853.0
	Fisheries	Reduced fisheries production	1 162.0

Table 7.9: Costs of water resources degradation Adapted from Mogaka et al 2002

the effects of water resources degradation based on estimates from particular sites. Table 7.9 illustrates some of the estimated costs although most appear to be very conservative.

Governance of transboundary waters

Kenya shares a number of important surface and groundwater resources with her neighbours—Ethiopia, South Sudan, Tanzania, Somalia and Uganda as shown in Table 7.10. Altogether about 54 percent of Kenya's water resources are shared with other countries. Kenya provides about 45 percent of surface water inflows into Lake Victoria, and hence to the upper Nile. Some of the challenges with transboundary water bodies threaten sustainable use and regional cooperation. For instance, the impacts of climate change and variability such as drought result in a decrease in water availability, competition over water and cause political instability. Because the political, social and economic pillars of Vision 2030 are interrelated as the 2008 post-election violence demonstrates, any potential sources of water tension must be urgently addressed in order to avert regional and national political uncertainty.

Water body	Shared with
Lake Victoria	Uganda and Tanzania
Lake Natron	Tanzania
Lake Turkana (River Omo)	Ethiopia
Lakes Jipe and Chala	Tanzania
Mara River	Tanzania
Rivers Umba and Lumi	Tanzania
Rivers Sio, Malaba and Malakisi	Uganda
Daua River	Ethiopia and Somalia
Merti Aquifer	Somalia
Kilimanjaro aquifer	Tanzania

Table 7.10: Water bodies shared by Kenya with her neighbours

Increasing water demand and accessibility

The government is facing enormous challenges in providing water and sewerage services to its increasing population. The most authoritative estimate for water demand is the admittedly dated 1992 National Water Master Plan (NWMP). It assesses demand for rural and urban domestic water supply, irrigation, livestock, industry, fisheries and wildlife.

At 73.6 percent, irrigation accounts for the highest water demand as can be seen from Table 7.11. In 1990, it was estimated that domestic water demand (both rural and urban) was 1 105 000 m^3/day. This demand was expected to rise to 1 918 000 m^3/day in 2000 and to 3 068 000 m^3/day in 2010. Irrigation water demand was predicted to rise from 3 965 000 m^3/day in 1990 to 7 810 000 m^3/day in 2000 and 11 655 000m^3/day in 2010. This increase was based on the assumption that the planned 160 irrigation schemes would all be implemented and that the current rates of water use would prevail. However, by the year 2000 only about 15 percent of the irrigation schemes had been developed. Livestock water demand also did not rapidly increase as projected. It had been estimated that it would rise from 326 000m^3/day to 621 000m^3/day over the 20-year period (1990-2010).

Category	Demand ('000 m^3/day)		
	1990	2000	2010
Residential water demand	1 105	1 918	3 068
Livestock water	326	427	621
Irrigation	3965	7 810	11 655
Industry	219	378	494
Grand Total	**5 615**	**10 533**	**15 838**

Table 7.11: Water demand projections up to the year 2010 Source: GoK 1992

The National Water Master Plan 1992 also highlighted several demand centres where there was or would be water deficits. These demand centres are mainly urban centres and include Nairobi, Mombasa and Kisumu, Kakamega, Eldoret, Nakuru and other smaller towns.

Domestic water demand

Domestic water demand is expected to continue growing. For example by 2030, it is expected that the total projected domestic water demand will have increased four times from the 1990 figure. Conservative estimates have placed the demand at 3 700 000 m^3/day and 4 700 000 m^3/day in 2020 and 2030 respectively.

A rural water treatment project in Kisii.

Basin	Irrigation potential (ha)	Currently developed areas 2(ha)			Total estimates
		Centrally managed public schemes	Smallholder-community-based schemes	Private commercial schemes	Developed areas (ha)
Tana	205 500	10 500	23 400	32 300	66 200
Athi	40 000	2 600	8 200	12 500	23 300
Lake Victoria	200 000	4 150	32 300	11 500	47 950
Rift Valley	64 000	1 400	7 200	16 500	25 100
Ewaso Ng'iro	30 000	250	15 400	4 700	20 350
Total	539 500	18 900	86 500	79 500	184 900

Table 7.12: Irrigation potential by basin in Kenya

Source: National Water Master Plan 1992, Ministry of Water and Irrigation (MWI) and Interim Report on Irrigation and Drainage Master Plan, 2009

Irrigation water demand

It is estimated that Kenya has an irrigation potential of 539 000 ha with 75 percent of this potential lying in the Tana River and Lake Victoria basins. In addition, the country has a potential of 600 000 ha that can be developed through drainage and flood protection. With water harvesting and storage interventions, the irrigation potential could increase to more than 1.3 million ha. The country has therefore not fully developed her irrigation potential yet this is vital if agriculture, which is the mainstay of the economy, is to help attain and maintain the 10 percent GDP annual growth rate. If the total irrigation potential had been developed, the water demand for irrigation was projected to rise from 3.9 MCM/day in 1990 to 8.1 MCM/day in 2010 putting pressure on other water uses. Table 7.12 shows the irrigation potential by basin, while Box 7.1 lists the different categories of irrigation development by management criteria.

The slow pace of development of the sector is mainly due to lack of appropriate national policy direction, low stakeholder participation and limited financial investment. Under Vision 2030, the aim of the Ministry of Water and Irrigation is to increase the area under irrigation to 300 000 ha by 2012. In order to develop a significant proportion of the potential for irrigated agriculture, strategies and projects should consider the following interventions:

- promote soil and water conservation;
- increase water storage infrastructure, and especially the enforcement of the 90-day water storage regulation;
- support the formulation of an agricultural policy to optimize water use in flood plains;
- ensure water use efficiency which should match or surpass the global average efficiency of 32 percent;
- enhance water harvesting; and
- encourage water reuse especially for irrigation.

Climate change and extreme climatic events

Climate change threatens the very survival of species and the integrity of ecosystems yet all life forms are dependent on the latter. Global warming has led to increased precipitation in some areas, with other regions experiencing severe droughts.

An increasing frequency of climate extremes like floods and droughts is aggravating the state of the available freshwater resources. Climate phenomena often cause widespread flooding particularly in the low-lying areas. For instance the El Niño rains that fell towards the end of 2009 and continued until April/May 2010 led to unprecedented levels of soil erosion, siltation and flood-related damage to infrastructure and an increased incidence of water-borne human diseases. Drought is also an increasingly recurring phenomenon and its impact on the quantities of freshwater resources is usually devastating, resulting in declining lake levels, changes in the flow regimes of rivers, negative impacts on the environment and loss of ecosystem functioning.

Box 7.1: Categorization of irrigation development by management criteria in Kenya

- Centrally managed (public) irrigation schemes: These are irrigation schemes developed and managed by National Irrigation Board (NIB) or by Regional Development Authorities (RDAs). They account for 18 percent of the developed irrigation potential.
- Smallholder irrigation schemes: These are schemes owned and managed by communities or individual farmers. The schemes are developed by farmers on their own or in partnership with other stakeholders. They account for about 42 percent of total irrigation schemes in the country.
- Private commercial farms: These are privately owned and run mainly for the production of horticultural crops such as vegetables and flowers. These schemes employ capital intensive technologies and account for the remaining 40 percent of the total irrigation development.

Source: GoK 1992, GoK 2009b

A section of a road in Baringo damaged by floods.

Lamu is an ancient Swahili settlement. It is one of Kenya's oldest towns and a World Heritage Site.

Land based pollution arising from agricultural activities in the hinterland, domestic and industrial waste from urban settlements and storm water run-off pose significant threats to the marine environment. Poor waste management practises, especially in urban centres also pose a public health risk. There was extensive mangrove die-back in a number of areas. Mwache Creek, a peri-urban mangrove forest in Mombasa, experienced mangrove death covering about 500 ha, while in the Lamu archipelago, extensive dieback of mangroves was reported in Dondori creek. In addition, it is reported that the 1997/8 El-Niño caused 50-80 percent mortality of coral reefs due to bleaching, following an abrupt rise in sea water temperature (NEMA 2009). Currently, there are inadequate mechanisms to address emerging issues affecting the coastal zone from climate-related occurrences such as droughts, floods, tsunamis and storm surges. More research and monitoring programmes are required so as to adequately inform the management of the coastal zone resources.

Marine pollution

Land based pollutants from agricultural activities in the hinterland, domestic and industrial waste from urban settlements and storm water run-off are major sources of pollution to the marine environment. Poor waste management practises, especially in urban centres, pose a public health risk. The major sectors contributing to marine pollution in Kenya include agriculture, coastal developments, processing industries, mining, transportation and energy. Oil spills originating from oil tanker accidents, and hazardous waste from petroleum refineries and shipping activities also pose considerable threats to the coastal and marine environment. These diverse pollutants impact various habitats, including coral reefs, mangroves, seagrass beds, beaches and ground water aquifers along the coast. Marine pollution adversely affects the tourism sector. And because the Kenyan coast is a popular tourist destination, marine pollution is bound to make the Vision 2030 goal of making the country one of the top ten long-haul tourist destinations in the world a much more difficult task.

Shoreline changes and erosion

Increasing human activities along the coastal strip exert more pressure on the shoreline. The main impacts of these activities include loss of coastal land and infrastructure through coastal erosion and accretion. Shoreline erosion poses a continuous threat to the coastal infrastructure, necessitating expensively engineered protection measures and sometimes even the abandonment of hotel developments. Coastal erosion is widespread along areas where unconsolidated deposits form in the low-lying environments. Lamu town, Mambrui and many ancient villages of the Lamu archipelago that were built on ancient deltaic settings are threatened by coastal erosion (Kairu and Nyandwi 2000). Further, the narrow, southern low-lying coastal belt, the beach areas and the coastal mangroves are affected by erosion.

Coastal shoreline change causes destruction to fishing grounds, fish landing sites, beaches, turtle nesting areas, and properties adjacent

the shoreline. Destruction and loss of coastal and marine habitats is a result of unsustainable exploitation, poor land use practises, encroachment and unplanned and unregulated human settlement and urban development.

Ground water quality in wells and boreholes also declines due to increased intrusion of salt water into underground aquifers. Other challenges are presented by salt mining, human encroachment on sea turtle nesting sites, and land tenure and ownership issues. In addition, declining water quality and inadequate sources of potable water are serious constraints to the socio-economic development of the coastal area.

Degradation due to new/emerging economic activities

Economic opportunities like mining of titanium in the Msambweni area of Kwale county are expected to cause profound reductions in faunal diversity, habitat degradation and transformation in the coastal region. The proposed titanium mining project will have a high impact on indigenous plant diversity and ethnobotanical resources, since vegetation will need to be removed before mining can commence. The planned ship loading facility at Shimoni will also lead to habitat loss, and the forest fragmentation will likely result in great loss of biodiversity (Ojiambo 2002). Accidental oil spills and siltation from dredging activities are also likely to cause habitat loss. While these economic activities have the potential to provide local people with jobs that would lift them out of poverty in line with the Vision 2030 aspirations, it is important that these welfare improvements are not achieved at the expense of ecological integrity. It will therefore be critical that the Environmental Management Plan is adhered to in terms of rehabilitation and remedial measures, so as to mitigate habitat and biodiversity loss. Table 7.13 provides a summary of the causes, impacts and results of human activity along the coast.

Poorly planned and uncoordinated coastal developments are a common sight. They occur as a result of a sectoral approach to planning and management. They are further compounded by inadequate partnerships and cooperation between government and non-government stakeholders at the local, national and regional levels in the development and management of the coastal zone. Inadequate communication, education and awareness on coastal zone management issues and weak institutional and legal frameworks that do not adequately address the complex multi-sectoral problems facing coastal areas are also contributory factors.

Table 7.13: Causes, impacts, and consequences of coastal degradation and loss of habitats

Source: GEF 2002, King 2004

Root causes	Impacts	Consequences
Social drivers		
•Increase in population •Lack of alternative livelihoods •Cultural attitudes •Increase in commodity prices •Lack of education and awareness •Community alienation/marginalization	•Poor regeneration capacity •Loss of biomass •Increased resource conflict •Loss of system productivity •Habitat fragmentation	•Loss of cultural heritage •Loss of revenue •Loss of livelihood •Increased poverty
Economic drivers		
•Land transformation for agriculture; salt works, etc. •Water abstraction •Increased market demand •Foreign markets and international trade •Tourism development	•Habitat fragmentation •Increased erosion and sedimentation, •Deterioration of water quantity/quality •Decline in harvestable resources •Loss of aesthetic value	•Loss of biotic integrity and threat to biodiversity •Invasive species •Disease outbreaks •Loss of revenue •Increased poverty
Climate change and natural phenomena		
•Increased greenhouse gases •Increased sea surface temperature	•Increased rainfall and flooding •More frequent droughts •Drying of rivers •Diseases •Coral bleaching •Loss of tourism opportunities	•Loss of biotic integrity and threat to biodiversity •Reduced biomass •Loss of revenue •Increased poverty
Governance		
•Little understanding of the values of ecosystem services •Inadequate financial mechanisms and support at all levels •Inappropriate/outdated legislation •Insufficient public involvement •Poor enforcement of legislation •Inadequate data to support sustainable utilization •Inadequate implementation of available regulatory instruments	•Unsuitable exploitation of living resources •Undervaluation of ecosystem services •Limited ability to think beyond immediate needs •Diminishing livelihoods	•Decline in harvestable resources •Decreased revenue •Increased conflicts •Increased poverty

Strategies for the management of freshwater, coastal and marine resources

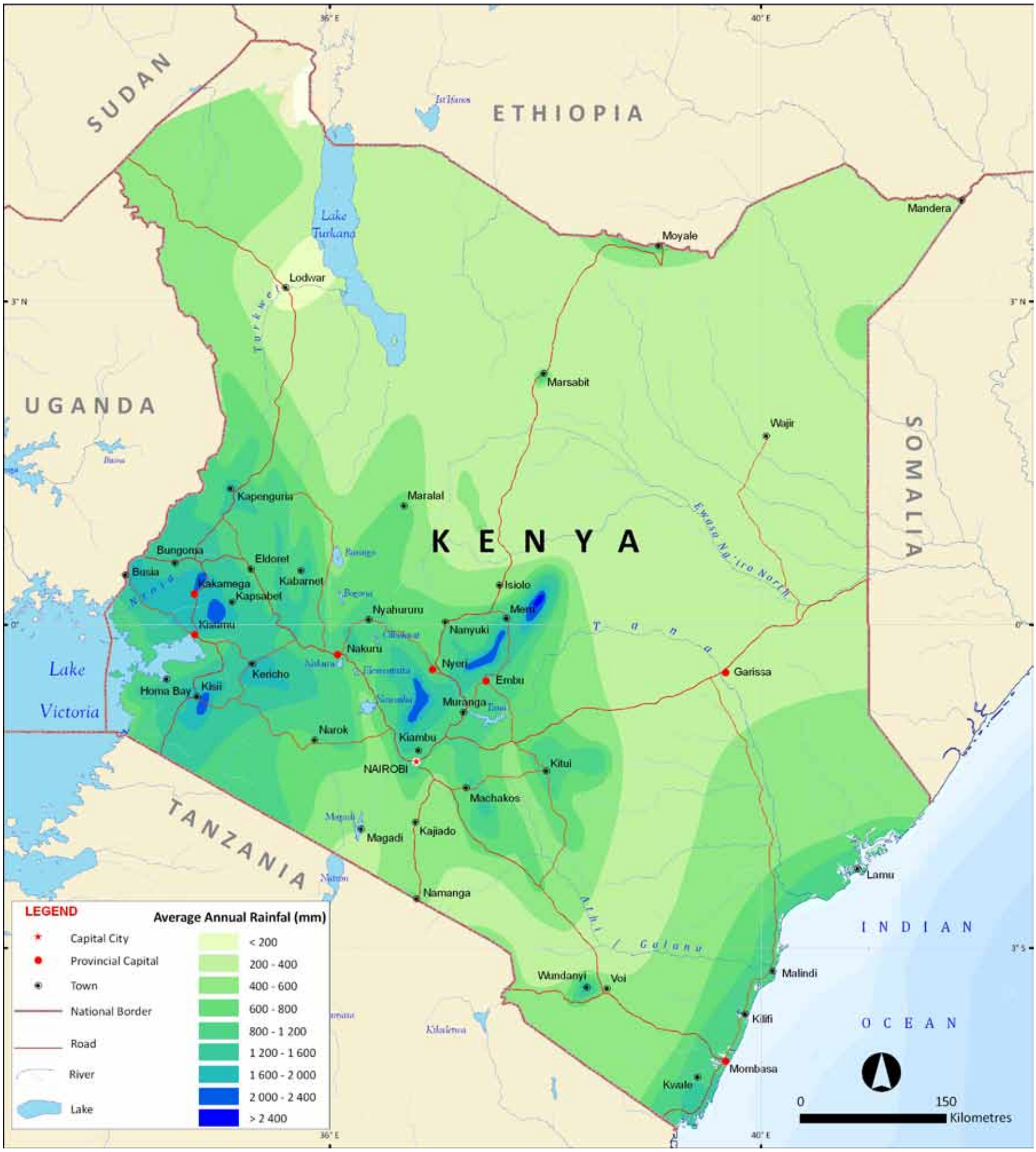
Strategies for the management of freshwater resources

There are several issues and challenges that need to be taken into account as the government attempts to undertake sustainable water resources management. First, Kenya has a limited fresh water endowment. Second, the country experiences wide climatic variations both in time and space. There is considerable spatial variability in rainfall received ranging from 250 mm per year in the arid areas to over to 2 000 mm per year in the mountainous areas. About two thirds of the country receives less than 500 mm of annual rainfall, as shown in Figure 7.10. The country is experiencing an increased incidence of droughts and floods which now occur every three to four years.

Third, the water distribution in the basins is also highly uneven. The highest water availability is found in the Lake Victoria basin which accounts for more than 50 percent while the lowest is in the Athi river basin system. As such, water demand in some urban centres is met by water abstracted from different drainage basins. For example, Nairobi receives the bulk of its water supply from the Tana River basin and this accounts for 15.9 percent of the water abstracted from that basin.

Figure 7.10: Distribution of mean annual rainfall

Source: ILRI 2010



Fishing boats on the shores of Lake Victoria, at Luanda K'Otieno, Siaya County.

To achieve the targets envisaged in Vision 2030, there must be a marked increase of water supply and sanitation services. This is particularly important for the economic activities such as agriculture, industry and tourism as well as education, health, housing and urban development. Despite their important role, Kenya's water and wetland resources face enormous challenges. These mostly manifest themselves in water pollution due to unsustainable farming practises as well as industrialization, urbanization and wetland degradation.

The strategies to improve water and wetlands management should include the protection of the five 'water towers' where most of Kenya's surface water originates, better management and utilization of transboundary water resources, improved management of groundwater sources and improved water storage capabilities. Other interventions should be geared at enhancing information and knowledge management, better funding of the water sector, incorporating gender and health concerns into water resources management and implementing a range of water sector reforms that should also include the wetlands sector.

Better management and utilization of transboundary waters

As already indicated, over half of Kenya's water resources—both ground and surface—are shared with her neighbours. Managing transboundary water resources obviously presents more challenges than national waters. For example, even though the Lake Victoria basin is one of the water surplus areas of Kenya, because the lake is a shared resource, large-scale use of its water resources must be attended by cooperation among the basin countries. In this regard, the Lake Victoria Tripartite Agreement signed by Kenya, Uganda and Tanzania established the Lake Victoria Environment Management Project (LVEMP) whose primary goal is to rehabilitate the Lake Victoria ecosystem.

On the wider front, the Nile Basin Initiative (NBI) provides the basis for cooperation of all riparian countries in the development of the water resources of the Nile Basin. The emphasis is on the need for equitable sharing of the benefits, the sustainability of water resources and the need to build trust and cooperation among riparian countries. This culminated in the signing of the Nile Cooperative Framework Agreement by Kenya, Uganda, Tanzania, Rwanda, Burundi and Ethiopia in 2010.

Improved management of groundwater resources

Although groundwater is widely available, its exploitation and use are largely limited by poor water quality, overexploitation, saline intrusion along the coastal areas and inadequate knowledge of the occurrence of the resource. For instance, in the ASALs where surface water is scarce, groundwater plays an important role in the local livelihoods. Contamination or over-abstraction of groundwater in the ASALs therefore has serious consequences for domestic and livestock needs. Major issues in groundwater management stem from the fact that, compared to surface water, the resource is remote and needs more sophisticated tools for assessment, monitoring and regulation. The situation is compounded by the fact that ground water processes are very slow and any damage to an aquifer may take decades to be remedied either naturally or artificially.

Some interventions have been undertaken in the management of the Nairobi and the Lamu sand dune aquifers. With regard to the Nairobi aquifer, a preliminary study was carried out in order to develop a Water Allocation Plan. The Lamu sand dunes aquifer encroachment was addressed by holding a stakeholder meeting which proposed that the area be gazetted as a groundwater conservation area.

Improved water storage capabilities

Consistent and reliable supply of water is required to counter the effects of climate change and variability. Inadequate harvesting of water has resulted in certain parts of the country having a lot of water during the rainy season and little or none during the dry season. The current water storage of 4.079 billion m^3 out of the available renewable water of 20 billion m^3 is dismally low especially when compared to countries with similar climatic regimes such as South Africa (756 m^3 per capita), China (2 486 m^3 per capita), Brazil (3 255 m^3 per capita) and Australia (4 729 m^3 per capita). Improving rainwater harvesting and storage infrastructure is therefore highly recommended especially in the ASALs which experience frequent droughts.

Sector	Linkages
Tourism	• Resort cities, premium parks, niche products – These will require additional water and expansion of water and sanitation infrastructure • Wildlife – Kenya's wildlife, a key attraction to tourists, requires water for survival
Agriculture	• Irrigation – Development of irrigation will increase demand for water as more land is brought under cultivation • Livestock – Water demand in ASALs will be met by constructing water conservation structures (dams and water pans) and drilling of more boreholes
Wholesale and retail trade	• Modernization of new retail markets – District-based retail markets require water and sanitation services, as will new supermarket chains
Manufacturing	• Special Economic Zones – Manufacturing processes require water supply and waste water disposal systems. Agro-processing is one of the highest consumers of water • SMEs – SME parks will also consume additional water and require sanitation services.
Health	• Improved Health – Since about 80%of all communicable diseases are water-related, access to safe water and sanitation to households will be required to improve health standards.
Environment	• Degraded catchment areas – Degraded water resources will be reclaimed to boost supply • Pollution – Industrial effluents and agricultural chemicals affect water quality, increase cost of treatment and endanger lives
Governance	• Cohesive society – Equitable distribution of water resources will help establish a more cohesive society since lack of water has been a source of conflict in the past

Figure 7.11: Linkages between water and other economic and social sectors

Enhancing information and knowledge management

A reliable water management information system should be put in place. This is because it is important to continuously measure and record water resources data, including their quantity and quality and the various human and other factors which affect the resource. Yet, the water resources monitoring network has undergone marked deterioration. At a national level, only 22 percent of the registered hydrometric stations were operating by 2001. The status of the hydrometric stations in Kenya is shown in Table 7.14. In order to provide a basis for planning and management of water resources, the water assessment and monitoring networks for surface and groundwater quantity and quality need to be urgently rehabilitated and improved. Further, scaling up research in the water sector is essential if the country is to achieve its long-term water resource management targets. This is in light of the linkages between water and the other economic and social sectors which are highlighted in Vision 2030 and are reproduced in Figure 7.11

Table 7.14: Status of hydrometric stations in Kenya Source: GoK 2004

Drainage Basin	Registered stations	Stations operating by 1990	Stations operating in 2001	% reduction from registered stations
L. Victoria	229	114	45	80
Rift Valley	153	50	33	78
Athi	223	74	31	86
Tana	205	116	66	67
Northern Ewaso Ng'iro	113	45	29	74
National	923	399	204	78

Better funding of the water sector

Budgetary allocations for water have traditionally been low although this has recently improved as is evident from Figure 7.12. Adequate and sustained funding is vital for the rehabilitation and expansion of the water supply and sewerage systems in Kenya.

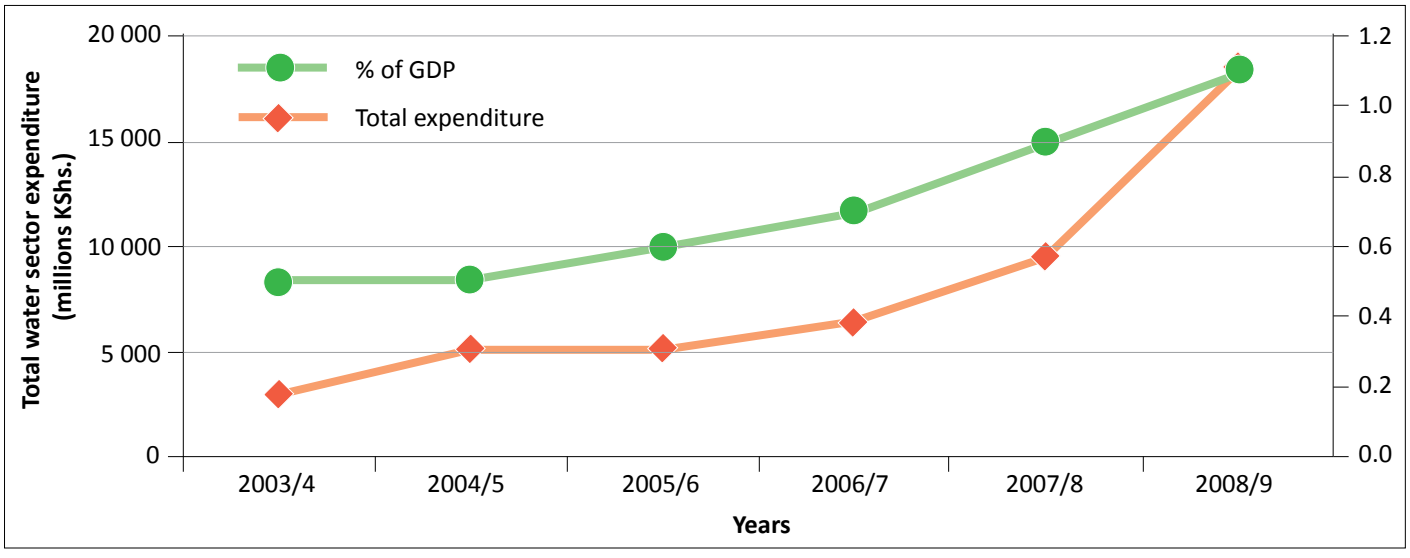
Incorporating gender and health into water resources management

There is a lack of a gender focus in water policy formulation and implementation. Issues of water scarcity generally affect women and girls more than men and boys, in both urban and rural settings. This is because fetching water for domestic use in Kenya is mainly the responsibility of women and girls. However, sometimes men will take the livestock to the water source and might also collect water if it is for sale or if they are employed to do so. In times of extreme hardship, men may assist in the collection of water for domestic use, but they will bring it back using a donkey or bicycle while women have to use their heads and backs. The government has made attempts to raise the level of participation of women and the youth in the water sector through the community water based organizations and Water Resources User Associations (WRUAs).

Improving water, health and sanitation

Water supply and sanitation have an important bearing on public health. Improved access to water and sanitation leads to improved health, reduced health costs and more productivity as employees take less sick-leave. It is estimated that 80 percent of all communicable diseases are water-related and hence constitute a major portion of health care expenditure. Benefits of improved water services and sanitation therefore include averted health related costs, which is a gain to the economy but also benefits individual households. However, the fairly high prevalence of HIV/AIDS presents additional health burdens. For example, aging grandparents who have been left to take care of

Figure 7.12: Budgetary allocations for the water sector financial years, 2003/4-2008/9 Adapted from: GoK 2010



their orphaned grandchildren are often too weak to carry sufficient water from the water points. Government, NGOs and community based organizations (CBOs) should institute targeted mechanisms to ensure access to water for this vulnerable category.

Water sector reforms

Following the operationalization of the 2002 Water Act, management of water resources has been separated from water development and services delivery. The Ministry's role now focuses on policy formulation, implementation and monitoring. The management of water resources is now spearheaded by the Water Resources Management Authority (WRMA) created under the Water Act 2002. Before the Act came into effect, water resource issues were not considered a priority because all efforts and financial resources were directed towards water development, and operation and maintenance of the existing water supplies. Water services regulation and provision are now undertaken by the Water Services Regulatory Board (WASREB) and eight Water Services Boards. Thus a direct result of the water reforms over the past decade was the creation of various institutions, each with distinct roles and functions covering policy and supervision, regulation and service delivery. These are outlined in Table 7.15.

Government interventions in the sustainable management of wetlands

The Environmental Management and Coordination (Wetlands, Riverbanks, Lakeshores and Seashores Management) Regulations 2009

In order to domesticate the Ramsar Convention (1971), the government gazetted the EMCA (Wetlands, Riverbanks, Lakeshores and Seashores Management) Regulations 2009 in February 2010. These regulations emphasize the sustainable utilization of wetlands in a way that is compatible with the maintenance of natural ecosystem properties. Box 7.2 lists some of the activities that are permitted in wetlands under these regulations. These regulations are guided by the following principles:

- Wetland resources shall be utilized in a sustainable manner compatible with the continued presence of wetlands and their hydrological, ecological, social and economic functions and services
- Environmental impact assessment and environmental audits are mandatory for all activities likely to adversely impact wetlands
- Special measures are essential to promote respect for and preserve indigenous knowledge, innovations and practises that are relevant for the conservation and sustainable use of biodiversity. These measures should also ensure equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practises
- Sustainable use of wetlands should be integrated into the national and local land use plans
- Public participation in the management of wetlands
- International cooperation in the management of transboundary environment resources
- Enforcement of the 'the polluter- pays' principle
- Enforcement of the precautionary principle.

Box 7.2: Activities permitted in wetlands

The Environmental Management and Coordination Act (Wetlands, Riverbanks, Lakeshores and Seashores Management) Regulations 2009 specify a number of activities that are permitted in the wetlands to ensure their sustainable management. These include:

- Subsistence harvesting of papyrus, medicinal plants, trees and reeds
- Cultivation provided that the cultivated area is not likely to adversely affect the wetland
- Fishing subject to the provisions of the Fisheries Act
- Collection of water for domestic use
- Hunting subject to the provisions of the Wildlife (Conservation and Management) Act
- Small-scale fish farming, and
- Grazing.

Table 7.15: Roles and functions of the various institutions with a water mandate under the Water Act (2002)

Institution	Function
Ministry of Water and Irrigation	Policy formulation, implementation and monitoring
Water Appeals Board (WAB)	Deals with conflict resolution within the sector as specified under the Water Act (2002)
Water Services Regulatory Board (WASREB)	Regulates water and sewerage services provision including: issuing of licences; and, setting service standards and guidelines for tariffs and prices
Water Resources Management Authority (WRMA)	Regulates water resources issues including: water allocation; source protection and conservation; water quality management; and pollution control and international waters
Water Services Trust Fund (WSTF)	Mobilizes financial resources for development and rehabilitation of water and sewerage services infrastructure especially to poor and under-served areas
Regional Water Services Boards (WSBs)	Manages water and sewerage service provision in respective regions by: contracting WSPs; developing water and sewerage facilities; regulating water services and tariffs; and procuring and leasing water and sewerage facilities
Kenya Water Institute (KEWI)	Provides training, research and consultancy services in the water and irrigation sector
National Water Conservation and Pipeline Corporation (NWCPC)	Contracts construction of dams and pans, bore holes and rehabilitation of flood canals on behalf of the Ministry of Water and Irrigation
National Irrigation Board (NIB)	Develops, promotes and improves irrigated agriculture through sustainable exploitation of available irrigation and drainage potential. Develops and manages national irrigation schemes.

Rehabilitation of the Nairobi River includes cleaning the river banks.

Inventory and mapping of wetlands in Kenya

The Ramsar Convention recognizes the importance of national wetland inventories as tools for informing policy and in order to ensure their conservation and wise use. Further, inventories are also important for identifying sites suitable for inclusion in the List of Wetlands of International Importance (the Ramsar List), for quantifying the global wetland resource as the basis for assessment of its status and trends, for identifying wetlands suitable for restoration, and for risk and vulnerability assessments. In Resolution VII.20 (1999) the Contracting Parties recognized the importance of maintaining a comprehensive national inventory as vital for achieving the wise use of wetlands, including policy development, identification and designation of Ramsar sites, documentation of wetland losses, and identification of wetlands with potential for restoration. It also encouraged the collection of information for the management of shared wetlands, including those within river basins or coastal zones.

Based on the above, Kenya is currently undertaking a national wetlands inventory and mapping exercise in order to come up with a wetland database that should inform these wetlands' sustainable management and policy development. The multi-stakeholder sub-committee mandated for this task is coordinated by the Ministry of Environment and Mineral Resources (MEMR) through the Department of Resource Surveys and Remote Sensing (DRSRS). Another taskforce has been constituted by the same ministry to undertake catchment profiling.

Draft National Wetlands Conservation and Management Policy

The formulation of the draft policy is in recognition of the importance of wetlands nationally. The draft policy also seeks to fulfil Kenya's obligations under the Ramsar Convention. The overarching objective is to ensure sustainable use of wetlands, riverbanks, lakeshores and seashores in order to enhance their ecological and socioeconomic functions for posterity. The draft policy aims:

- To establish an effective and efficient *institutional and legal framework* for integrated management and wise use of wetlands,
- To *enhance and maintain functions and values derived from wetlands* in order to protect biological diversity and improve livelihoods,
- To *promote communication, education and public awareness among stakeholders* in order to enhance their appreciation and participation in wetland conservation,
- To carry out d*emand-driven research and monitoring on wetlands* in order to improve the scientific information and knowledge base,
- To enhance *capacity building within relevant institutions* and for the individual personnel involved in the conservation and management of wetlands,
- To establish a *national wetlands information management system and database,*
- To promote *innovative planning and integrated management approaches* towards wetlands conservation and management in Kenya, and
- To *promote partnership and cooperation* at the regional and international levels for the management of transboundary wetlands and migratory species.

Draft Integrated Coastal Zone Management Policy

EMCA (1999) requires NEMA to develop an Integrated Coastal Zone Management (ICZM) plan to guide sustainable coastal development. The ICZM approach is one that aims to balance environmental conservation and development interests in coastal zones. A properly constituted ICZM framework empowers all stakeholders including government, NGOs, the private sector and local communities, to ensure equitable and sustainable use of coastal and marine resources and ecosystems. In so doing, it improves decision-making processes, enhances community participation, minimizes resource-use conflicts, promotes local coastal management programmes, and helps the country to meet its regional and international obligations such as those under the Nairobi Convention, the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC).

The goal of the country's draft ICZM policy (2010) is 'to guide the sustainable management and equitable use of coastal and marine resources of Kenya.' Its specific objectives are:

- To ensure that ecological values of the coastal zone are fully integrated into the planning, management and use of coastal resources,
- To conserve and manage critical coastal ecosystems, habitats and species,
- To improve the knowledge base on sustainable coastal zone management, and
- To develop and support education and information programmes to promote coastal zone conservation, protection and management.

Conclusion and recommendations

Kenya's freshwater, coastal and marine resources collectively constitute a considerable natural resource and their sustainable use is a prerequisite to the delivery of Vision 2030. This is because these resources support manufacturing, agriculture, tourism and other important economic activities that are vital to Kenya's long term development. Besides making a major contribution to the GDP and being a major driver of the 10 percent annual economic growth rate anticipated by Vision 2030, tourism is the country's principal foreign exchange earner.

Kenya's renewable freshwater resources amount to only 20.3 BCM. A large proportion of these water resources is confined to about one fifth of the country rendering several regions severely water stressed or water scarce. Kenya's water deficiency will be exacerbated further with the implementation of Vision 2030 if no remedial measures are instituted because demand for water from all the economic and social sectors will increase. Other challenges will emanate from the country's high population growth rate, climate change and the transboundary nature of more than half (54 percent) of the country's water resources.

In light of the above, the following interventions are proposed in order to sustainably manage Kenya's water and marine resources:

- **Effective management of water catchment areas.** This should involve formulation of and harmonization of policies on land use for agriculture, wildlife, environment, industry and forests, and for improved coordination in catchment management.
- **Increased availability of water to deficit areas** through inter-basin transfers and construction of large water storage structures and optimum development of groundwater resources.
- **Development of all irrigable land in order to realize food security and economic development and to ease pressure on the existing cultivated lands.** This is in light of the fact that agriculture is slated to remain the backbone of the Kenyan economy and increased agricultural productivity will be vital to the attainment of the Vision 2030 goals, including improved welfare for the citizens.
- **Establishment of collaboration and cooperation mechanisms** allowing for catchment-wide approaches in management of international water resources in order to benefit the basin/ riparian countries.
- **Initiation and improvement of applied water research in important areas** such as application of appropriate and modern technology in water resources management, effective and efficient methods of catchment protection, pollution control, conservation and water use efficiency particularly in agriculture.
- **Development and implementation of an ICZM policy and legislation on coastal and marine resources** that will harmonize many of the issues contained in the various sectoral laws, EMCA and other regional and international conventions.

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CHAPTER 8
HEALTH AND ENVIRONMENT

Introduction

Health, as defined by the World Health Organization (WHO), is a complete state of physical, mental and social well being and not merely the absence of disease or infirmity (WHO 1948). The environment is where we live and includes the physical, biological, chemical, social and economic aspects of land, water and air. The environment is therefore considered a key determinant of individual and community health (WHO 2006). The state of the environment influences human health in various ways. A tranquil and good state of the environment positively contributes to good health and well-being. A poor state of the environment on the other hand undermines the internal capacity of the human body to fight off disease, and also harbours communicable disease agents and vectors (UNEP 2006). Pollution may actually directly compromise human health through poisoning or tainting the food chain.

There are therefore, clear interlinkages between the state of the environment and the health and well-being of people. Sound environmental management practises directly reduce the disease burden and significantly lower the cost of healthcare. Poor environmental management on the other hand exacerbates negative health impacts such as disease outbreaks and pollution while natural disasters such as floods and droughts and significantly multiply the cost of healthcare. Degraded environments place heavy strains on the environment's ability to meet medicine, food, safe water, clean air and energy needs which are central to good health. Environmental health interventions can therefore offer valuable and sustainable contributions towards reducing the national disease burden and improving the wellbeing of communities. Many interventions can be cost-effective and extend co-benefits beyond improving human health. These benefits include those related to poverty alleviation, good hygiene, provision of safe water and adequate sanitation, improved self-esteem and academic performance and reduced gender inequalities in resource utilization. Addressing the health and environment nexus would therefore have positive outcomes for Vision 2030 which seeks to markedly improve the welfare of the country's citizens.

Environment and health interlinkages

Global outlook

Healthy ecosystems and the goods and services they provide are the foundations of survival for all societies. However, given current consumption levels in the industrialized world and the rapidly accelerating material aspirations of developing countries, these foundations are severely threatened. Globally, nearly one quarter of all deaths and of the total disease burden can be attributed to environmental issues. In children, environmental risk factors account for slightly more than one-third of the disease burden. These findings have important policy implications as the environmental risk factors can be prevented, modified or mitigated by establishing cost-effective interventions (WHO and UNEP 2008).

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The interlinkages between environment and health have become more elaborate with the support of research. 60 percent of vital ecosystem services are being degraded, or are subject to excessive pressures. For instance, entire forest ecosystems have disappeared in 25 countries and have declined by 90 percent in a further 29 countries (UNEP 2009). In addition, over 23 percent of deaths in Africa, estimated at more than 2.4 million each year, are attributable to avoidable environmental risk factors, with significant impacts on the poorest and most vulnerable groups such as children, women, the rural poor, people with disabilities, displaced populations and the elderly (MOPHS and MEMR 2009).

The risks resulting from natural factors such as floods include pollution of drinking water which leads to proliferation of disease vectors and disease outbreaks such as cholera. Figure 8.1 maps out the 2009 cholera outbreaks by district. In addition, drought causes extreme water scarcity for both rural and urban households with devastating health impacts. Further, anthropogenic activities such as outdoor and indoor air pollution, chemical pollution, environmental degradation and marine pollution affect both rural and urban settings albeit disproportionately. The relative risk's importance varies according to a country's level of industrialization, urbanization, poverty and malnutrition levels, overcrowding, the severity of other impacts of climate change and the robustness of existing levels of environment management systems. In Kenya for instance, food contamination by aflatoxins during prolonged El-Niño-related rains primarily affects maize and wheat due to their high moisture content during the harvesting and drying operations. Contamination by pesticide residues on horticultural products is largely associated with the sustained fight against early and late blight during heavy rains.

Good health is central to human happiness and wellbeing. It is also a prerequisite for economic development as healthy populations live longer, are more productive, and save more. It is estimated that the global burden of disease measured by the Global Burden of Disease (GBD) is heaviest in the sub-Sahara region where it affects an average 538 of every 1 000 people. The comparable figures are 190 for Latin-America and Caribbean, 387 for Asia, 277 for the Eastern Mediterranean and 127 people for the most developed regions. Kenya's Environmental Burden of Disease (EBD) stands at 101 which compares favourably

Figure 8.1: Cholera outbreaks by district in 2009

Source: OCHA 2010

with that of other developing countries such as Ghana (89), Uganda (137), Nigeria (165), Malawi (165) and Rwanda (183) (WHO 2007). In assessing the burden of disease various other factors are considered. These include loss of man hours, the cost of medical treatment and care (hospitalization, homecare and support equipment), foregone earnings, lost school time for children and the additional cost of special education for people with disabilities.

There are efforts to address these issues at the regional level. In August 2008, African Ministers of Health and Environment met in Libreville, Gabon where they discussed key interlinkages between health and environment. This meeting culminated in the signing of the Libreville Declaration, which committed member countries to conducting a Situation Analysis and Needs Assessment (SANA) and to further developing elaborate Joint Plans of Action to implement the declaration. Kenya was nominated to pilot this important task and completed its SANA in 2009 (WHO and UNEP 2008).The Joint Plans of Action are at an advanced stage of development.

Population-health-environment dynamics in Kenya

Population overview

Kenya's population has been growing over the years; and is expected to continue to do so. This is likely to result in more pressure on the environment with serious negative consequences on public health. Kenya's population distribution by gender is shown in Table 8.1. The almost equal ratio offers the country a unique opportunity to promote gender equality and the empowerment of women as effective ways to combat poverty, hunger and disease and to stimulate development that is truly sustainable as envisaged in the MDGs and Vision 2030.

Province	Total	Female	Female %	Male	Male %
Nairobi	3 138 369	1 533 139	48.85	1 605 230	51.15
Central	4 383 743	2 230 760	50.89	2 152 983	49.11
Coast	3 325 307	1 668 628	50.18	1 656 679	49.82
Eastern	5 668 123	2 884 776	50.89	2 783 347	49.11
North Eastern	2 310 757	1 052 109	45.53	1 258 648	54.47
Nyanza	5 442 711	2 824 977	51.90	2 617 734	48.10
Rift Valley	10 006 805	4 980 343	49.77	5 026 462	50.23
Western	4 334 282	2 242 907	51.75	2 091 375	48.25
TOTAL	**38 610 097**	**19 417 639**	**50.29**	**19 192 458**	**49.71**

Table 8.1: Total population in Kenya by province and gender Source: KNBS 2010

Poverty and environment

It is well documented that ecosystem degradation and natural resource depletion are exacerbated by social-demographic factors, particularly when combined with poverty (WRI et al 2008). The rural majority are usually the worst affected by poverty due to poor access to social services such as education, healthcare and lack of sources of alternative clean energy. As such, they are very vulnerable to the impacts of environmental disasters such as floods, famine and disease. These issues are also discussed in Chapter 2.

Poverty differentials indicate that there are more poor people in the rural (49.1 percent) than in urban settings (33.7 percent) (GoK 2007). It has also been shown that the level of education of the household head is inversely related with the incidence, depth and severity of poverty. This ranges from 65.5 percent where the household head has no education to 9.5 percent where the household head has attained university education (GoK 2007). These factors combine to keep the poor in the poverty cycle. For this reason, there is urgent need to restructure the policy approaches in order to target and reach this huge underserved population.

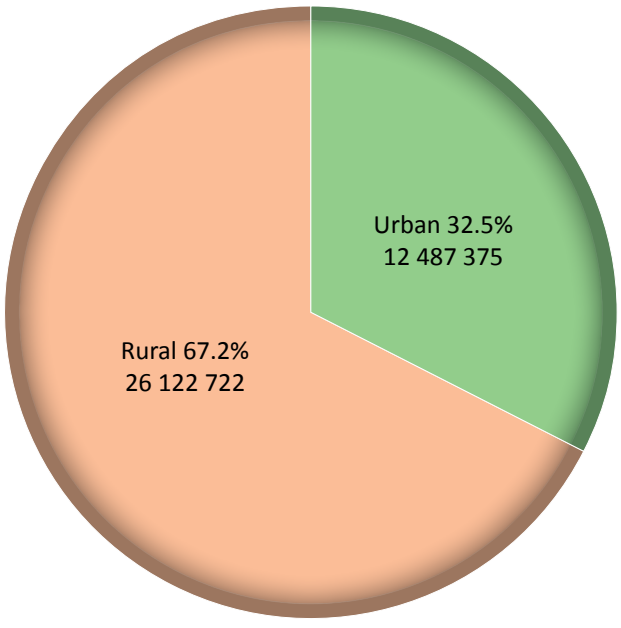

Figure 8.2: Urban and rural population in 2009 Source: KNBS 2010

While poverty is more prevalent in Kenya's rural areas, the fertility rate in the rural areas is much higher than that in the urban ones and currently stands at 5.2 compared to 2.9 in the urban areas. In a bid to escape poverty, a sizeable proportion of the poor rural population migrates to the urban centres and lives in the informal settlements. In so doing, they swell the numbers of the urban poor and exacerbate urban poverty. Figure 8.2 shows the proportion of the urban and rural population in 2009.

Characteristics of poor households

Most of Kenya's poor households are characterized by low incomes and deplorable living conditions. For the rural population, the major cause of low income has been stagnating agricultural production due to declining land productivity. The poor are concentrated on low potential lands (defined as resource-poor or marginal agricultural lands) where inadequate or unreliable rainfall, adverse soil conditions, fertility and topography limit agricultural productivity and increase the risk of chronic land degradation. The poor in urban areas are characterized by limited access to employment opportunities and income, inadequate and insecure housing and services, violent and unhealthy environments, little or no social protection mechanisms, and limited access to adequate health and education opportunities.

Although there have been positive moves to expand access to primary healthcare facilities and reduce financial barriers, the poorest suffer the biggest obstacles in accessing healthcare, with considerable regional inequities. Although 80 percent of the country's households have access to a healthcare facility within three kilometres, the distance decay gradient is clearly manifest for distances to a health facility of over 4.55 km to a facility. Therefore, there is low utilization of these facilities among the the rural population that lives 4.55 km or more away from a healthcare facility, particularly the poor. It is well established on a worldwide basis that there is a distance decay gradient, by which the rate of utilization of a health facility declines with increasing distance. The gradients are steeper for lower level facilities, and their regularity is disturbed by poverty, local transport and topographical features, but

the overall effect is powerful. Populations whose nearest hospital is far off use it very infrequently as compared to populations with facilities that are within reach.

Drivers of environmental health risks

The main drivers of environmental health risks are rapid population growth, increasing urbanization, rural-urban migration leading to overstretched solid and liquid waste management services, rapid increase in the number of vehicles, rapid growth of industrial and commercial enterprises, and proliferation of slums or unplanned settlements.

High population growth and fertility rates, coupled with the fact that the country is rapidly urbanizing are exerting enormous pressure on natural resources and the urban infrastructure in terms of health services, housing, sanitation, education, water services, transport, and waste management. Consequently serious collateral environmental damage in terms of over-exploitation of resources, pollution, unsustainable consumption and production patterns are leading to massive waste accumulation, ecosystem degradation and depletion particularly as the search for cheap biomass fuel increases. This scenario calls for urgent revitalization of the National Population Policy for Sustainable Development (2000), coupled with renewed family planning policies and strategies.

Priority environment-health issues

Environmental health and climate change

The changing climate will inevitably affect the fundamentals of human health and wellbeing such as clean air and water, sufficient food and adequate shelter. It will thus lead to an increase in environmentally-related diseases that result from a lack of access to clean water and sanitation, urban air pollution, malnutrition and natural disasters. Climate change is also likely to lead to new challenges in the control of infectious diseases, as well as those spread by vectors such as malaria and Rift Valley Fever. Mortality rates are on the increase as a result of climate-change related disasters leading to overstretching the healthcare infrastructure. The country will therefore be required to spend more on the health sector. For example, malaria currently accounts for 50 percent of household expenditure on health (GoK 2009a). Figure 8.3 shows the proportions of some of the climate related disasters that occur in Kenya.

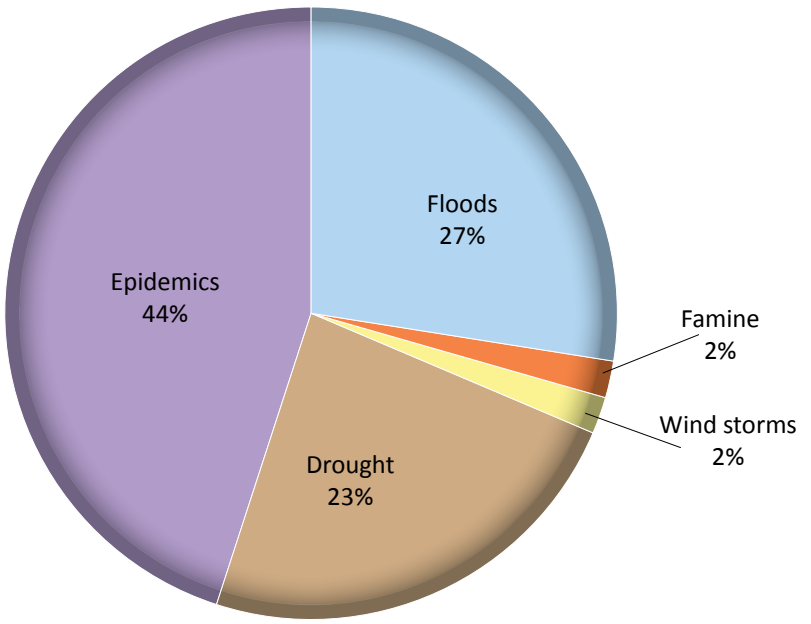

Figure 8.3: Major climatic disasters in Kenya Source: UNEP 2009

If Kenya was to take no action to reduce or minimize expected impacts by improving resilience and adaptation measures, the impacts could be enormous. Through Vision 2030, the government is progressively instituting measures within its means to address environmental management in the country (GoK 2010).

Solid waste management

Unsustainable patterns of production and consumption have resulted in a considerable increase in both the quantity and variety of waste.

Solid waste management bins like this one have been put in place throughout Nairobi city.

Eugene Apindi Ochieng

Open dumping of wastes next to residential areas is a health hazard.

This is a result of urbanization, economic growth, and industrialization which are growing problems for the national and local governments. These pressures cause severe impacts on the environment in terms of pollution of land, natural resources depletion, public health and costs to the local economy. These in turn threaten the attainment of the MDGs and the economic, social and political pillar goals of Vision 2030.

In Kenya, the responsibility for waste management lies with the Ministry of Local Government through the respective county, municipal and city councils. These local authorities are generally financially, technically and institutionally weak. They are therefore unable to discharge their mandates on waste management. The typical waste management scenario in most of Kenya's urban centres includes poor onsite storage, lack of onsite separation facilities, poor or unavailable formal waste transport systems, lack of formal waste transfer stations, poor formal recycling practises and plants, and a lack of appropriate waste disposal sites thereby encouraging the practise of crude dumping and open burning of wastes. This poses serious risks to public health and the environment because these wastes produce offensive smells (effluvia), release dioxins when burnt, act as rodent and insect breeding sites and portray a poor aesthetic picture of the environment. In many urban areas, open drains are usually blocked by heaps of refuse, occasioning waste water and sewage overflows onto the adjacent areas.

Local institutions do not prioritize waste management in their financial budgetary allocations. This is probably due to lack of appropriate information on the potential economic value that waste has. Moreover, waste management operations create substantial employment opportunities thus enhancing economic empowerment of the communities in line with the poverty reduction strategies outlined in Vision 2030. The integrated solid waste management approach which enhances economic, environmental and social benefits needs to be appreciated and mainstreamed into Kenya's development policies and strategies.

Transportation of wastes in the country is poor and ranges from makeshift hand and donkey carts in poor localities to poorly serviced and maintained ordinary, open trucks in the wealthier municipal and city councils. Such vehicles are inappropriate as they transport waste in an unsanitary and dangerous manner as the uncovered and often decomposing waste is likely to spill or get blown onto the road as the vehicle moves. Most local authorities, particularly in Kenya's highly urbanized areas, are privatizing waste collection by contracting the private sector although they retain an oversight role. This privatization strategy has been piloted in Nairobi with overwhelming success and is suitable for replication. Further, the government instituted tax incentives in 2007 to facilitate cost effective supply of technologically efficient waste collection vehicles which were zero-rated in the budget estimates of 2007 (MOF 2007).

Sorting of wastes

Onsite waste segregation, classification and quantification are not practised in the country thus domestic wastes and hazardous wastes are

Informal groups increasingly salvage waste for recycling.

intermixed, rendering the entire waste stream potentially dangerous. Recycling and recovery processes are thus unattractive and more tedious. Further, poor spatial planning of the waste disposal sites creates problems related to the wastes' potential to pollute adjacent watercourses, land and the air. Those most disproportionately affected by poor waste management are the small informal groups of women, men and children who eke out a living as rag-pickers. They salvage mainly plastics, paper and broken glass (cullet) for recycling and organic material for informal composting. These materials are later sold to private recycling firms at exploitative prices mainly due to the absence of elaborate waste recycling, material recovery and reuse policies and guidelines. However as Kenya industrializes in line with the aspirations of Vision 2030, it is important for the government and the private sector to seize the enormous opportunity of transforming waste into valuable and economically viable business opportunities through formal and informal recovery, recycling and reuse because this has the potential to create considerable job opportunities.

National data on the quantification and classification of wastes are not available. However, it is estimated that Nairobi alone produces 2 400 metric tonnes of mixed wastes each day. It is also estimated that only 30 percent of this is collected and disposed of (MEMR 2008). The rest of the waste is left uncollected at various sites posing a risk to human health and the environment.

Healthcare waste management

Healthcare waste management in the country has shown some improvement in recent years with a substantial number of healthcare and research institutions practising controlled thermal treatment of waste using incinerators. However, in terms of dioxin release into the environment, uncontrolled solid waste and hospital waste incinerators are often the worst culprits due to incomplete burning. It is therefore crucial that all healthcare waste incinerators achieve temperatures of between 850-1000°C which substantially reduces the percentage of dioxins released (WHO 2010).

This improvement follows the finalization of the National Healthcare Waste Management Plan and Guidelines in 2007 by the Ministry of Public Health and Sanitation, and the vigorous enforcement of the Environmental Management and Coordination (Waste Management) Regulations 2006 by NEMA. In areas where healthcare waste management has not been taken up, the situation remains dire. The risks associated with this practise range from contact with highly infectious materials, pathological waste (body parts), and contaminated needle prick injuries which could lead to contracting HIV/AIDS and hepatitis infections.

Solid waste management in Nairobi

Another significant development is the Nairobi River Rehabilitation and Restoration Programme 2007 coordinated by UNEP and spearheaded by the Ministry of Environment and Mineral Resources through an inter-ministerial steering committee. Embedded in this programme is the Integrated Solid Waste Management initiative for Nairobi. The programme's solid waste management component intends to decommission the unsanitary 45-hectare Dandora dumping site which has been the sole crude waste dumping site for Nairobi for the last 35 years. The decommissioned site will be transformed into a public recreation park with all the necessary amenities. The programme will further develop a modern sanitary landfill in Ruai on an 80-hectare

The waste dumpsite at Dandora that is due for decommissioning.

piece of land. This will fundamentally transform waste management in Nairobi into 'best practise' standards. In addition, at least five strategically located waste transfer stations will be constructed and equipped to facilitate formal solid waste separation and quantification thereby enhancing formal recycling, recovery and reuse as viable economic undertakings for the private sector and communities (MEMR 2008).

Plastics

The plastic industry is one of the fastest growing in Africa. Plastics owe their wide acceptance to properties such as low density, low cost, versatility for a wide range of applications and durability. The latter is however the main reason these products are a major environmental problem and an aesthetic eyesore on the entire Kenyan landscape. In Kenya, plastics are used for various commercial and economic purposes including water storage, water distribution, irrigation, electric conduits,

Plastic packaging materials are prevalent at all dumpsites and this is dangerous for the environment.

ornamental and general packaging. Kenya has 84 plastic manufacturing industries (Elmi 2008). Consumption of plastics is high due to the changing consumption and production patterns.

In 2007, the government set out to address this problem and held extensive bilateral consultations within the East African region. An understanding that Kenya would only manufacture and distribute plastic packaging materials processed from bio-degradable plastics of gauges not lower than 40 nanometres was reached. The overall effect is that safer and recyclable products are now available in the regional market. More importantly, plastic waste now offers distinct economic opportunities to the manufacturers and recyclers while safeguarding environmental integrity at the same time.

Electronic waste

Globalization has facilitated the unprecedented growth of the ICT sector. In Kenya, this is causing a high rate of obsolescence of ICTs due to rapid technological changes and initiatives that enhance competitiveness in this global information age. Initiatives such as telemedicine, e-governance, e-education, mobile telephony, mobile money transfer, e-banking, e-mail and social networking sites have necessitated the increased acquisition and use of mobile phones, computers and other electronic equipment in the country. The government, in a bid to ensure access to IT for its citizens in tandem with global standards, has deliberately lowered the cost of ICTs. The use of the fibre optic cable and reduced taxation on computers are some of the principal attributes of the National ICT Policy.

As massive numbers of electric and electronic equipment become obsolete, or are no longer usable or serviceable, the need to remove them from offices and other user sites and to dispose of them becomes inevitable. Globally, UNEP estimates that up to 50 million tonnes of e-waste is generated annually.

Electronic and electrical equipment waste (e-waste) is the fastest emerging waste stream that is rapidly and increasingly being seen in dumpsites around Kenya. E-waste can be defined as wastes from electronic or used electric equipments like computers, mobile and static phones, television sets, refrigerators, radios and other digital appliances. They are complex, multi-material wastes with heavy and precious metals, plastics (polyvinyl-chlorides) and glass. E-waste contains hazardous materials and includes waste streams of flame retardants used in plastics, printed circuit boards, solders, lead, cathode-ray tubes, beryllium alloys in connectors, mercury in bulbs, cadmium, nickel, zinc and chromium. Unprotected handling can increase one's exposure to heavy metals, posing severe health risks. The uncontrolled burning of e-waste releases extremely high levels of dioxins and furans plus an array of heavy metals into the air, land and water and poses serious risks to human health and the environment.

However, opportunities for valuable material recovery exist particularly for copper, tin, aluminium, iron, germanium, silicon, nickel, lithium, zinc and gold which can be recovered from this waste stream and utilized for other economic purposes. However, due to lack of appropriate technology in the country, Kenya's material recovery activities are informal and quite insignificant. The Nairobi Declaration on the Environmentally Sound Management of Electronic and Electrical Waste (2006) and the global work plan on e-waste finalized in Bali in 2009 have not been fully implemented in the country.

According to a survey conducted in 2010, e-waste generated in Kenya includes refrigerators, TVs, personal computers, printers and mobile phones. The mass flow study carried out in 2007 by Kenya ICT Action Network showed that 1 513 tonnes of electronics entered the market. 1 489.4 tonnes of these are brand new while 151.3 tonnes are second hand. In addition, consumers are likely to dispose of about 1 210.4 tonnes in the second-hand market each year, and 18.6 tonnes to collectors which are sent to refurbishing firms. Recyclers then release a further 605.2 tonnes annually for disposal (Waema and Mureithi 2008). Chapter 9 contains a discussion of the emerging e-waste problem in the country.

Chemicals

Chemicals have potentially significant positive as well as negative impacts. On the positive side, they contribute to the health of humans, livestock, wildlife and to agricultural production, energy efficiency and other aspects of sustainable development. However, adverse consequences of unsound management of chemicals on the environment and human health can be significant and long lasting. This is due to their toxicity, persistence in the environment, bio-accumulation, bio-magnification, carcinogenicity and teratogenicity. Heavy metal contamination of food, water, and pollution of air and land by chemicals such as ioxins, mercury, lead, cyanide and arsenic have been found to have devastating impacts on exposed populations (WHO 2007b, WHO 2008).

Pesticides, such as lindane, DDT and dieldrin, have been used extensively in Kenya for agricultural and public health purposes for over 50 years. These pesticides have been restricted or banned over the years but continue to be heavily used in western Kenya particularly along the River Nzoia catchment (Getenga et al 2000). These are likely to have severe health impacts on the riparian human population.

Addressing the risks associated with chemicals

Kenya has undertaken to address the risks associated with chemicals by implementing the Strategic Approach to International Chemical Management (SAICM). So far, two important processes related to chemicals have been completed. These are the National Chemicals Profile, and the National Inventory of Persistent Organic Pollutants. Current trends show that industrial manufacturing is rapidly picking up in line with the Vision 2030 goal to accelerate transformation of Kenya into a rapidly industrializing middle-income nation by 2030. Because chemical enterprises are increasingly formulating and packaging imported chemicals, there is an urgent need to institute regulatory controls.

The government recognizes the importance of managing risks posed by chemicals through the support of the SAICM Quick Start Project and the Integrated Vector Management Programmes (MEMR 2010). The strategy intends to strengthen existing chemical management initiatives by government and stakeholders, and to mainstream policy and regulatory frameworks. The strategy also seeks to link these initiatives to national development planning goals on sustainable development, poverty reduction and enhanced public awareness.

The proposed legal regime should, of necessity, be supported by effective and consistent enforcement by the relevant government bodies and complemented by and promoted through advocacy

An improved sanitation facility ("Iko Toilet") in Nairobi's Jeevanjee Gardens.

by the private sector and the civil society. Citizens' participation in monitoring the impacts of these efforts in the East African region will be championed within the programme. All national stakeholders will benefit from the proposed capacity building programmes embedded in SAICMs' wider global action plan. These efforts will help to regulate and minimize release of hazardous chemicals and their wastes into the environment. Ultimately, this will help Kenya to reach the target set by the World Summit on Sustainable Development (WSSD) that by the year 2020, chemicals are produced and used in ways that do not negatively affect human health and the environment (UN 2002, MEMR 2010, MEMR 2010, MOPHS and MEMR 2009).

Scrap tires

According to the Waste Tyre Working group comprising key stakeholders such as NEMA, Kenya Revenue Authority, cement manufacturers, tyre manufacturers, and dealers, Kenya generates over one million scrap tyres annually. Only a small fraction of the scrap tyres is managed in an environmentally sound manner while the rest continues to pileup in cities and various urban centres. Currently, scrap tyres are stockpiled in consumers' yards or continually dumped into the environment where they become a fire hazard, breeding grounds for snakes, bees and rodents particularly rats, and human disease vectors such as mosquitoes. This is because appropriate disposal methods or technologies are lacking. Further, open burning of tyres to recover steel wire as well as burning of tyres during riots pollutes the environment with dioxins and furans, posing serious respiratory risks to human and animal life (NEMA 2009).

Scrap tyres are classified as hazardous waste in Kenya. Their management comprises minimal environmentally friendly re-use and disposal such as small-scale manufacture of carpet underlay and sandals, retreading especially in the truck sector and limited use as an alternative fuel. However more economically viable and environmentally friendly technological options are available globally and include shredding and using them in civil works (roads-rubber, bitumen, asphalt mix), processing them into carbon black for UV protection of water tanks and tyres, processing scrap tyres into drainage sheet lining for sanitary landfills and open oxidation ponds and use as plant mulching and soil conditioning in agriculture.

Investing in appropriate technologies to handle the available scrap tyre stockpiles and the million scrap tyres that are generated annually in Kenya should make business sense and the government should create an enabling environment for investment in these by the private sector. This would help address the public health and environmental risks and create jobs that would enable the poor to escape the poverty trap as anticipated by Vision 2030.

Opportunities to improve environmental health

There are various opportunities to improve environmental health through sanitation and hygiene, provision of health services, improving housing, reducing air pollution and promoting safety in the work environment.

Sanitation and hygiene

The overall importance of access to safe water and improved sanitation to human wellbeing cannot be underestimated and is emphasized by the MDG 7 commitment to halve the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015. It is estimated that unsafe water and lack of basic sanitation and hygiene claims the lives of 1.5 million under-5 children through diarrhoea every year (UNICEF 2006). While water and sanitation are vital in themselves, they are also key prerequisites for reducing child and maternal mortality (MDGs 4 and 5 respectively) and combating diseases (MDG 6). They are also crucial in reducing child malnutrition (MDG 1) and achieving universal primary education (MDG 2). Basic sanitation refers to a safe, hygienic and convenient facility that prevents the user and his or her immediate environment from coming into contact with human excreta (UNICEF 2006). The provision of sanitation takes varied forms. Table 8.2

IMPROVED SANITATION	UNIMPROVED SANITATION
Use of the following facilities:	*Use of the following facilities:*
Flush or pour-flush to; • Piped sewer system • Septic tank • Pit latrine	Flush or pour-flush to elsewhere (that is, not to piped sewer system, septic tank or pit latrine.
Ventilated improved pit (VIP) Latrine	Pit latrine without slab/ open pit
Pit latrine with slab	Bucket
Composting toilet	Hanging toilet or hanging toilet • Shared facilities of any type • No facilities bush or field.

Table 8.2: Improved and unimproved sanitation options available in Kenya

Source: WHO/UNICEF 2010

IMPROVED DRINKING WATER	UNIMPROVED DRINKING WATER
Use of the following sources:	*Use of the following sources:*
Piped water into dwelling, yard or plot	Unprotected dug well
Public tap or standpipe	Unprotected spring
Tube well or borehole	Cart with small tank or drum
Protected dug well	Tanker truck
Protected spring	Surface water (river, dam, lake, pond, steam, canal irrigation channel)
Rainwater collection	Bottled water

Table 8.3: Examples of improved and unimproved sources of drinking water in Kenya

Source: WHO/UNICEF 2010

highlights the different improved and unimproved sanitation options that are available in Kenya.

Progress on sanitation and drinking water

It is estimated that 94 percent of the diarrhoeal burden of disease is attributable to environmental degradation and is associated with risk factors such as unsafe drinking-water and poor sanitation and hygiene (WHO 2006). Providing access to improved drinking-water sources in developing countries would considerably reduce the time spent by women and children in collecting water. Providing access to improved sanitation and imparting good hygiene habits would help break the overall cycle of faecal-oral pathogen contamination of water bodies, yielding benefits to the country's health, poverty reduction, wellbeing and economic development efforts. Globally, WHO has estimated that the economic benefits of investments in meeting this MDG 7 would outweigh costs by a ratio of about 8:1. These benefits include gains in economic productivity as well as savings in healthcare costs, more healthy lives that are free from diarrhoeal diseases, intestinal nematode infections and related malnutrition (WHO 2006). Table 8.3 highlights what is meant by improved and unimproved sources of drinking water.

According to the National Environmental Sanitation and Hygiene Policy (2007), 80 percent of hospital attendance in Kenya is due to preventable diseases. An estimated 50 percent of these illnesses are related to water, sanitation and hygiene (GoK 2007). According to the latest update on the Global Progress on Sanitation and Drinking Water, 2.6 billon people do not use improved sanitation while 884 million people do not use an improved source of drinking water. Further, 37 percent of the population who do not use an improved source of drinking water live in sub-Saharan Africa. Overall, the world is on track to meeting the MDG target on drinking water. However, the sanitation picture is grim. This is because even if the MDG target of 77 percent of the population is met, 1.7 billion people will still be without access to basic sanitation (JMP 2010 Report). Indeed in Kenya, by 2008, access to improved sanitation was only 31 percent. While this has improved from 26 percent in 1990, it is still below the MDG target of 77 percent coverage of total population by 46 percent. Interestingly, the rural areas have better coverage of improved sanitation with 32 percent compared with the urban areas at 27 percent. Table 8.4 presents a summary of this information.

With regard to drinking water, the national proportion of people accessing improved drinking water sources was 59 percent in 2008,

Table 8.4: Kenya's progress on access to sanitation, 1990-2008

Source: WHO/UNICEF 2010

	Year	Population (thousands)	% Urban Population	Use of of sanitation facilities (% of population)												Number of People who gained access to improved sanitation 1990-2008 (thousand)
				Urban				Rural				Total				
				Improved	Unimproved			Improved	Unimproved			Improved	Unimproved			
					Shared	Unimproved facilities	Open Defecation		Shared	Unimproved facilities	Open Defecation		Shared	Unimproved facilities	Open Defecation	
Kenya	1990	23433	18	24	45	28	3	27	15	41	17	26	20	40	14	5 925
	2000	31441	20	26	48	23	3	30	16	36	18	29	22	34	15	
	2008	38765	22	27	51	20	2	32	18	32	18	31	25	29	15	

Table 8.5: Kenya's progress on access to drinking water, 1990-2008

Source: WHO/UNICEF 2010

	Year	Population (thousands)	% Urban Population	Use of Drinking- Water Sources (% of Population)												Number of People who gained access to improved Sources of drinking water 1990-2008 (thousands)
				Urban				Rural				Total				
				Improved			Unimproved	Improved			Unimproved	Improved			Unimproved	
				Total improved	Piped on premises	Over improved		Total improved	Piped on premises	Over improved		Total improved	Piped on premise	Over improved		
Kenya	1990	23 433	18	91	57	34	9	32	10	22	68	43	19	24	57	12 795
	2000	31 441	20	87	49	38	13	43	11	32	57	52	18	34	48	
	2008	38 765	22	83	44	39	17	52	12	40	48	59	19	40	41	

up from 43 percent in 1990. In the urban areas, the percentage of people accessing improved sources of drinking water was down from 91 percent in 1990 to 83 percent in 2008. For rural areas, the total was up from 32 percent in 1990 to 52 percent in 2008 as shown in Table 8.5.

People's basic water needs for drinking, cooking and hygiene are deemed to have been met if they can reach a public water source, collect water and return to their homes within 30 minutes. If the round trip takes longer than 30 minutes, people tend to fetch less water than they need. However current strategies on water safety emphasize the need for household water treatment (disinfection) and storage practises as well as hand washing which are high impact interventions in disease prevention (WHO/UNICEF 2006). For instance, hand washing with soap at the appropriate times (such as immediately after visiting the toilet and before eating anything) reduces the chances of contracting diarrhoeal diseases by 47 percent and upper respiratory diseases by 23 percent (World Bank 2008).

Gender parity issues in access to water sources and sanitation

Women particularly in developing countries such as Kenya are the primary providers of household necessities such as food, fuel and water for cooking, bathing, drinking and washing. Apart from collecting safe water for the family, they are also involved in looking after children who may be sick from environmental risk factors such as contaminated water or polluted indoor air (from using biomass fuels to boil or heat the water). In performing these tasks, they receive assistance from children, particularly girls. Time invested in these chores could be directed to activities that could improve the educational, nutritional and health standards of the entire family. Figure 8.4 highlights the gender disparities in time spent in search of water.

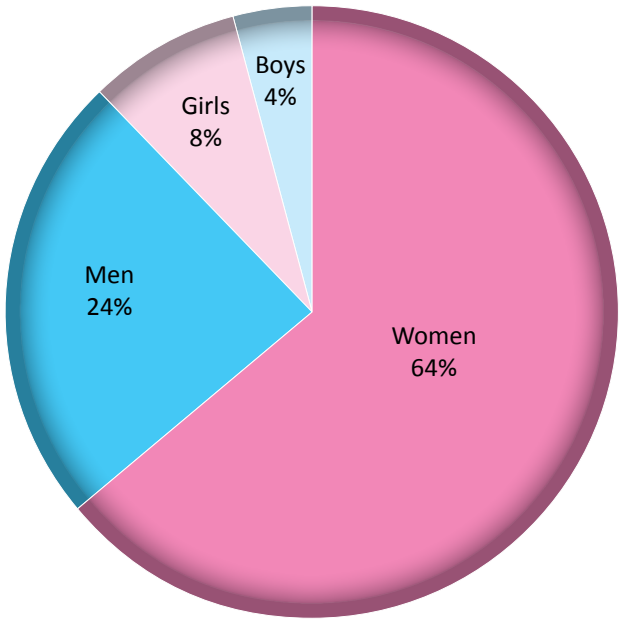

Figure 8.4: Gender disparities in time spent in search of water Source: WHO/UNICEF 2010

There are a number of interventions that government could pursue. Interventions that provide water and fuel for houses will also improve school attendance. This is because the children will not need to spend time collecting water and fuel or taking care of family members who are sick with diseases which are environment-related. This time could then be used for income generating or educational activities. Further, the provision of clean water and latrines at school will encourage primary school students, particularly girls, to attend school more regularly. This will in turn contribute to MDG 3 that aims to empower women and promote gender equality.

Liquid waste treatment in urban areas

Though the coverage of sewage by conventional sewerage treatment plants is not included in the Joint Management Programme report, it is an important aspect of sanitation coverage in urban centres and is an important future focal area. However, while such plants can deliver long life spans ranging from 15-50 years, they are capital-intensive, cost millions of shillings and often require Strategic Environment Assessment during the planning and implementation stages. They are therefore unaffordable to poor urban local authorities. In addition, they require localized hands-on training as operational and maintenance activities need to be regularly carried out.

In informal settlement settings where the population density is high and toilet facilities are shared, exhaustible underground sludge digesters complete with energy recovery components are advocated as these offer better and cleaner facilities. These facilities are being implemented mainly through NGOs and other public-private partnership initiatives.

Out of the current 175 local authorities in the country, only 47 operate conventional sewage treatment plants. Unfortunately, maintenance costs are high and quite a number of them are broken down or operating below capacity (GoK 2008b). The need for substantial investment in conventional sewage treatment infrastructure is critical. This is because it will raise national sanitation and hygiene standards in the urban centres thereby uplifting self-esteem while also preventing water-borne and water-related diseases and epidemics. Furthermore, treated sludge can be sold to farmers for use as a fertilizing soil conditioner to enhance agricultural production. The sustainable use of natural and artificial wetlands as effluent treatment options has proved effective and is gaining popularity. The processes are natural, cost effective and sustainable and should be upscaled (WASREB 2010).

However adequate care must be exercised to prevent unlawful diversion of raw sewage for illegal use in urban agriculture. This practise

A major sewer line under construction at the Ngara Area of Nairobi.

Eugene Apindi Ochieng

poses serious public health threats such as the spread of diarrhoeal diseases, intestinal parasitic infestations as well as soil and product contamination by heavy metals that are present in the sewage and exacerbate incidences of poor health and by extension, poverty. These risks can seriously undermine the overall objective of conventional sewage treatment if they continue unabated. This scenario, although currently illegal, is quite common.

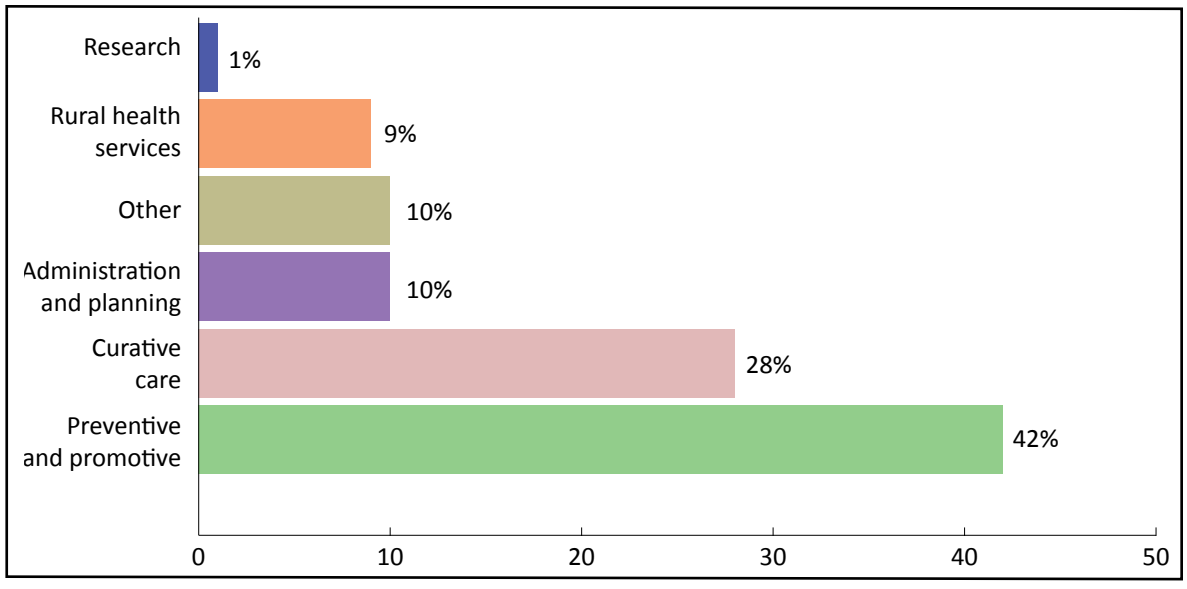

Figure 8.5: Health expenditure by functional classification, 2009/10

Source: GoK 2009b

While urban agriculture presents opportunities to support alternative livelihood strategies and to reduce poverty in line with the Vision 2030 goals, it can have detrimental environmental and health impacts. Kenya is a signatory to the 2003 Harare Declaration on Urban and Peri-urban Agriculture in Eastern and Southern Africa, which recommended the development of policies that create an enabling environment for integrating urban agriculture into the urban economies. Against this background, there are opportunities for the development of an appropriate policy framework for urban agriculture in Kenya (Ayaga et al 2004). This policy is in line with the National Land Policy which provides for the promotion of a multi-functional urban land use framework and the development of an appropriate legal framework to regulate and govern urban agriculture to complement the existing Local Government Act, Public Health Act and relevant municipal bylaws. Government is also working to finalize the proposed Policy on Urban and Peri-urban Agriculture.

Hygiene promotion approaches

Throughout the developing world, the low sanitation coverage remains a major concern. It is obvious that sanitation hardware or physical structures alone are not sufficient to ensure wide coverage. Even when new toilets and washing facilities have been built, proper usage remains low and little or no benefit is derived.

The belief among public health practitioners is that until hygiene is properly practised both at home and in the community as a whole, the desired impacts accruing from improved water and sanitation services in terms of community health benefits cannot be realized. The modern approaches being advocated endeavour to stimulate a change in behaviour and practise or to create a sustained demand for sanitation and hygiene services. These approaches are referred to as software activities to distinguish them from the provision of the hardware discussed above. Key to these approaches is that individual and community needs are prioritized to include increased privacy, comfort, convenience and safety for women and children. Dignity and social status are also considered. Lessons learnt indicate that these considerations rank above any sort of health benefit or link to reduced illness in the community. New software approaches that are in use in Kenya include Community Led Total Sanitation (CLTS), School Led Total Sanitation (SLTS) Household-Centred Environmental Sanitation (HCES) Household Water Treatment and Safe Storage (HWTS), Water Sanitation and Hygiene (WASH) and the hand washing initiative (WSSCC 2009).

Provision of health services

The health sector has witnessed significant improvement since 2003, as depicted by selected health sector indicators. Government-financed expenditure on health as well as that by development partners has progressively increased over the years. The total amount spent on the health sector was estimated at 4 percent of GDP in 2008/9. Resources are predominantly spent on preventive care which is more efficient than curative care (GoK 2009b). The breakdown of health expenditure is depicted in Figure 8.5.

Delivery of health services

Health services in Kenya are delivered through two ministries namely; the Ministry of Medical Services and the Ministry of Public Health and Sanitation. The two ministries work together with the ultimate aim of preventing and controlling diseases while also ensuring prompt diagnosis, treatment and rehabilitation of those infected and affected by diseases. Doctor/nurse-patient ratios and affordability are therefore critical to the overall performance of the sector. As at 2008, the country had 6 190 health facilities organized at six levels, up from 4 767 facilities in 2004. 48 percent of these facilities are run by the government, 13 percent by Faith Based Organisations, 2 percent by communities, 1 percent by local authorities while 36 percent are operated as private businesses. These facilities translate to 16 health facilities per 100 000 people and 11 facilities per 1 000 km^2.

Although overall poverty levels have declined from 52.3 percent in 1997 to 46.6, poverty and illiteracy remain major impediments to accessing health services (MOPHS and MOMS 2008a). In its wider definition, poverty means ill health, social exclusion, insecurity and powerlessness, a lack of access to information and institutions, often a lack of confidence and voice. It is therefore more than just lack of income, but includes the lack of means to meet basic social needs (WRI et al 2005). In order to fast track and improve overall access, the government, in its Economic Stimulus Programme 2009-2010, intended to construct an additional 210 healthcare facilities at the constituency level each of which would be capable of serving at least 10 000 people. The government also planned to recruit and deploy an additional 20 nurses per constituency which would bring the total of newly employed nurses to 4 200. This would raise the doctor-patient and nurse-patient ratios to 17:10 000 and 33:10 000 respectively. The targeted activities are deliberately designed to deliver high intensity and high impact results, releasing short- and long-term benefits to the communities by enhancing investment in human capital development (MOMS 2008, MOPHS 2008, MOF 2009).

Medical services in Kenya are provided at six levels of care as shown in Figure 8.6. At the apex (level 6) are the tertiary hospitals.

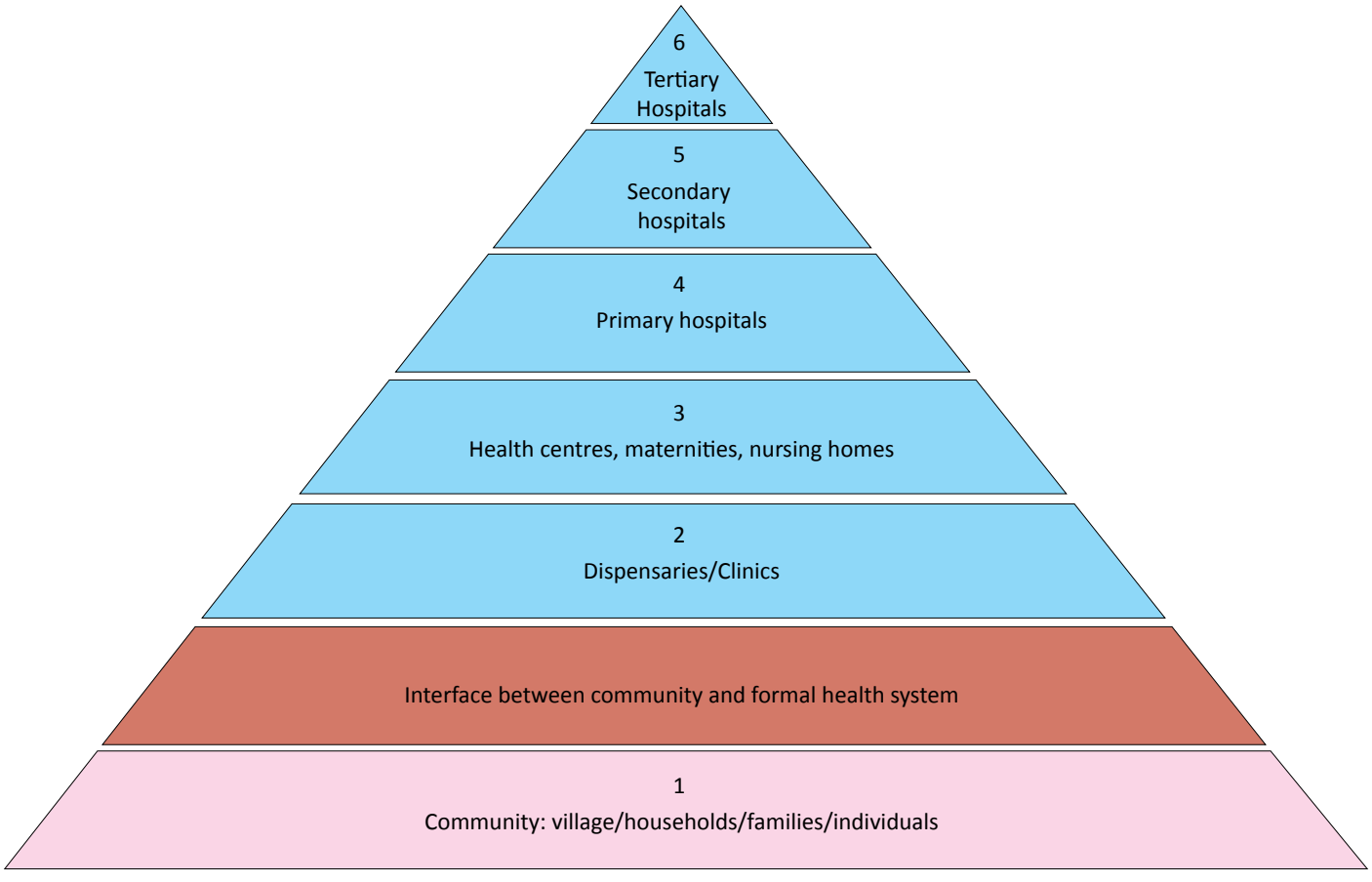

Figure 8.6: Levels of healthcare in Kenya

These include the large referral hospitals like Kenyatta National Hospital in Nairobi and Moi Teaching and Referral Hospital in Eldoret. At level 5 are the Provincial General Hospitals with one in each of the eight provinces. Level 4 includes 446 district hospitals. At level 3 are 854 health centres, while at level 2 are dispensaries and clinics totalling 4 890 (MOH 2005).

There is also a National Health Insurance Fund (NHIF) which is a contributory scheme that offers economic cushion by ensuring economical access to health services in the country (MOPHS and MOMS 2009).

Prevention and control of communicable diseases

The mandate for public health lies with the Ministry of Public Health and Sanitation. The vision of the ministry is to have a nation that is free from preventable diseases and ill health. Public health is about managing threats to the health of a community, paying special attention to the social context and interplay of disease, the environment and health. It incorporates the science and art of preventing disease, prolonging life and promoting health through the organized efforts and informed choices of individuals, households and society (MOPHS 2008). Vision 2030, in its social pillar, envisages a just and cohesive society enjoying equitable social development in a clean and secure environment. In line with this vision, the Ministry of Public Health and Sanitation aims to provide equitable and affordable health care at the highest possible standard to all citizens by restructuring healthcare delivery systems to shift the emphasis to preventive and promotive health (MOPHS 2008). Table 8.6 shows the structure and functions of the ministry.

The emphasis is geared towards public health and sanitation interventions while enhancing access, equity, capacity and institutional strengthening. This will provide the nation with a healthy workforce necessary for the increased labour productivity required for global competitiveness as envisaged by Vision 2030.

The Directorate of Public Health and Sanitation is therefore strategically structured to comprehensively address aspects of disease prevention, surveillance and control, maternal and child healthcare, immunization, household water safety and sanitation, food safety, health promotion/education, primary health services, and administrative aspects. This structure and strategy ensures that emerging synergies are positively utilized to achieve overall performance and efficiency especially aimed at meeting the MDGs.

Table 8.6: The structure and targeted function summary of the Ministry of Public Health and Sanitation Source: MOPHS 2008

Ministry of Public Health and Sanitation				
Strategic levels of intervention in disease prevention control				
Disease control MDG-6	**Family Health MDG-4&5**	**Sanitation & Environmental Health(MDG7)**	**Health Promotion**	**Primary Health Services**
Disease surveillance and response	Immunization services	Sanitation and hygiene	Health communication & social Marketing	Health facility services - Levels 2 & 3
Malaria control	Nutrition (MDG-1)	Food quality & safety	Policy advocacy & strategic Alliances	Standards & quality assurance
AIDS/STI control	Child and adolescent health	Occupational health	Setting health promotion programmes	Commodities & supplies
Tuberculosis, leprosy & lung diseases	Reproductive health	Water safety		Community health services
Vector-borne & neglected diseases		Pollution control & housing		Health administration
Non-communicable diseases		Vector & vermin control		
National public health labs		Port health		

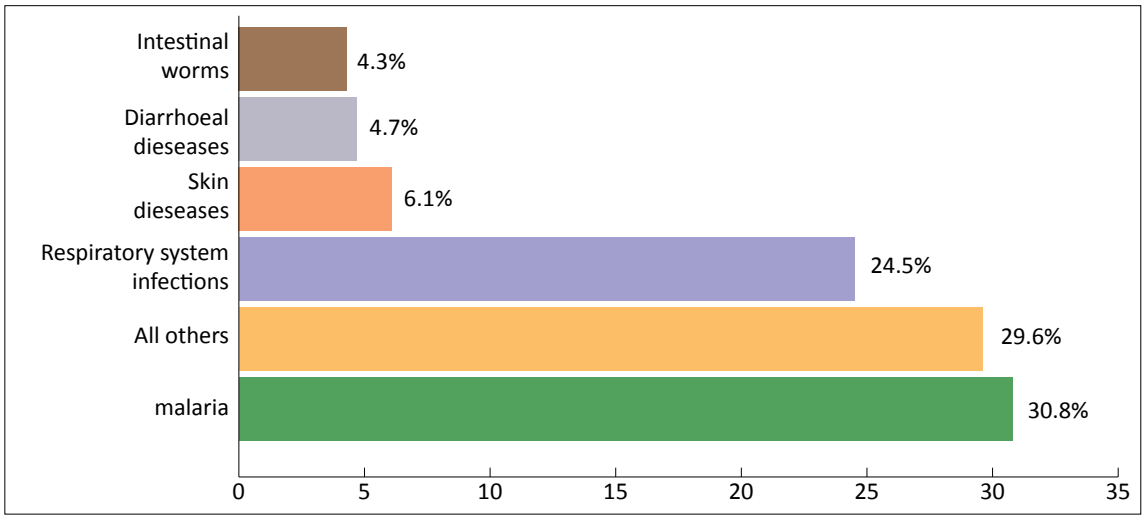

Figure 8.7: Leading causes of outpatient morbidity in 2007

Source: MOPHS and MOMS 2009

Priority environment-related communicable diseases

Priority communicable diseases and conditions afflicting Kenyans include diseases with the largest absolute burden attributable to modifiable environmental factors. These include malaria, lower respiratory infections, diarrhoea, intestinal worms, skin diseases, non-communicable diseases and 'other' unintentional injuries. These may include injuries arising from workplace hazards or industrial accidents, the majority of which are attributable to environmental factors. Figure 8.7 shows the leading causes of morbidity in 2007.

The proportion of malaria attributable to modifiable environmental factors (30.8 percent) is associated with policies and practises regarding land use, deforestation, water resource management, settlement location and modified house design, such as improved drainage. In light of the significance of malaria in the epidemiological profile, the National Malaria Policy was developed in April 2010 (MOPHS 2010).

Lower respiratory infections are associated with indoor air pollution related largely to the use of household solid fuel (biomass). Other contributory factors include second-hand tobacco smoke as well as outdoor air pollution. An estimated 24.5 percent of such infections are attributable to environmental causes. Tuberculosis is also a priority respiratory disease in Kenya which is posing a serious public health threat due to the emergence of multiple drug resistance strains and also because it is usually a co-infection with HIV/AIDS.

Diarrhoea and intestinal worms are spread from contaminated water and soil and account for 4.7 and 4.3 percent of the outpatient morbidity respectively (MOPHS and MOMS 2009). Effective guidelines for the prevention and treatment of diarrhoea are available while early childhood de-worming is now mandatory in primary schools as a requirement of the School Health Policy, 2009.

HIV/AIDS is a devastating systemic communicable disease affecting the auto-immune systems of the body leading to debility and death. The disease is transmitted primarily through unprotected sexual intercourse with infected persons and contact with blood and other body fluids from infected persons. A cure is not yet available but is still being sought through extensive research. The disease attracts intense social stigma in communities and a severe loss of self esteem to the infected and affected.

The government has intensified comprehensive preventive and health promotion programmes through high profile targeted community awareness programmes at all levels, establishment of VCTs (Voluntary Counselling and Testing Centres), Prevention of Mother to Child Transmission (PMCT) programmes, screening of donated blood, use of condoms, promotion of abstinence and the provision and use of antiretroviral drugs aimed at prolonging active life. Available data indicates that substantial progress has been made in lowering the overall prevalence rate among the population aged 15-64 years from 13.9 percent in 2000 to 7.5 percent in 2007 (MOPHS and MOMS 2009).

Coordinated investments in the health sector can promote more cost-effective development strategies with multiple social and economic co-benefits, in addition to immediate and long term national health gains. Repositioning the health sector to act more effectively on preventive health policies, while enhancing inter-sectoral partnerships, is thus critical to addressing the environmental causes of disease and injury, meeting the MDGs, and achieving better health for all (WHO 2006).

Health indicators

Health status indicators have shown remarkable improvement, and this can be linked in part to improvements in health service delivery. In particular, the infant mortality rate has improved from 77 deaths in 2003 to 52 deaths per 1 000 live births in 2009; and under-5 mortality rates have improved from 115 in 2003 to 74 deaths per 1 000 live births in 2009. This is shown in Table 8.7

Table 8.7: Selected health indicators, 1993-2008/09

Source: MOPHS and MOMS 2009

Heath indicator	1993	1998	2003	2008/09
Infant mortality rate (deaths per 1 000)	62	74	78	52
Under 5 mortality rate (deaths per 1 000)	96	112	114	74
Fully immunized (per cent 12-23 months)	79	65	60	77
Measles immunized (%)	84	79	74	85
BCG immunized (%)	96	96	89	96
Births with skilled attendants (%)	45	44	42	44
Maternal mortality rate (deaths per 100 000)	N.A.	590	414	414

The demographic structure is shifting: 16.9 percent of the population is aged less than five years and 42 percent are under fifteen years of age. Life expectancy is 55.2 years for men and 55.3 years for women. It differs significantly across the country and has dropped from 60 years in early 1980s. The Total Fertility Rate (TFR) has fallen from 8 births per woman in the 1970s to 4.6 births in the 1990s where it has stagnated for the last one and half decades. However, there exist fertility differentials. TFR of 5.2 in rural areas is significantly higher than the 2.9 for urban areas (MOPHS and MOMS 2009).

Improving housing for better health

The provision of shelter in Kenya remains a huge challenge. High population growth, rapid urbanization, pervasive poverty and rural-urban migration have contributed to the inadequate provision of housing in both urban and rural settings. There is an annual housing supply of 35 000 units against the projected demand of 150 000 units (GoK 2007). Within this context, investment in housing especially for the low and middle income families is quite low. It is estimated that investment in housing yields benefits on a ratio of 1:9 shillings (GoK

Under government plans for slum upgrading, houses are being demolished to clear space for road widening and urban infrastructure development. This photo shows the Kibera slums upgrading initiative being undertaken by the government and UN-Habitat under KENSUP.

2008b). The resultant phenomenal growth in informal settlements and slums has ensued to cover this chronic deficiency.

Informal settlements pose serious public health and environmental risks particularly due to poor housing, overcrowding, indoor air pollution, and lack of sanitation, water service and waste management infrastructure, poor access to healthcare and education facilities, poor surface drainage and increased vulnerability to intermittent fires. This scenario predisposes the informal settlement communities to diseases and poor health conditions associated with the poor environmental conditions. The stagnating and decomposing sewage, for instance, intermixes with plastic wastes posing health risks (diarrhoeal diseases, nematode infestations and physical accidents) to school children.

The government has developed a National Housing Policy, 2007, and further established the National Housing Authority which is mandated to coordinate and oversee the provision of housing in the country. In tackling the issue of slums development and proliferation, the government in partnership with UN-Habitat, developed the Kenya Slum Upgrading Project (KENSUP) which provides decent housing and relevant infrastructure. Although the programme is capital intensive and slow, it offers part of the solution to the slum dwellers' housing problems, while substantially reducing health and environmental risks. This strategy is in line with other on-going government initiatives such as the poverty reduction and employment creation strategies, the National Youth Fund, Women Enterprise Fund and the Economic Stimulus Programme all of which aim at empowering the poor.

Reducing air pollution

The 2008 Blacksmith Institute World's Worst Polluted Places report lists indoor air quality and urban air quality as the world's worst pollution problems (Blacksmith 2008). Lack of ventilation indoors concentrates the pollutants where people often spend the majority of their time. Wood fires in stoves and fireplaces can add significant amounts of smoke and particulates into indoor and outdoor air. Indoor pollution may also be caused by using pesticides and other chemical sprays indoors without proper ventilation. Box 8.1 lists some of these pollutants.

Biomass fuels used in Kenya for cooking and heating, account for 88 percent of the total energy use. There is virtually no access to alternative clean energy in the rural areas and this is aggravated by the attendant high costs. In the urban centres, the increasing number of vehicles and industrial emissions contribute to significant amounts of urban air pollution with serious acute and chronic health impacts. These include respiratory, cardiac, stress and skin diseases.

Box 8.1: What pollutes the air?

1. Particulate matter consisting of fine solid or liquid particles suspended in air. This is linked to health hazards such as heart disease, altered lung function and lung cancer.

2. Persistent organic pollutants are organic compounds which are chemical compounds that are resistant to environmental degradation. They include DDT and are capable of long-range transportation, bioaccumulation in human and animal tissue and biomagnifications in food chains. They are known to cause significant short and long term negative impacts on human health and the environment.

3. Other pollutants are:

- Sulphur oxides (SO_x) especially sulphur dioxide,
- NO_x especially nitrogen dioxide which is a colourless, odourless, non-irritating but very poisonous gas,
- Carbon dioxide (CO_2)—a greenhouse gas (GHG),
- Volatile organic compounds like methane which is an extremely efficient greenhouse gas that contributes to global warming.

Source: Seinfeld and Pandis 1998

The health effects caused by air pollutants range from subtle biochemical and physiological changes to difficulty in breathing, wheezing, coughing and aggravation of existing respiratory and cardiac conditions. These conditions can result in increased use of medicaments, increased frequency of doctor visits, loss of man-hours, more hospital admissions and premature death. The health effects of poor air quality are far reaching although they principally affect the body's respiratory system causing chronic bronchitis, emphysema, asthma and cardiovascular disorders.

Unpaved roads like this one in Lucky Summer Estate, Nairobi, contribute significant amounts of particulate matter into the air exposing populations in such areas to health hazards.

Tackling air pollution

At its most basic, tackling air pollution calls for land use planning that involves spatial zoning (commercial, industrial, residential, educational, farming, recreational and sporting). In addition, transport infrastructure planning is also essential to proactively safeguarding health and

protecting the environment. Industry or transportation devices can either destroy contaminants or remove them from an exhaust stream before emission into the atmosphere. They include mechanical collectors for instance, dust cyclones, multi-cyclones, electrostatic precipitators, bag-houses and particulate scrubbers.

Air pollution legislation in Kenya is contained in various legislative documents which include: the Penal Code (Cap 63), Public Health Act (Cap 242), Traffic Act (Cap 365), Grass Fires Act (Cap 327), Occupation Health and Safety Act, 2007, Mining Act (Cap 306), Local Government Act (Cap 265), Chiefs Authority Act (Cap 128), Air Quality Regulations under EMCA, 1999, and the Building Code Adoptive Bylaws, 2000. However weaknesses exist in enforcement and compliance practises.

Safety in the work environment

Health and safety effects encountered in the working environment have long been recognized and documented particularly in the developed world. The negative effects are not localized to developed countries only and are being experienced in the developing world with disastrous short and long term health consequences.

There are at least 250 million occupational accidents every year worldwide, at least 335 000 of which result in death. Developing countries have more fatal accidents than industrialized nations mainly because they lack the technology and knowhow to ensure workers safety. Further, they suffer from inadequate financial capacity and poor policy frameworks. The number of cases, type and severity of occupational diseases are increasing in both developing and industrialized countries. The need to prioritize and mainstream workers' safety and health at all levels of development planning especially in developing countries is therefore both critical and urgent.

Range of hazards

The nature and type of occupational hazards that can be found in almost any workplace is predictable. There are clearly obvious unsafe working conditions, such as unguarded machinery, slippery floors, leaking roofs or inadequate fire precautions, but there are also a number of categories of insidious hazards. These are those hazards that are dangerous but which may not be obvious and include:

- chemical hazards, arising from liquids, solids, dusts, fumes, vapours and gases
- physical hazards, such as noise, vibration, unsatisfactory lighting and ventilation, radiation and extreme temperatures
- biological hazards, such as bacteria, viruses, infectious waste and infestations
- psychological hazards resulting from stress and strain
- hazards associated with the non-application of ergonomic principles, for example badly designed machinery, mechanical devices and tools used by workers, improper seating, poor work station design or poorly designed work practises.

Construction workers face a variety of safety hazards such as falls, slips, trips, cuts, and being hit by falling objects. There are also dangers from working high up, often without adequate safety equipment. Musculoskeletal problems may arise from lifting heavy objects, and there are hazards associated with exposure to vibrations and excessively noisy machinery. The range of occupational diseases is listed in Box 8.2.

Box: 8.2: The range of common occupational diseases and conditions

Occupational disease	Exposure material
Asbestosis (pneumoconiosis)	Asbestos (dust)
Silicosis (pneumoconiosis)	Sand and broken glass - cullet (dust)
Baggasosis (pneumoconiosis)	Sugarcane waste (dust)
Sidellosis (pneumoconiosis)	Electrical arc wielding (smoke)
Bysinosis (pneumoconiosis)	Cotton wool (dust) textiles
Berrylosis (granullomatosis)	Talc (contact with)
Biological	
Cutaneous Anthrax	Infected animals and materials (farmers' disease)
Schistosomiasis	Infected snails in rice paddies
Hay fever	Hay dust (an allergic reaction)
Conditions	
White muscle disease	(Low temperature/Frost bite)
Occupational deafness..	(Continuous high noise levels)
Occupational asthma.	(Hardening agents, adhesives and paints)
Scoliosis (Sideways curvature of spine	Ergonomics (poor posturing)
Lordosis (deformed lower back)	Ergonomics (poor positioning)
Kyphosis (hunched back)	Ergonomics (poor positioning)
Psychosocial	
Depression	
Stress	

Machinery accidents: (blasts, physical injuries).

Chemical accidents: (contact, inhalation) indoor and outdoor.

Fires: (electrical pressurized liquid petroleum gas, and liquid petroleum).

Addressing safety in the workplace

To address the problem, government has undertaken deliberate steps to establish the Directorate of Occupational Safety and Health in the Ministry of Labour which works in collaboration with the Ministry of Public Health and Sanitation, and to enact the Occupational Safety and Health Act, 2007. This law aims to ensure employee health and workplace safety.

At the workplace, strong management commitment towards health and safety is essential. Equally, worker participation in all efforts to create and maintain a safe and healthy workplace is vital. The need to train workers is therefore a prerequisite to ensuring their safety and health.

Strategies to improve health and environment

The legal framework

The operative legal framework for human and environmental health, is embedded in a range of laws that include the Local Government

Act (Cap 265), Public Health Act (Cap 242), Environment Management and Coordination Act 1999, Food Drugs and Chemical Substances Act (Cap 254), Physical Planning Act, Water Act 2002, and the Occupation Safety and Health Act 2007.

The legislations are fairly comprehensive. However there are two contributory factors that impede full implementation. First, the penalties in the older laws are too low to deter contraveners. This calls for a review of these laws. The other weakness is inadequate and inconsistent enforcement and compliance. Improvement in enforcement and public awareness will lead to more compliance which will have a multiplier effect resulting in a reduced disease burden on both government and households. The savings can then be channelled to productive sectors of the economy which will help to attain the Vision 2030 goals.

Conclusion and recommendations

It is clear that achieving progress for better health and environmental integrity should aim at reducing the environmental burden of disease while encouraging the sustainable use of environmental resources. However it will require support from the centre as well as inter-sectoral collaborative approaches through an enabling policy and regulatory structure, adequate funding and sufficient human resource capacity. Priority attention and specific techniques are needed to reach the vulnerable poor in both the rural and urban areas of the country and to address gender inequities. Emergency preparedness and efficient coordination are central to achieving appropriate and timely response at all times. Kenya has an elaborate environment and health regulatory regime. All that is required is rigorous and sustained implementation of this regulatory framework as well as the associated sanctions and rewards.

Specific policy interventions will however further improve the policy implementation landscape:

- First, **full exploration of the environment and health interlinkages** discussed in this report will be pertinent. A health and environment strategic alliance (HESA) as envisaged and recommended in the Libreville Declaration (WHO and UNEP, 2008) should be established. Other inter-sectoral strategic partnerships with the lead agencies on weather and climate change monitoring, finance, agriculture as well as water and sanitation should also be established, strengthened and operationalized.

- **The established link between the cost of healthcare and the state of the environment must also be articulated to policy makers.** Relevant and well articulated health-environment indicators and other advocacy instruments should be developed, monitored and communicated to policy makers.

- **Targeted capacity building interventions are also needed and should include focused and needs-driven human resource and technical capacity development within all the institutions with health and environment mandates.** Special emphasis must be made for specific areas and levels where known gaps exist for instance, environmental health, environmental engineering and integrated environmental mangement.

- In order to achieve the required standards in health and environment, **there is need to strengthen environmental health enforcement and compliance practises**. There is also need to domesticate and implement all relevant regional and international multilateral environmental agreements.

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PART 3
EMERGING CHALLENGES

CHAPTER 9 EMERGING ISSUES

Introduction

Emerging issues are 'old issues looked at in a new light, or that are exerting an increased impact on the environment and the people. They may also be completely new environmental phenomena' (UNEP 2006). In the broader sense however, emerging issues are external environmental phenomena that pose potential future risks. Emerging issues meet a number of criteria. First, they are issues that have persisted in the past without raising concern, but new opportunities or effects are emerging or re-emerging. They could also be issues that through evolution, have taken on new dimensions of concern. For purposes of this report, emerging issues are also issues of specific relevance to Vision 2030. Vision 2030 is Kenya's long-term development blueprint and therefore, for an issue to be prioritized by the government in terms of relevance and budgetary allocation, it has to fit within the framework of this vision.

Emerging issues also have remarkable impacts on the economy and society and tend to have a national scope. Emerging issues however, have the potential to cause impacts on a regional scale, especially with regard to transboundary natural resources. As such, a critical emerging issue might not manifest in Kenya but could exist within the region and have the potential to spread to and affect the country. This calls for devising regional approaches to dealing with such issues. Unless urgent action to stem all the above emerging issues is urgently instituted, they are anticipated to worsen as the population rises, as the economic growth and development envisaged by Vision 2030 leads to more affluence and as new urban centres mushroom in line with the decentralization envisaged by the new Constitution. However, there are a number of income generating opportunities embedded in these challenges which individuals, communities, groups and business entities should be encouraged to tap.

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Key emerging issues in Kenya

Three emerging issues merit discussion in this SoE Report. These include management of hazardous waste (such as medical waste and e-waste), invasive alien species and environmental justice.

Hazardous wastes

Hazardous wastes are those categories of waste that have immediate or long-term health effects including asthma, skin rashes, allergic reactions, cancer or other long-term diseases (GOA 2009). They pose substantial or potential threats to public health and the environment. Hazardous wastes may also be associated with work places and include discarded wastes that are medicinal, poisonous or ionizing in nature.

The commonest hazardous wastes are wastes containing radio-nucleids, corrosives, toxics, explosives, medical waste, pharmaceuticals, chemicals, solvents, inorganic cyanides, waste oils, hydrocarbons, emulsions, waste resins, metal carbonyls, beryllium, copper, arsenic, selenium, cadmium, antimony, tellurium, mercury, thallium, lead, inorganic fluorine, organic phosphorous, phenols, organo-halogens and zinc compounds, acidic and basic solutions and asbestos. The discussion in this chapter however focuses on the medical and e-waste categories of hazardous wastes.

Medical waste

According to the Pakistan Antimicrobial Resistance Network, hospital waste is 'any waste which is generated in the diagnosis, treatment or immunization of human beings or animals or in research' in a hospital. Box 9.1 contains a more specific description of medical waste categories by WHO.

The main sources of medical waste in Kenya include medical and dental offices, clinics, hospitals, laboratories and research facilities,

Box 9.1: World Health Organization (WHO) medical waste categories

(a) Infectious waste
- Materials containing pathogens which if exposed to can cause disease
- Human anatomical waste: waste from surgery and autopsies on bodies with infectious diseases
- Sharps: disposable needles, syringes, saws, blades, broken glass, nails or any other item that could cause a cut
- Pathological: tissues, organs, body parts, human flesh, foetuses, blood and body fluids

(b) Non infectious (hazardous) waste
- Pharmaceuticals: drugs and chemicals that are returned from wards and include spilled, outdated or contaminated medicines that are no longer required
- Radioactive: solids, liquids and gaseous waste contaminated with radioactive substances used in diagnosis and treatment of diseases like toxic goitre

(c) Non infectious (non hazardous) waste
- Domestic waste: from offices, kitchens, rooms, including bed linen, utensils and paper

Source: WHO 2007

Note: Incineration ash is also a waste that needs to be managed properly.

veterinary and agricultural undertakings. Medical facilities generate a variety of waste materials (either in the course of treatment or diagnosis). These facilities are also spread all over the country which makes centralized waste collection and disposal difficult. Poor disposal and management presents potential risks to human health and the environment. The waste produced includes human tissue, used equipment such as needles and syringes and pathogenic organisms.

Medical research laboratories in the country handle a wide variety of highly pathogenic organisms used in specialized research activities. The laboratories are categorized at different levels on the basis of an international standard that correlates to their capacity to handle infectious microorganisms. A number of these facilities are aspiring to upgrade to higher categories (notably level 4 and above) that have the capacity to handle even more virulent microorganisms. The concern from a public health perspective would be whether the security of stored specimens, the safety of the workers at these institutions, and the eventual safe disposal of specimens can be assured. Careless disposal could lead to serious, expensive and difficult-to-treat disease outbreaks. They could also be used for a variety of activities that threaten national security.

Disposal of used needles and syringes and toxic chemicals represents a major threat to public health. In 2000, WHO estimated that worldwide, injections given with contaminated syringes caused about 23 million infections of Hepatitis B, Hepatitis C and HIV. Such situations are likely to happen when healthcare waste is dumped on uncontrolled sites where it can be easily accessed by the public. Children are particularly at risk of coming into contact with infectious waste. Also contact with toxic chemicals, such as disinfectants, may cause accidents when they are accessible to the public. In 2002, an assessment conducted in 22 developing countries showed that between 18-64 percent of healthcare facilities do not use proper waste disposal methods (WHO 2005).

The key driver for indiscriminate dumping of medical waste is the lack of proper disposal facilities, particularly incinerators. Incineration facilities are limited and where available, they are either broken down or improperly used. It is known that incineration as a waste treatment technique releases toxic gases produced by the combustion of by-product or other materials and that this can affect the environment and human health. However current technology has developed more efficient incinerating units that control these emissions to a point that

Medical waste often contains used needles, which pose a major threat to public health.

Benny Lin/Flickr.com

Parameter	Standards, guideline, criteria and procedures
Basic plant design	An approved plant must have four distinct sections that demonstrate the three principles of turbulence, residence time and temperature.
Feeding and charging	Controlled hygienic, mechanical or automatic feeding methods have to be used which will not influence the air temperature in the primary and secondary chambers of the incinerator negatively. No waste is to be fed into the incinerator: • Until the minimum temperatures have been reached. • If the minimum combustion temperatures are not maintained. • Whenever the previous charge has not been completely combusted in the case of batch feeding. • Until such time as the addition of more waste will not cause the design parameters of the incinerator to be exceeded
Primary combustion chamber	The primary combustion chamber must be appropriately equipped and be operated within the prescribed conditions (fuel, temperature, air supply)
Secondary combustion chamber (afterburner)	The secondary combustion chamber must be equipped appropriately and operated within the prescribed conditions (fuel, temperature, air supply)
Particulate removers	A mechanical particulate collector must be incorporated after the secondary combustion chamber for removal of particulate pollutants entrained in the flue gas stream. The particulate collectors may include any of the following or a combination thereof: • Cyclone separator • Electrostatic precipitators • Fabric filters
Chimney/stack	The chimney should have a minimum height of 10 m above ground level and clear the highest point of the building by not less than 3 m for all roofs. The topography and height of adjacent buildings within 50 m radius should be taken into account. Other provisions with regard to chimney structure and emissions must be adhered to.
Instrumentation	Instrument for determining the inside wall temperature and not burner flame temperature must be provided for both primary and secondary chambers
Location	Must be sited in accordance with the relevant local municipal authority planning scheme, the topography of the area and be compatible with premises in the neighborhood, and in a suitable room.
Emission limits	Need to meet specified combustion efficiency limits
Operation	Materials destined for incineration should be of known origin and composition and must be only incinerated in a furnace that is registered for the particular type of waste. Requisite records must be kept. Incinerators must operate within the specified parameters and staff appropriately trained.
Housekeeping	The site where the incinerator is built must have running water, a solid floor, lighting if 24hrs operation, fly ash containerization and storage before disposal.
Health and safety (protective gear)	Must operate within the provisions of the Occupational Health And Safety Act.

Table 9.1: Standards, guidelines, criteria and procedures for installing and operating incinerators Source: GoK 2006

this treatment is considered a more beneficial option. There are different types of incinerators and these vary depending on the characteristics of the waste.

Incinerators should operate under certain specifications to ensure complete destruction of the hazardous components of waste. The Third Schedule of the Environmental Management and Coordination (Waste Management) Regulations 2006 has defined specifications for incinerators. The guidelines and procedures for installing and operating incinerators are listed in Table 9.1.

Opportunities and risks

Healthcare waste management has, in the past, not been given much attention. However the Ministry of Public Health and Sanitation has come up with the National Healthcare Waste Management Plan 2008-2012 which provides opportunities to address the problems caused by medical waste. Other supportive frameworks include Vision 2030 and the WHO-Kenya Country Cooperation Strategy (2008-2013). Vision 2030 aims to reduce hazards related to an unhealthy environment. The WHO Kenya country strategy, in priority area 1, aims 'to build health security at the household, community and national levels'.

Name of institution	District	Waste type
Tenwek Hospital	Bomet	Biomedical and domestic waste
Aga Khan Hospital	Mombasa	Biomedical and domestic waste
Aga Khan Hospital	Kisumu	Biomedical and domestic waste
Lions Sight First Eye Hospital	Nairobi East	Biomedical and domestic waste
Aga Khan University Hospital	Nairobi North	Biomedical and industrial waste
Franciscan sisters of St. Joseph's	Kisii Central	Biomedical/industrial/domestic
Muthale Mission Hospital	Kitui	Biomedical/industrial
Moi Teaching and Referral hospital	Eldoret	Biomedical and domestic waste

Table 9.2: Health institutions licensed to operate incinerators Source: NEMA

Note: In addition to the above, a number of institutions are in discussions with NEMA about renewal of their incineration licenses. These include three sites under KEMRI (Kilifi, Kisumu and Nairobi), Guru Nanak Hospital, and Gertrude's Children's Hospital.

Apart from incineration, other options for treating healthcare waste include chemical disinfection, shredding, microbial inactivation using sterilization technologies, autoclaving or steam sterilization and microwave irradiation, among others.

In Kenya, NEMA has licensed a number of institutions that operate incinerators. The incinerators are designed to handle a variety of

Name of proponent	District	Waste type
Oserian Development Corporation	Nakuru	Biomedical/hazardous
Environmental and Combustion	Kajiado	Hazardous/industrial
Green City Incinerator	Nairobi East	Biomedical/industrial
Mabati Rolling Mills Ltd.	Kilifi	Scum/industrial waste
Enviro-safe	Nairobi East	Biomedical/pharmaceutical
East African Port Land Cement	Nairobi West	Used oil
Standard Rolling Mills	Kilifi district	Industrial sludge
Agro Chemicals and Food Co. Ltd	Nyando	Industrial/domestic / biomedical
James Finlays (K) Ltd	Kericho	Biomedical wastes
Homegrown Kenya Ltd	Naivasha	Biomedical wastes
Envirowaste	Machakos	Biomedical and industrial waste

Table 9.3: Other entities licensed to incinerate an assortment of hazardous wastes Source: NEMA

hazardous wastes. Some are private and only take waste generated in-house while others operate commercially and take in waste from off site. The entities that have been licensed to incinerate medical waste are listed in Tables 9.2 and 9.3.

The majority of incinerators in the above entities have not fully met the required specifications. Their licences are therefore conditional and full licences will be granted if and when the required improvements are carried out. Failure to meet the specifications, for example, regarding temperature and other operating conditions pose significant risks to human health. Indeed, even the fractions left after 'incineration' in these facilities are still hazardous in and of themselves. There is therefore urgent need to work with these facilities to swiftly ensure their compliance with the required standards.

The low number of licensed incinerators also indicates that a large number of Kenyans are exposed to dangers associated with the lack of proper, functional incinerators. Whereas the opportunity exists for medical facilities to transport waste to commercial incinerators for disposal, there is no evidence to support this practise on the ground. The magnitude of the challenge posed by medical waste can be appreciated if we bear in mind the number of health institutions scattered all over the country from dispensaries to the larger facilities. It is common practise for most of the hazardous medical waste to be dumped in shallow pits within the precincts of medical institutions. These pits are easily accessible to scavenging birds and rodents. These then serve as reservoirs for pathogens/disease transmission. In addition, these pits are not properly lined and there is a real risk of contaminating underground water sources. Further, many jobless people also forage in these pits in search of salvageable items for sale. These individuals are exposed to the risk of contact with contaminated materials or the risk of being pricked by sharps. The attempt to dispose of the waste by periodic burning only exacerbates the problem as it exposes surrounding communities to dangerous fumes. Proper quantification of medical waste generated in the country has not been done. Because of this data gap, it is difficult to formulate effective strategies to deal with medical waste management. Moreover, a number of agricultural and veterinary labs might be disposing of waste that could fall within the biomedical category in an unhygienic manner as none of the latter facilities have been licensed by NEMA.

E-waste

E-waste is a term that encompasses various forms of electrical and electronic equipment that are old, end-of-life appliances that have ceased to be of any value to their owners (Waema and Muriuki 2008). It includes electronics which are destined for re-use, resale, salvage, recycling, or disposal. E-waste is the most rapidly growing problem in waste streams due to its quantity, toxicity, and carcinogenicity. As equipment reaches its end-of-life, disposal challenges arise. Often the material is improperly disposed of posing a threat to human health and the environment (Waema and Muriuki 2008).

The exact amount of e-waste generated in Kenya is not known. Mureithi et al, 2008 estimate the annual tonnage of e-waste in Kenya at about 2 984.35 per year. The authors also note that e-waste in Kenya consists of old PCs and cathode ray tubes (CRTs) in almost equal proportions. A separate study by UNEP (2009b) puts the quantity of electric and electronic equipment (consisting of PCs and mobile phones alone) in the Kenyan market at 5 650 metric tonnes per year. The same assessment puts the stock (installed base) of electric and electronic equipment at 58 110 tonnes per year. This is broken down as follows: 21 300 tonnes of PCs, 610 tonnes of mobile phones, 22 600 tonnes of TVs and 13 600 tonnes of refrigerators. It places the quantity of e-waste generated in metric tonnes per year at 11 400 tonnes from refrigerators, 2 800 tonnes from TV sets, 2 500 tonnes from PCs, 500 tonnes from printers and 150 tonnes from mobile phones, making a total of 17 350 tonnes. According to industry research, Kenya is already well on the way to becoming a major e-waste producer and runs the increased risk of corresponding health, economic and social implications. Table 9.4 highlights the quantities of electrical and electronic waste produced.

Appliance	Lifetime (years)	Weight (kg)
PC + monitor	5 – 8	25
Laptop	5 – 8	5
Printer	5	8
Mobile phone	4	0.1
TV	8	30
Refrigerator	10	45

Table 9.4: Average lifetime and weights of different electrical and electronic appliances Source: UNEP 2009b

The key driver to the rapid generation of e-waste in Kenya is policy failure particularly with respect to importation of used computers and other electronic equipment. Vision 2030 is expected to worsen this policy gap. The first Medium Term Plan (2008-2012) of Vision 2030 states the government's commitment to improve ICT infrastructure as a foundation for a knowledge economy. The same document states the government's commitment to simulating investment in the ICT sector. This has seen a rapid expansion in the use of ICT through interventions meant to promote use of computer technology, mobile telephony and other ICTs. If growth in these sectors is not well managed, the problem of e-waste could rapidly worsen.

Within the medium term plan of Vision 2030, there is a proposal to migrate from analogue to digital broadcasting by 2012. This has potentially huge benefits but will also see most of the analogue televisions sets currently used in Kenyan households rendered obsolete. This will come with a huge waste disposal problem.

More impetus for growth of the ICT sector has come from regional decisions such as the AMCEN Decision 6 from the Johannesburg conference of 2008 that encouraged governments to promote ICT and environmental education. Capacity constraints hindering the disposal of e-waste as well as the collection system and recycling infrastructure are the major challenges facing all the East African countries. A lot of the old technology is held in storage due to lack of clear strategies for disposal. Box 9.2 lists some of the programmes planned in the ICT sector.

Box 9.2: Some programmes and projects for the ICT sector 2008-2012

1. The East African Marine Systems (TEAMS)
2. National terrestrial fibre optic network project
3. Government common core network
4. Local and Wide Area Networks
5. Kenya Transparency Communication Infrastructure Programme (establishment of digital villages and bandwidth subsidy)
6. Data centre/data recovery centre
7. Intregrated management information systems
8. ICT hardware
9. Madaraka PC project

Most e-waste recycling in developing countries is done informally and there is little regulation in place to safeguard the health of those who dismantle the electronic equipment. In Kenya quite a huge quantity of e-waste is handled by the informal (*jua kali*) sector. In addition, many developing countries have been caught up in the web of global e-waste dumping (Waema and Muriuki 2008).

Opportunities and risks

The first medium term plan of Vision 2030 recognizes the problem of lack of standardization for ICT components and systems being procured and installed and applied across the government ministries and departments. The result is accumulation of old electrical equipment in institutions and households. Some are arbitrarily disposed of in dumpsites that are intended for non-hazardous waste. E-waste contains a number of harmful fractions some of which are outlined below.

- Lead is found in the Cathode Ray Tubes (CRTs) of computer and television monitors. The metal causes damage to the nervous system.
- Mercury, a hazardous metal used in the flat-panel display screens, is a neurotoxin. High levels of metallic mercury damages the nervous system and the developing foetus. It is also difficult to get rid of mercury once it is released in the environment.
- Circuit boards and batteries contain cadmium which is known to be a carcinogen as it is directly implicated in the promotion of various types of cancer.
- Polyvinyl Chloride (PVC), a synthetic polymer used for the insulation of wires and cables of electronic equipments, emits chlorinated dioxins and furans which pollute the air when it is exposed to heat.

Inappropriate disposal of e-waste leads to significant environmental problems but also to a systematic loss of secondary materials. There is need to put in place appropriate interventions to both protect human

A "computer for schools Kenya" lab used for recycling used computers.

Computer for schools Kenya

Box 9.3: Computer for Schools Kenya: Recycling and Refurbishment

Computer for Schools Kenya (CFSK) is a non-governmental organization registered in Kenya whose vision is the establishment of an information-rich Kenyan society that actively participates in sustainable development. CFSK hopes to help achieve this by facilitating the development of information and communication technology infrastructure and capacity in educational and training institutions as well as community information resource centres. In conjunction with Masinde Muliro University of Science and Technology, CFSK has also developed a training programme in e-waste management and is in the process of starting an e-waste recycling centre to handle e-waste in western Kenya.

CFSK has also established the first eco-friendly e-waste management centre in the Eastern Africa region at Embakasi, Nairobi at a cost of KSh 3.8 million. Its in-house e-waste management protocol is guided by three principles namely: environmentally friendliness, health safety and sustainability.

CFSK's e-waste management process entails local recycling and reuse of metal, plastic parts and other functional components, and re-export of components that cannot be safely disposed of locally. The Norwegian government supports recycling of 50 000 tonnes of monitors by CFSK every year. Both metals and plastics derived from decommissioned computers are sold to environmentally compliant local metal and plastics recyclers for conversion into other products.

Reusable components from circuit boards (such as capacitors and transistors) are extracted, inventoried and stored for CFSK's own extensive maintenance and support programmes and occasionally sold to micro-enterprises that repair and maintain consumer electronics. The other components are safely stored in secured premises for re-export to recyclers overseas who have the technical capacity to safely dispose of them or extract valuable materials from them. Decommissioned monitors are converted into quality affordable television sets for sale to partner institutions and others.

CFSK also offers services of collection and management of electronic waste on behalf of their clients—which comprise large manufacturers and businesses—on a contractual basis. This service is designed specifically for the electronics industry and other large clients. Their facilities were soon overwhelmed after corporate organizations embraced the 'no dumping' policy and started giving them electronic waste for proper disposal. Currently, Barclays Bank, Joint Voluntary Agency (JVA), KPMG, and Dell of South Africa are some of the organizations sending their old computers, mobile phones, television sets, radios, printers, faxes, photocopiers and other types of e-waste to CFSK for recycling.

health and create opportunities for employment and wealth creation. The interventions could be in the form of amending the current waste regulations of 2006 to embrace e-waste and promoting refurbishment to extend the life of appliances through recycling. In addition, stringent enforcement of the Basel Convention should be observed so that Kenya does not unwittingly become an importer of e-waste. The inter-agency cooperation required to prevent dumping of illegal goods in the country needs to be quickly instituted. There have been incidents of electrical goods earmarked for transit ending up in the country. There have also been incidents of deliberate mislabelling of containers in a bid to conceal the true identity of goods. This has led to substandard electrical and electronic goods finding their way into the local market.

Other opportunities to improve disposal of e-waste include take-back schemes, recycling, reuse and educational research. Some manufacturers, for instance Sony Ericsson, LG and associated suppliers and service providers are implementing take-back schemes. When the Safaricom scheme became operational, it only took back its own obsolete appliances. The scheme has stalled in recent years and is in the process of being revitalized. Kenya was the first sub-Saharan country to have a NOKIA take-back point and the firm has six take-back points in Nairobi, Kisumu and Mombasa. This presents a business opportunity for those who collect e-waste and hand it over to recyclers, refurbishing firms and treatment plants because they are paid a take-back fee.

Hewlett Packard is currently partnering with Camara Education, a non-profit organization that uses technology to improve education in Africa to establish the East Africa Recycling Company. This is to be run as a viable self-sustaining business in Mombasa. The partnership targets to capture at least 20 percent of the e-waste market in Kenya.

Individuals and entities could engage in recycling activities as a way of employment creation. E-waste contains hundreds of tonnes of various metals. These metals can be isolated, treated and made available for use in new forms.

A NOKIA take-back point in Nairobi. Kenya was the first sub-Saharan country to have a NOKIA take-back point and the firm has six take-back points in Nairobi, Kisumu and Mombasa.

E-waste management is also a potential research and educational area for institutions of higher learning. Some private organizations are already partnering with universities to develop and implement training programmes. Box 9.2 highlights some of the activities in this area.

The growth of the electronics sector provides numerous economic and environmental opportunities. Innovations in e-banking, education, and research are now possible. The mobile telephony growth has been phenomenal in recent years and has been largely fuelled by the government's liberalization of the mobile cellular market leading to an exponential increase in the number of handsets and their accessories. Access to telephone services has helped to grow a number of other sectors including agriculture, education, health and business. In the financial arena, for instance, Kenyans transfer huge sums of money daily through various mobile phone products offered by the different telecommunication operators. Growth in the ICT sector has led to a significant reduction in transaction costs and time as well as the migration to less energy and material-dependent processes. In the learning sector alone, e-learning promises to reach a vast number of people, especially the youth that are currently outside the formal education bracket.

Invasive alien species

Kenya hosts a number of invasive alien species with the water hyacinth, *Lantana camara* and *Prosopis* weeds as well as the common carp being major concerns. The emergence of invasive species may be due to a range of factors that include climate change, pollution and poor agricultural practises. This section will focus on two invasive species namely; the Common carp and the Water hyacinth.

The Common Carp

The Common carp (*Cyprinus carpio*) is a relatively large, slender, freshwater fish that can grow to a length of 120cm and weigh as much as 35kg (Howard and Matindi 2003). This species originated from Asia and Eastern Europe. It may have been introduced to Africa more than two hundred years ago for aquaculture. Many hatcheries in Africa supply common carp fingerlings to fish farmers as they are popular in both subsistence and commercial fishponds. The government started fish ponds in the highland areas of Central province where this fish was introduced in order to diversify livelihood options and to provide a much needed source of animal protein. Carp are known to escape from aquaculture, especially as larvae or young fish. They are then able to easily disperse in natural systems both upstream and downstream. The El-Niño rains of 1997 are thought to have helped spread it to other areas in Central province.

The Common carp is problematic primarily because of its destructive feeding habits. It preys on other fish and on invertebrates and also forages on important submerged vegetation. Indeed, a major impact of this fish is that it is associated with the disappearance of other fish species. It has, for instance, replaced other fish like the tilapia and Black bass and is thus a threat to biodiversity and it could lead to the destabilization of aquatic food chains (GoK 2008). The benefits that used to accrue from the presence of the other species such as research have also been lost.

Their potential for reproduction is excessive: large females lay as many as a million eggs. The first carp catch was recorded in Lake Naivasha in 2002. Currently, it accounts for 89 percent of the total fish catch of Lake Naivasha and this is projected to increase in the coming years (GoK 2008). Control is difficult especially because this fish species is prized by anglers as well as those seeking affordable fish protein.

The Water Hyacinth

The water hyacinth (*Eichhornia crassipes*) is native to the Amazon basin in South America. The plant was introduced in many tropical and subtropical parts of the world including East Africa in the second half of the 19th century as an ornamental plant. The plant first appeared in Egypt in 1879 and in South Africa in 1910. It spread to the Congo in 1952 and to Nigeria in 1987. It was first observed in Lake Naivasha in 1982, Lake Kyoga (Uganda) in 1988 and finally Lake Victoria in 1989. A number of factors including wind, water currents and probably fishermen accelerated its dispersal across the lake. By the late 1990s, the water hyacinth had colonized about 20 000 ha of Lake Victoria (EAC 2008). Its rapid spread in the continent's lakes is largely due to the fact that it is particularly suited to tropical and subtropical climates.

The water hyacinth has devastating effects on lake systems and the socio-economic activities associated with fishing and navigation. Dense mats of hyacinth cover fish landing sites, block fishing grounds, block water pipes for local water works, destroy fishermen's fishing gear and make fishing grounds inaccessible by blocking navigation routes for both transport and small fishing vessels (LVFO 2005). The

The Common carp (Cyprinus carpio).

Wikipedia

The water hyacinth weed covering most beaches along Lake Victoria makes it increasingly difficult for communities to access fresh water from the lake.

water hyacinth is also known to disrupt hydro-power generation, water purification and supply with all of these having been observed on Lake Victoria. In addition to disrupting economic activities, the control of the hyacinth requires a lot of resources. Mechanical control is slow, tedious and expensive. Biological control methods, though more efficacious, may have many unintended side effects. Chemicals could pollute the water systems, while the dead vegetation putrefies and increases the nutrient levels in the water system. This de-oxygenates the water and causes its eutrophication, adversely impacting fish populations.

In the case of Lake Victoria, the control methods used were not effective and the water hyacinth moved upstream into the rivers that drain into the lake system. Through dispersal by aquatic birds and domestic animals the water hyacinth continues to invade almost all the small water bodies around Lake Victoria. Runoff and flood waters during the rainy seasons are some of the new vehicles that restock the lake with water hyacinth from the small water bodies and rice fields within the basin. The annual cost of this 'hyacinth infestation' has been estimated at as high as US$ 6-10 million (Warutere and Auma 2007). Climate change is expected to compound this problem.

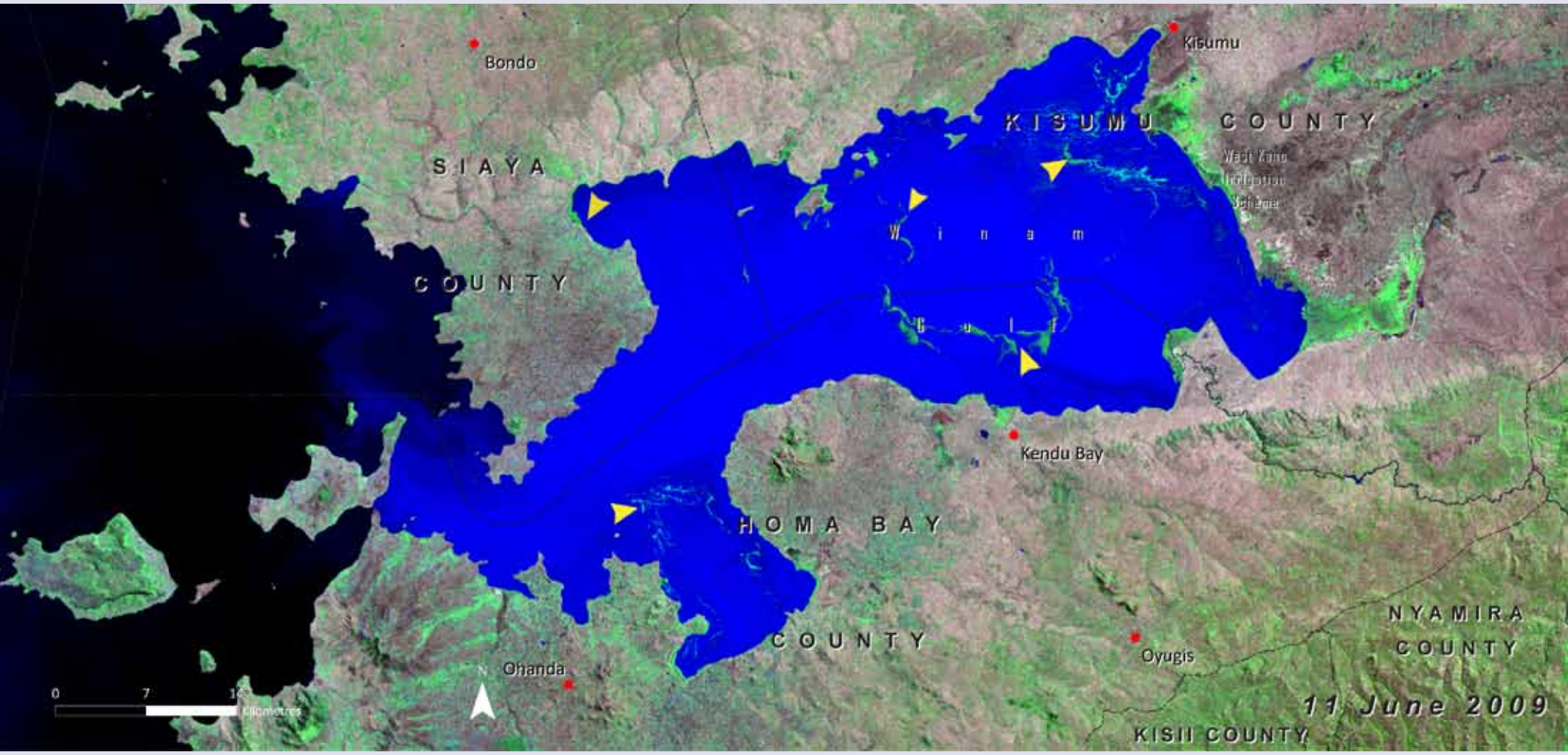
Opportunities

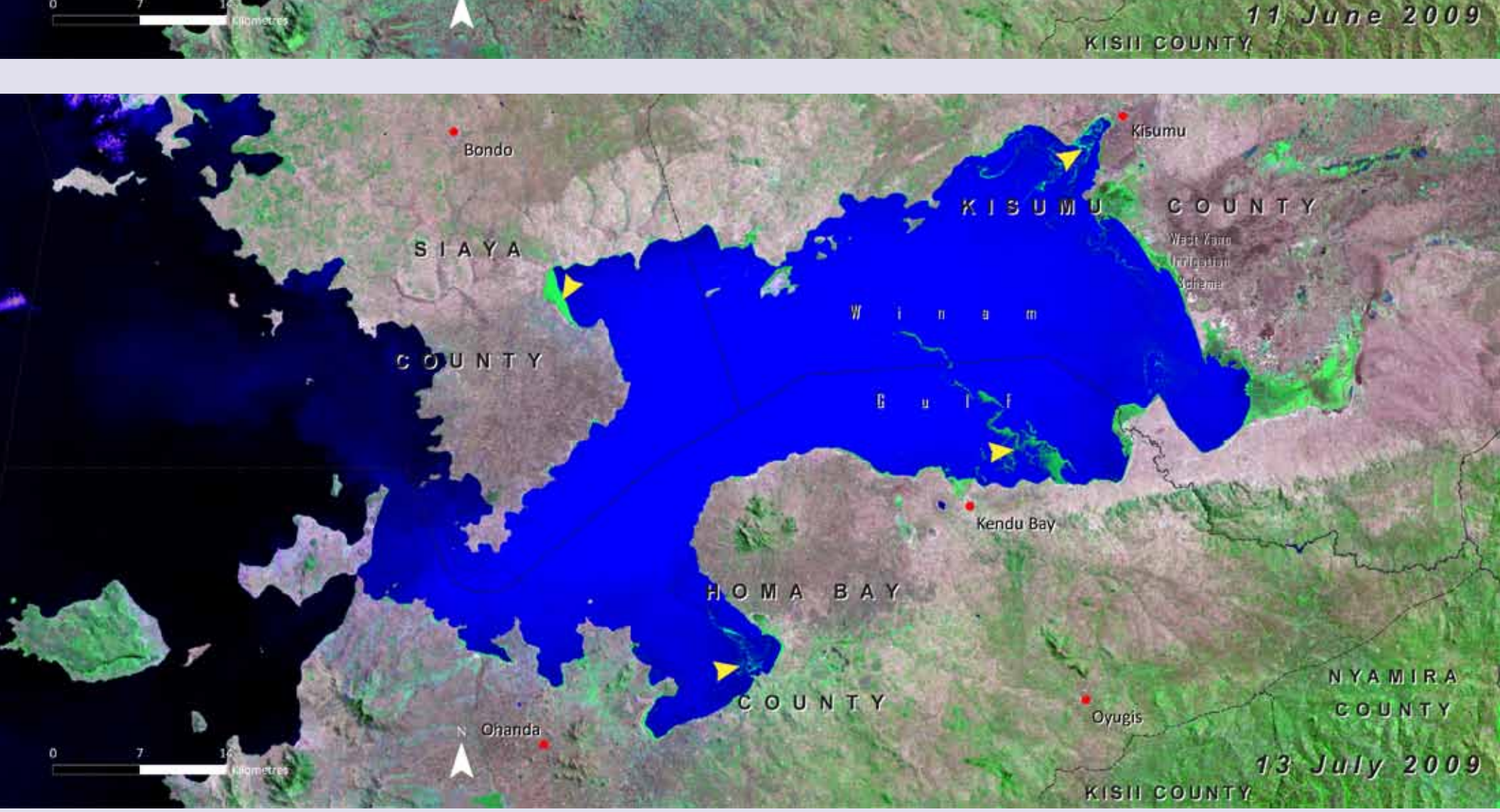
There has been some experimental use of the water hyacinth as animal feed and as manure. It has also been used as a test plant in the purification of polluted water (especially heavy metals and nutrient removal). It has been demonstrated that the reed from this plant can be used to make furniture and handicrafts thereby offering alternative livelihood for both men and women. The manual removal of the weed from Lake Victoria provides employment to several communities bordering the lake (EAC 2008).

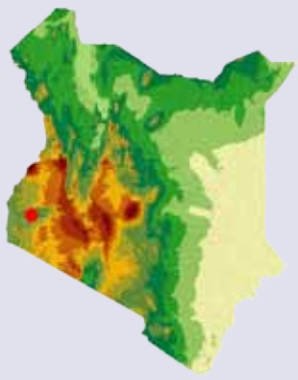
Strategies to manage the water hyacinth

Experimental control programmes continue to prove futile. A variety of harvesting mechanisms have been attempted including removal by hand where local communities were mobilized to remove the weed. The governments of Kenya and Uganda provided support in the form of hoes and wheel barrows but several challenges rendered hand harvesting unviable. In other areas of the lake, mechanical harvesting through shredding machines was also attempted. The government of Uganda has also introduced floating harvesters (EAC 2008) although these proved unviable due to frequent breakdowns and high costs of repair.

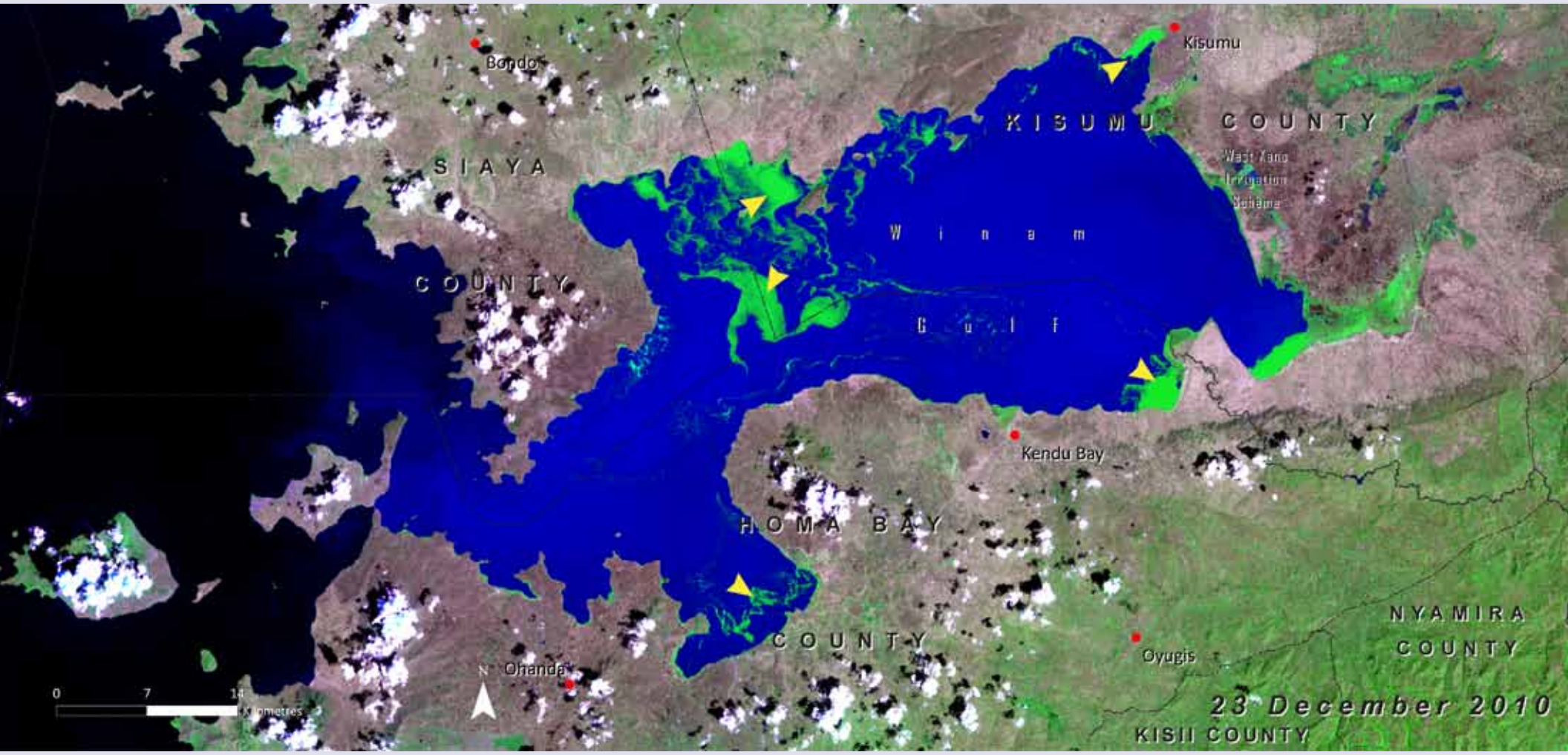
Chemical control was considered, but shelved as well. A beetle, Neochetina eichorniae was introduced, but it had limited success due to the seasonality of the damage to hyacinth caused by the weevils (EAC 2008). The primary reason these methods have failed is that the weed's regeneration has tended to outstrip the attempted control methods.







Whither Water Hyacinth? —Water hyacinth (*Eichhornia crassipes*) invaded Lake Victoria in the 1990s, and Winam Gulf became one of the most severely affected regions. The plant's growth creates dense mats of vegetation that restrict oxygen exchange across the interface between the air and water. Dying organic matter also uses oxygen, which leads to the deterioration in water quality and can cause fish mortality. Biodiversity levels usually decline. In addition, the mass of plants can block waterways and harbours and damage generating turbines, resulting in



Richard Portsmouth/Flickr.com

significant economic losses. The winds blowing across the lake move the mats of water hyacinth around depending on the prevailing direction. As seen in the above images, not only does this plant change its position over time, the thickness of the mats also change with the highest concentration in these images visible in the 23rd December 2010 image. In all these images, water hyacinth weed infestation has been marked by yellow arrows. The photograph above serves to illustrate the servere impacts the invasive weed has on the transportation and fishing vessels operating from the Kisumu Harbour—in this case, the mat has completely immobilized these vessels.

Box 9.4: Principles of environmental justice

Environmental justice:

- Demands that public policy be based on mutual respect and justice for all peoples, free from any form of discrimination or bias
- Calls for universal protection from nuclear testing, extraction, production and disposal of toxic/hazardous wastes
- Demands the right to participate as equal partners at every level of decision-making
- Protects the rights of victims of environmental injustice to receive full compensation and reparations

Source: http://www.ejrc.cau.edu/princej.html

Environmental justice

What is environmental justice?

Environmental justice refers to an equitable spatial distribution of environmental burdens and benefits to groups such as racial minorities, residents of economically disadvantaged areas, or developing nations. It also includes providing opportunities for meaningful participation, recognition or awareness of local or cultural issues, and enabling people to function fully in society (Schlosberg 2007). It incorporates environmental concerns into the framework of human rights and democracy. Box 9.4 highlights the principles of environmental justice.

The environmental justice movement in Kenya

At a very basic level, environmental justice is about incorporating environmental issues into the broader policy and institutional framework. From the discussions in the rest of this SoE Report, it is obvious that environmental legislation in Kenya is scattered in a multiplicity of sector-specific laws. However in 1999, the Environmental Management and Coordination Act (EMCA), the country's a framework environmental law became operational. The law attempts to cover all environmental issues that may require a coordinated approach to their management.

Environmental injustice in Kenya

The issue of environmental justice in Kenya should be viewed from a social, ethical, economic and ecological perspective. It is anchored on the provisions of EMCA and more recently, the new Constitution. Section 3(1) of EMCA (1999) states that 'every person in Kenya is entitled to a clean and healthy environment and has the duty to safeguard and enhance the environment'. The right to a clean and healthy environment is reiterated in Article 42 of the new Constitution promulgated in August 2010. In addition, Articles 60-72 comprehensively address issues of land and the environment which obligate the government to:

- Ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources
- Encourage public participation in the management, protection and conservation of the environment
- Protect and enhance intellectual property in indigenous knowledge on biodiversity and the genetic resources of the communities.

Despite these provisions, there are incidences where local communities are prevented from enjoying ecosystem services for various purposes such as recreation and culture. Examples have included blockage of access to public beaches at the Kenyan coast by private developers and hoteliers through erection of walls and other barriers. Some have even claimed to own public beaches. Denying indigenous communities access to ecosystems such as forests for cultural activities has also been documented. A case in point is the claim by the Ogiek that they enjoy an indefeasible historical right to the Mau Forest Complex.

Communal land is by law held in trust by county councils on behalf of the people. Unfortunately it has tended to be given out to influential people without consulting the local communities and sometimes without following the due process.

Another issue that could fall within this bracket is the failure to provide up-to-date and accurate, environmental information to rural communities to enable them to effectively participate in decision making. Examples here include consultations about large projects that are likely to have significant environmental impacts and also where prior informed consent is required for extraction of biological resources. Mechanisms that have taken community concerns into account have tended to be weak and exploitative. Questions have, for instance, been

Box 9.5: Chemical spill in Kipevu, Mombasa

On 14th February, 2008 a consignment of two containers carrying 80 barrels of 68 percent concentrated nitric acid, weighing 200 kg each were cleared and left Mombasa port for delivery to a consignee in Uganda. Later the same day, the Kenya Ports Authority (KPA) was called in to remove one container from a lorry as it was found to be leaking. It was subsequently placed on the road side for stripping and replacing of the damaged barrels.

Two weeks later a report was filed with NEMA from an anonymous caller reporting a leaking container abandoned at the roadside. After assessing the scene, NEMA, through the Coast Provincial Director of Environment mobilized a Nairobi based firm to neutralize the chemical and clean up the scene. According to a report on the incident by NEMA, investigations pointed out that the stripping operation was abandoned when the leakage became uncontrollable. The scene was strewn with barrels and the acid flowed freely down a drain into the Kalahari informal settlement next to the road. A report by the Kilindini District Medical Office stated that 64 people had been adversely affected by the contamination of nitric acid. Reports of various degrees of injuries to human health as well as domestic animals were also filed with the police and widely reported in the media.

A legal suit was initiated by the Mombasa Municipal Council's department of Public Health seeking legal redress for nuisance in contravention of the Public Health Act. Charges were preferred against the perpetrators who pleaded guilty and were fined Ksh 5 000 which was promptly paid. Clearly, the fine was not commensurate to the damage to human health and the environment and in normal circumstances this should have been filed as a class action suit. To date, no compensation has been offered to the affected persons and no measures to rehabilitate the scorched environment have been undertaken.

raised about the location of garbage dumps within or close to poor neighbourhoods.

Access to legal representation and redress for environmental disasters has also been a recurrent challenge. Despite the best efforts by the judiciary, the State law office and the National Environment Tribunal, it is difficult for poor citizens or local communities to obtain proper representation in environmental matters. The rules of procedure are quite complex and intimidating. There is need for further simplification of these procedures and to make the legal environment less intimidating to the general citizenry.

Environmental disasters such as oil spills and fires that result from poor handling of chemicals have been witnessed in various parts of the country yet no reparations have been paid to the affected local communities. Box 9.5 discusses the Kipevu chemical spill disaster. Another thorny issue has been compensation for deaths and injuries to humans or damage to crops and property occasioned by wildlife.

Opportunities for enhancing environmental justice

Building capacity in the judiciary

To further strengthen environmental justice in the country there is need to continually build capacity of both the bar and the bench on environmental legislation. There is also need to sensitize local communities on their rights particularly the raft of rights that are enshrined in the new Constitution. It is difficult to see how Kenya will, for instance, attain MDG7 on environmental sustainability without ensuring environmental justice.

Both the county and national governments have the onerous task of fulfilling the mandates entrusted to them by the new Constitution. The provisions on the regulation of land use and the roles of the national land commission have far reaching implications on the management of land as a resource and the challenge is for the state to ensure that the enabling regulatory and institutional framework is in place within the timeframes set out in the Fifth Schedule of the Constitution.

Another challenge arising from enactment of the new constitution is the devolution of governance to the county governments. These are expected to take over responsibilities initially exercised by local authorities in addition to assuming some responsibilities initially exercised by the national government. As such, these county governments will have jurisdiction over a significant proportion of environmental affairs set out in the Fourth Schedule including:

- Agriculture (crop and animal husbandry, plant and animal disease control, fisheries; refuse removal)
- Control of air and noise pollution,
- County planning and development
- Implementation of specific national government policies on natural resources and environmental conservation (including soil and water conservation; and water and sanitation services).

Because the county governments will be new, it will be important for the national government to provide technical support to the counties from the outset in order to avert environmental catastrophes.

Conclusion and recommendations

Unless well managed, Kenya's economic development path that is envisaged in Vision 2030 is likely to generate considerable environmental pressure. This pressure will be exacerbated by Kenya's rapidly growing population. In such a situation, the emerging issues discussed in this chapter could worsen. New pressures may also emerge while old issues could also take on new dimensions.

Measures to address new and emerging environmental issues along the following recommendations should be developed and implemented:

- **Policy measures that encourage investment in incinerators should be developed and implemented in order to increase access to the service by all the country's healthcare facilities**
- **Material recovery and re-use especially of electronic equipment needs to be promoted** to reduce the e-waste load
- **Proper documentation and quantification of waste** including e-waste should be promoted in order to ensure better risk management, proper disposal and better allocation of management responsibilities
- **A well coordinated and integrated waste management system should be developed** and implemented to improve solid waste management, reduce pollution loading of water systems and forestall the risks of lake eutrophication, water quality degradation and lower the high costs of waste management
- **Government should adopt and align national economic development priorities with the concept of the green economy.**

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Eugene Apindi Ochieng

PART 4
ENVIRONMENTAL GOVERNANCE — NOW AND IN THE FUTURE

CHAPTER 10
KENYA ENVIRONMENTAL FUTURES: PATHWAYS TO REALIZING VISION 2030 AND BEYOND

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Introduction

Background to environmental scenarios

The challenges of environmental management such as degradation of ecosystems, climate change, biodiversity loss and unsustainable natural resources use have long-term implications which require long-term policy solutions. To make informed strategic decisions and actions, it is desirable to anticipate the future trends in the state of the environment. This is better done by understanding the ongoing, emerging and latent developments that will drive the future. By exploring more than two development planning and legislative cycles, we are better able to explain the long-term costs of our actions on the environment. Tools that offer an insight into the future (like environmental scenarios and outlooks) help to explain the discontinuity and uncertainties of future developments (Alcamo 2008, Raskin 2005).

Scenarios are consistent and coherent descriptions of alternative hypothetical futures that reflect different perspectives on past, present, and future developments, which can serve as a basis for action and a means of handling uncertainty (van Asselt et al 2007). Contemporary scenario practise varies and is indicated by a wide range of use in many aspects of socio-economic development, including environmental assessment. Environmental scenario analysis is becoming a commonly used approach for supporting forward-looking assessments in integrated environmental assessments. They offer a framework for bringing together insights from a range of perspectives and disciplines to assess the complex interactions between socio-economic and environmental developments (Alcamo and Henrichs 2008, Börjeson et al 2006). In doing so, scenario exercises provide a structure within which to reflect on and think through the possible implications of alternative decision pathways, bringing expert knowledge and stakeholder perspectives to bear. Indeed, environmental scenario analysis has become one of the key tools for bridging environmental science and policy. Well-thought out scenarios are therefore vital to sensitizing the breadth of actors about potential risks or critical thresholds, to eliciting positive paradigm shifts (Jäger et al 2007), identifying the drivers and symptoms of emerging trends and to prioritizing policy formulation or adaptation in order to achieve desired outcomes such as delivering the Vision 2030 promises.

Many recent international assessments have conducted high-profile scenario exercises to combine the latest understanding of environmental research with society's concerns about environmental changes. For example, many assessments regarding climate change (IPCC 2007), the future of ecosystem services (MA 2005) or the interplay between environment and development (UNEP 2006 and 2007) have been undertaken. Further, at national and regional levels, a host of environmental scenarios have been developed and analysed, and many current environmental outlooks make use of scenario analysis. A growing number of countries in Africa now include scenario analysis as part of their environment outlook reports (UNEP 2007). They are no longer developed and applied on an ad hoc basis, but have become an integral part of state of the environment reporting in order to inform policy option formulation and assessment.

A process-oriented environmental scenario development procedure functions to promote: learning, communication, and the improvement of observational skills (De Vries and Petersen 2009). It seeks to inform resource users and policy makers by deciphering the often confusing overload of information and integrating possible future events and developments into consistent pictures of the future (Zurek and Henrichs 2007). Making sense of the future in this way can challenge mental models and prevailing mind-sets, and can involve learning from the past and investigating fundamental uncertainties about the future. Product-oriented environmental scenario studies are more concerned with the nature and quality of the output than with how it was arrived at. They function to: identify driving forces and signs of emerging trends, policy development, and to test policy. Scenarios can be used to identify and prioritize the dangers and opportunities in emerging environmental states, trends and processes. The signs of these are sometimes referred to as 'weak signals', 'early warnings', 'seeds' or 'traces'. Scenarios may also be a tool for evaluating decisions and testing policy options by doing 'practise runs' of possible future situations which indicate the possible effects of decisions.

The aim of conducting scenario analysis is to attempt to anticipate possible consequences of current developments and options to either prevent, counter, prepare for, enhance or benefit from future changes —and to better understand the implications of the uncertainties that surround our assumptions about how the future may unfold (Girod et al, 2009, Grooves and Lampert 2007). According to Jäger et al 2007, scenarios aid in:

- Recognition of 'weak signals' of change
- Avoiding being caught off guard by 'living the future in advance'
- Challenging 'mental maps'
- Raising awareness about future risks or critical thresholds
- Testing strategies for robustness using 'what if' questions

- Providing a common language by, for instance, unveiling different perceptions and beliefs
- Stimulating discussion and creative thinking
- Providing better policy or decision support, and
- Stimulating engagement in the process of change.

The purposes of undertaking any environmental scenario exercise fall into three overarching clusters: research and scientific exploration, education and public information, and decision support and strategic planning.

Objectives of Kenya SoE scenarios

The objectives of conducting outlook scenarios for the Kenya state of the environment process were to:

- Follow through the emerging issues, challenges and opportunities presented by the natural resources that are of socio-economic importance
- Identify and track changes in key environmental drivers in order to isolate major thresholds and tipping points for negotiating tradeoffs that would inform policy and environmental management at different scales
- Track progress, under different pathways, towards the realization of key development outcomes including MDGs, the Vision 2030 national development goals and other related environmental targets like the NEPAD environmental action plan for 2020
- Perform sensitivity analyses of alternative policy options in order to generate a range of policy actions that would fast-track progress towards key environmental goals, and
- Create awareness among key stakeholders especially policy makers and local communities on salient environmental management options as well as the costs and benefits of alternative environmental management schemes.

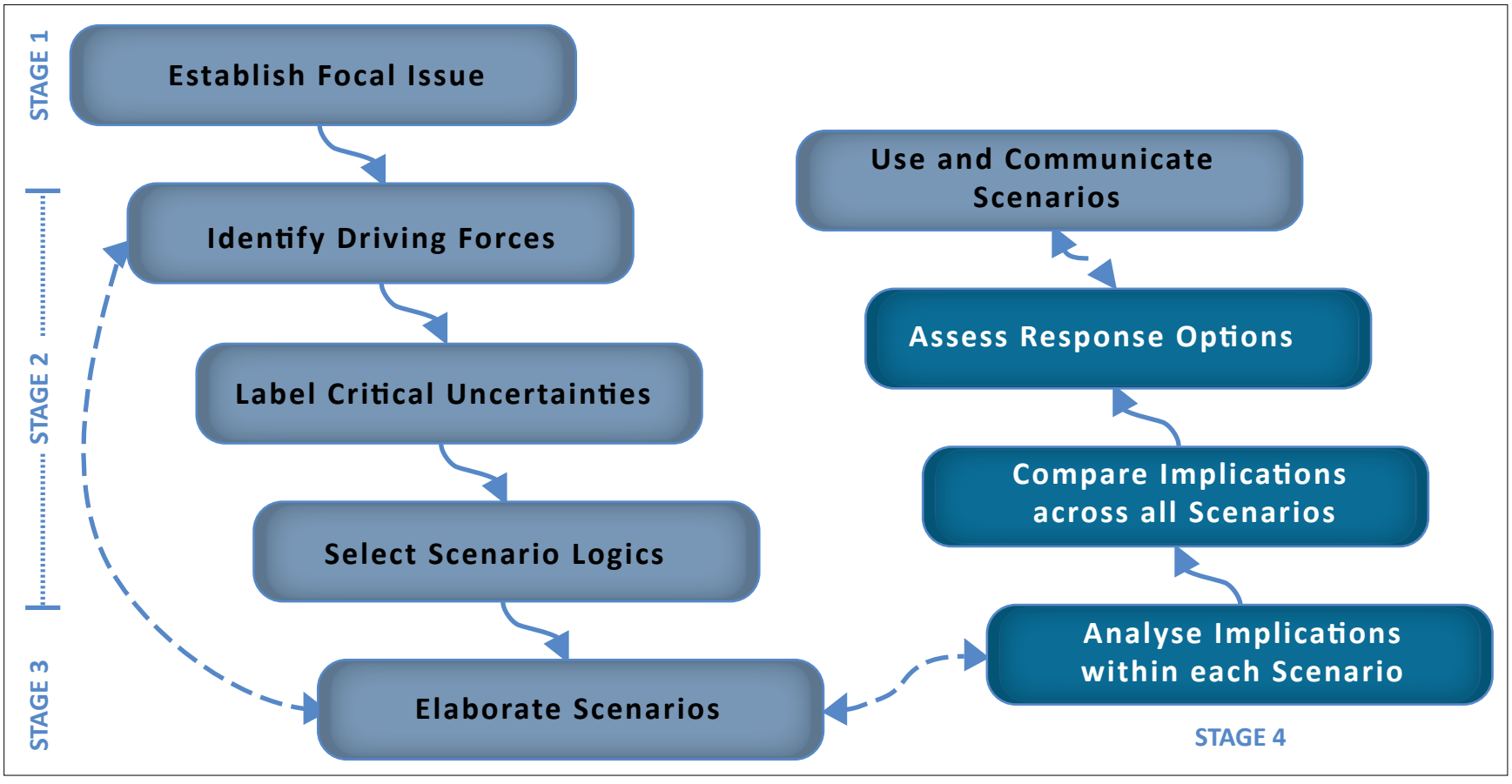
Process of building the scenarios

This SoE report adopted a deductive scenario analysis approach depicted in Figure 10.1.

As part of the scoping process to identify the scenario focus and foundation, the participants established 2030 as the temporal scale in line with the Vision 2030 targets. They also agreed to capture major socio-economic development milestones including the MDG target year of 2015 and the NEPAD environmental action plan target year of 2020. Key drivers including demography, economic development,

Figure 10.1: The four-stage scenario analysis adopted for production of Kenya environmental scenarios

Source: Adapted from Alcamo and Henrichs (2008)



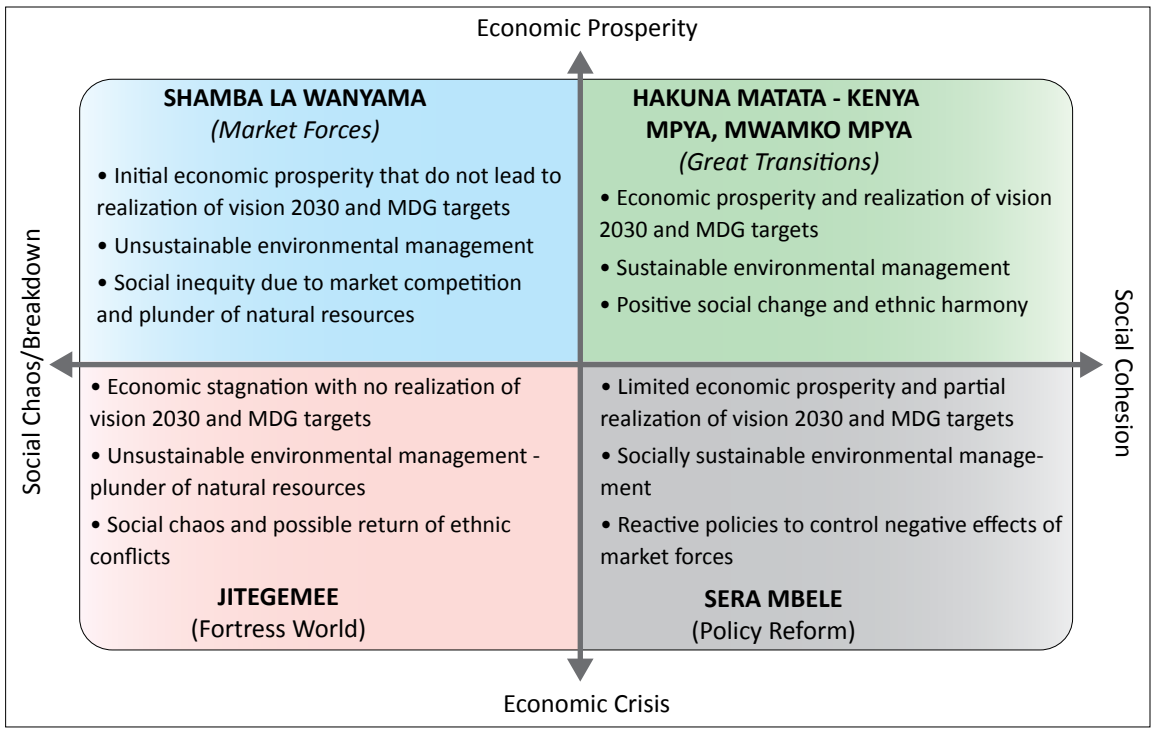


Figure 10.2: Scenario logic for Kenya's environmental futures

social change, culture and tradition, technology, environment as well as climate change and governance were identified and explored as antecedent factors that would effect change in Kenya's environment towards 2030. By focusing on the most important but least certain environmental drivers (the critical uncertainties namely economic development and social change), the scenario logic in Figure 10.2 was created to define the scenario exploration framework and logic.

Realizing Vision 2030

The government has over the past few years recognized that short-term strategies have to be put in the context of long-term development planning. Environmental changes are largely long-term and must be overlaid on the broader socio-economic development landscape. Vision 2030, whose primary goal is to transform Kenya into a globally competitive and prosperous nation, was launched in 2007 and has become the reference point for all government policy activities including those on the environment. Central to this effort has been a reconsideration of the manner in which the state engages in development policy and, which models of development to emulate.

The environmental scenarios in this chapter will be used to provide stakeholders with key lessons from plausible development pathways. These scenarios are pegged to the 2010-2030 temporal scale and use the aspirations of Vision 2030 as targets to measure the impact of environmental action over this period.

Environmental concerns are mainstreamed into programmes and activities that underpin Vision 2030's social, economic and political pillars (GoK 2007). This development philosophy takes cognizance of the emerging global and national environmental challenges including climate change, skewed land distribution and environmental degradation in rural and urban areas. Soil erosion and loss of soil fertility resulting in lower yields for rain-fed agriculture, deforestation, encroachment into forests and reserves, and settlement and agriculture on important wildlife corridors and dispersal areas are examples of the challenges that require urgent attention if the Vision 2030 aspirations are to be realized.

This chapter provides various options for tackling the environmental challenges that have been highlighted throughout the document. It takes a positive approach by presenting alternative pathways with differing solution sets and laying out opportunities for entrenching progress towards the various development targets. These include tradeoffs for avoiding pitfalls along the way. The chapter underscores the principle of Vision 2030 which is that the country should embark on a broad environmental programme aimed at conserving watersheds, terracing fragile agricultural lands, managing invasive alien species, and reforesting both public and private land. Taking note of the lessons provided will offer opportunities to reengineer action towards Vision 2030.

Overview of the scenarios

The scenarios are couched in Kiswahili (which is Kenya's only national language and is alongside English, one of country's official languages) and range from *Shamba la wanyama* (Kiswahili for 'animal farm'), *Sera mbele* (which literally translates as 'policy first'), *Jitegemee* ('you are on your own') which is the most pessimistic scenario and *Hakuna Matata, Kenya mpya—mwamko mpya* ('no problem, new Kenya—new beginning') which is the most optimistic scenario.

Shamba la Wanyama

This is a national reflection of the Market Forces scenario in the Africa Environment Outlook (AEO) (UNEP 2006). It assumes a continued emphasis on profit-making and exploitation of key environmental assets. In this scenario, competition and market trends dictate the pace of environmental utilization. Since government structures do not support controlled exploitation of natural resources, plunder and social chaos result with far-reaching implications on socio-economic inequity and resource-driven conflicts. The scenario has the following key attributes:

- Inequity and inequality in access to ecosystem goods and services
- Overexploitation of natural resources driven by profit goals
- Disempowerment of communities and gender inequality
- Poor provision of social services
- Increased globalization and privatization

Sera Mbele

In this scenario, the government and other actors put in place reactive policies and regulations in an attempt to reverse the negative effects of uncontrolled market-driven exploitation in the *Shamba la Wanyama scenario*. These policies are primarily top-down in nature and thus fail to entrench participatory conservation. They do not lead to the establishment of sustainable and equitable environmental management institutions. The efforts are too little too late. This scenario mirrors the Africa Environment Outlook's Policy Reform Scenario and is symbolized by the following attributes:

- Cohesive society working in unity
- There is ownership of environmental protection irrespective of social class

- High level of environmental compliance and enforcement regulations
- Presence of powerful groupings and political parties that are pro-conservation
- Little resource exploitation since local entrepreneurship is not dynamic and vibrant
- Sluggish economic growth
- Controlled economy

Jitegemee

The basic assumption in the *Jitegemee Scenario* is a total breakdown in social systems coupled with unprecedented economic crises. In this world, a select elite group of individuals, communities and institutions take control of the lion's share of national environmental assets at the expense of the majority for their own selfish economic gains. There occurs wanton plunder of natural resources, a drastic increase in environmental degradation and escalation of poverty and environmental conflicts. In this most pessimistic scenario, the future of Kenya is characterized by inefficient institutions, and a failure to address environmental degradation, slow economic growth, unemployment and poverty. The political dilemma is characterized by poor policy formulation and weaknesses in the oversight institutions. In this scenario Kenya slides systematically into an 'abyss of underdevelopment and hopelessness.' The assumptions are similar to those guiding the AEO Fortress World Scenario and are characterized by the following:

- Poor infrastructural development
- Inability to adapt to climate change and manage its impacts on society and the environment
- Economy controlled by a few people
- Inequity and insecurity
- Negative ethnicity
- Low life expectancy
- Massive plunder of environmental resources occasioned by impunity
- Poorly functioning public institutions for supporting agriculture and market development
- Unfavourable market barriers (internal and external) and poor market infrastructure
- Policy environment that stifles innovation in both rural and urban economies.

Hakuna Matata, Kenya mpya—mwamko mpya

A new renaissance of Kenya is assumed in this scenario which would see the country meet all the MDG targets, realize the Vision 2030 aspirations and sustainably manage its environmental assets. The assumptions are akin to those underlying the AEO Great Transitions Scenario (UNEP 2006). As a result of carefully thought out policies and institutional arrangements, the environment is fully mainstreamed in national development planning. Well-functioning public institutions support environmental management, agriculture and market development. Market barriers are reduced, infrastructure improved and the prevailing policy environment facilitates environmentally sensitive innovation in both urban and rural economies. The impact of climate change is adequately addressed through low carbon growth, vibrant adaptation strategies and technologies. This is the most optimistic scenario and Kenya witnesses political, social and economic reforms in line with the Vision 2030 aspirations. The policy and institutional environment is characterized by functioning institutions, policies and a strong regulatory environment that is able to address issues to support economic growth and environmental sustainability. Under this scenario, the Economic Recovery Strategy for Wealth and Employment Creation is fully and successfully implemented and the following prevail:

- Increase in agricultural productivity and sufficiency in food supply accompanied by environmental benefits due to less pressure on land and other resources
- Vibrant economy with the majority of households able to produce, eat, save, and invest in a clean, secure and sustainable environment
- Enhanced equity and wealth creation opportunities for the poor
- Laws, institutions and systems working at their optimum
- Positive social change with social cohesion and positive ethnicity
- Environmental governance is at the centre of development planning at the national and devolved levels

Grazing wildebeest.

Curt Carnemark / World Bank

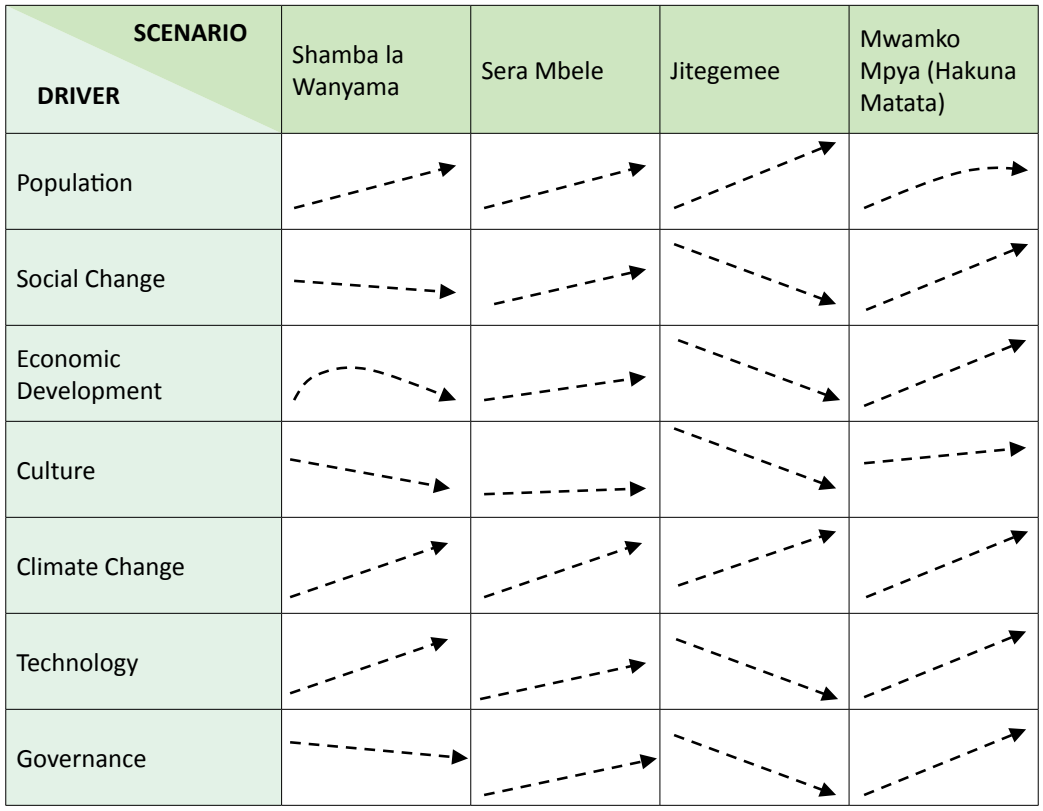
Driver	Elements/Issues
Demography	Total population size, growth rate, mortality rates, fertility rates, spatial distribution, population structure, rate of urbanization
Economy	GDP, infrastructure, growth rate, per capita income, poverty index, equity, wealth distribution, industrialization, trade, markets, inflation
Social change	Literacy and illiteracy levels, education, household sizes, gender, social cohesion, social services, change in dietary habits/ lifestyles/consumption patterns, globalization
Culture	Indigenous knowledge, language and ethnicity, religion, traditional protection, sacred sites, cultural practices, traditional beliefs, taboos, values
Climate change (and variability)	Weather extremes (floods, drought), change in rainfall patterns, length of growing period, species relevance, alien and invasive species, change in disease trends, livestock deaths, national, regional and international negotiation processes, tidal changes
Technology	ICTs, environmental management technologies, clean development mechanisms (CDM), technology transfer issues, early warning systems, indigenous traditional knowledge, outreach and dissemination
Governance	Political will, policies (policy nesting), poor negotiation skills, environmental governance capacity, accountability, corruption, integrity, nepotism, institutional structures/frameworks, compliance and enforcement, access and benefits, leadership, community based management, transboundary resource management, popular participation, discourse, disclosure, financing environmental management/ mainstreaming

Table 10.1: Drivers of environmental change in Kenya

The scenario drivers

The Kenya SoE process identified seven major drivers of environmental change, namely: demography, economic development, social change, culture, climate change, technology and governance. The elements of these drivers that are highly likely to influence environmental change are summarized in Table 10.1 while Figure 10.3 presents a summary of the qualitative assumptions of these drivers by scenario.

Figure 10.3: Qualitative assumptions of key drivers of environmental futures



Demography

Demography is one of the main drivers of environmental change. The subsequent paragraphs will highlight how the different elements of demography are expected to evolve under the different scenarios. Each of the other drivers will also influence environmental change in different ways and to differing extents.

The population stood at 38 610 097 million in 2009 (KNBS 2009) and is growing at 2.9 percent per year. At this rate, the country's population is expected to increase and will likely reach 70.4 million in 2030, exerting more pressure on the environment. The difference in the impact of population change will vary depending on the extent to which population, environment and health are integrated in development planning. Only under the *Hakuna Matata Scenario* will the anticipated wide range of environmental problems be managed despite the population increase. With approximately 20 percent of the land surface suitable for cultivation, a rapidly growing population will continue to put tremendous pressure on land and water resources. Furthermore, continued deforestation, loss of natural habitats, and illegal poaching would escalate as the population increases especially under *Jitegemee* and *Shamba la Wanyama scenarios* leading to a decline in most wildlife species in the country, including large mammals such as the African elephant, rhinoceros and wildebeest.

Population distribution is expected to remain uneven under all the scenarios. The patterns will be linked to the agricultural potential of the land and hence regional population densities will become more pronounced. The pace of rural-urban migration is expected to be stepped up under the *Jitegemee Scenario*. Inter-censal population growth rates are likely to decline systematically under the *Hakuna Matata Scenario* from the current 2.9 to under 2 percent by 2030. Additionally, total fertility rates will continue to fall in this scenario. Such a rapidly increasing population is expected to limit the government's ability to satisfactorily provide social services and invest in productive sectors, create employment and deal effectively with serious environmental concerns. In all scenarios, except the *Hakuna Matata Scenario*, if climate change results in reduced precipitation in Kenya, then the area of land classified as arid and semi-arid would increase while the high potential land would diminish. Consequently, the existing population would have to rely on a constricted resource base. This might increase migration to urban areas, result in environmental degradation, deforestation for settlement and wood fuel. Increased numbers of migrants to urban areas would further stress urban facilities beyond their carrying capacities in terms of provision of water, education, health, housing, energy and transport.

The environment towards 2030

This section is an integrated assessment of three sectors under the different development pathways highlighted in the earlier section. These are land, agriculture and livestock; freshwater, marine and coastal resources; and biodiversity.

Integrated assessment of alternative pathways

Land, agriculture and livestock

Under the *Shamba la Wanyama* scenario, the anticipated exponential increase in population, which stabilizes towards 2030, occasions the fragmentation of arable land, diminishing available agricultural land per capita and leading to widespread soil and rangeland degradation, land cover changes and conversions especially in livestock concentration areas. Social systems including the provision of services such as health, education, security, extension services and water provision are weakened, making it harder to meet the targets of Vision 2030's social pillar. This contributes to decreased productivity from agriculture and livestock and frequent conflicts over natural resources such as grazing areas, watering points and forest reserves. Other developments towards 2030 which are occasioned by these trends include a decline in the economic growth rate towards 2030 due to the weakening social systems and fluctuations in the international oil and food prices and erosion of cultural practises which cannot compete with more profit-driven approaches. This contributes to a rapid decline in species, genetic and ecosystem diversity. A major contributor to this state especially after 2020 is poor leadership, institutional structures and policies, an increase in corruption, nepotism, negative ethnicity and unsustainable management of land and water resources.

Under the *Hakuna Matata Scenario*, Kenya's land resources are sustainably managed owing to availability of skilled labour, increased agricultural and livestock production through increased uptake of technologies and markets for agricultural produce and livestock products. In 2030, there is a marked reduction in resource-based conflicts and land degradation due to increased environmental awareness and the increased use of sustainable land management practises. Systematic policy review, reform and changes between 2010 and 2025 address the gaps in the scenario. These efforts also target the agricultural institutions that provide services to farmers such as extension, training, research and regulatory services ensuring that they serve farmers efficiently and more cost effectively. Additionally institutional, legal and regulatory reforms encourage individual farmers to shift from subsistence to market-oriented production, and to adopt modern farming practises. Similar successes are not possible in both *Jitegemee* and *Sera Mbele scenarios* in which there is likely to be an increase in land fragmentation and diminishing agricultural land per capita and degradation.

Freshwater, coastal and marine resources

As 2030 approaches, the *Hakuna Matata scenario* witnesses increased access to improved water and sanitation because of favourable conditions for water resources management and development. By 2030, there is a 25 percent expansion of irrigated land for food security and commercial farming with the pace of degradation (pollution, overuse, destruction and deterioration) of water and coastal marine resources being brought under control. The achievements are largely due to effective implementation of the national policy on water resources management and development. The policy, based on the Sessional Paper No. 1 of 1999, was reformed early after 2010 to ensure efficient mobilization of resources for water resources management and development. The implementation of the policy was well coordinated and regulated with participation of all water sector actors. The economic boom after 2020 supported investments required for the infrastructural development for water storage and for water schemes to improve water accessibility. Restoration and community based coastal management also benefit from the policy reforms bolstered by better governance at all levels. These enable the implementation of the principle of integrated water resources management (IWRM) as well as integrated coastal and marine resources management (ICMRM) allowing the following to be achieved or consolidated:

- Effective river basin management systems and water conservation programmes
- Clearly defined support roles and functions of various water actors at all levels
- Integrated Water Resources Management (IWRM) approaches to help reduce competition and conflict among water uses and users
- Strengthened legal framework through a review of the current law (Water Act 2002), policy and various strategies to harmonize them with prevailing and future aspirations and goals including the new Constitution
- Water projects that are undertaken in an environmentally sustainable manner
- An end to water degradation (in terms of pollution and overuse)
- Water resources assessment and monitoring, research and information systems are in place
- Financing mechanisms for the water sector are instituted
- An increase in access to water from the current average of 59 to 100 percent is recorded by 2030, meeting the relevant social pillar goals of Vision 2030. Access to sanitation likewise improved to 100 percent from the current average of 31percent.

Under the current trajectory, the national water endowment is expected to decline from the current level of 548 m^3 to about 235 m^3 per capita per annum by 2020. This is likely to occur under the *Jitegemee* and *Shamba la Wanyama scenarios*. The reduction in national water endowment is expected to be slightly halted under *Sera Mbele scenario* but efforts could still fail to halt the decline after 2025. The decline would be effectively altered under *Hakuna Matata scenario* as the Vision 2030 flagship projects in the water sector are fully implemented and a national master plan for intensive large-scale and small-scale irrigation is rolled out in 2012. Economic exploitation of rivers, lakes, rainwater and ground water resources are realized by 2020 with a resulting significant reduction in the cost of water resources degradation.

Water Resource Development Outcome Indicator	2009	2015				2030			
		S1	S2	S3	S4	S1	S2	S3	S4
Urban households with access to piped water (per cent)	61.0	65.0	67.5	60.0	75.6	65.0	70.0	45.0	94.5
Rural households with access to water from a protected source (per cent)	42.0	48.0	52.0	40.0	65.3	47.0	59.0	25.0	89.2
Water storage per capita (m^3)	5.3.0	6.3	7.5	5.2	17.5	8.2	14.5	5.0	24.0
Urban households with individual or shared access to sewerage facility (per cent)	32.0	47.0	52.3	29.0	58.0	55.0	60.4	25.0	87.0
Rural households with individual or shared access to sewerage facility (per cent)	6.0	8.5	15.0	4.0	45.0	12.5	25.0	3.0	78.0
Hectares under irrigation for food production ('000)	123.2	142.0	176.0	122.0	375.0	175.0	224.5	115.0	445.0

Table 10.2: Projected outcome indicators of water resources development in 2015 and 2030 in each scenario

Key to scenario labels: S1 (shamba la wanyama), S2 (Sera Mbele), S3 (Jitegemee), and S4 (Hakuna Matata – Kenya mpya, mwamko mpya)

Note: Computed in MS Excel macro-based model according to Vision 2030 flagship projections and scenario population and economic growth assumptions

Under the different scenarios, the levels of achievement of water resources development outcomes are likely to change as shown in Table 10.2. This will occasion varying daily water demands by sector as shown in Figure 10.4.

Biodiversity

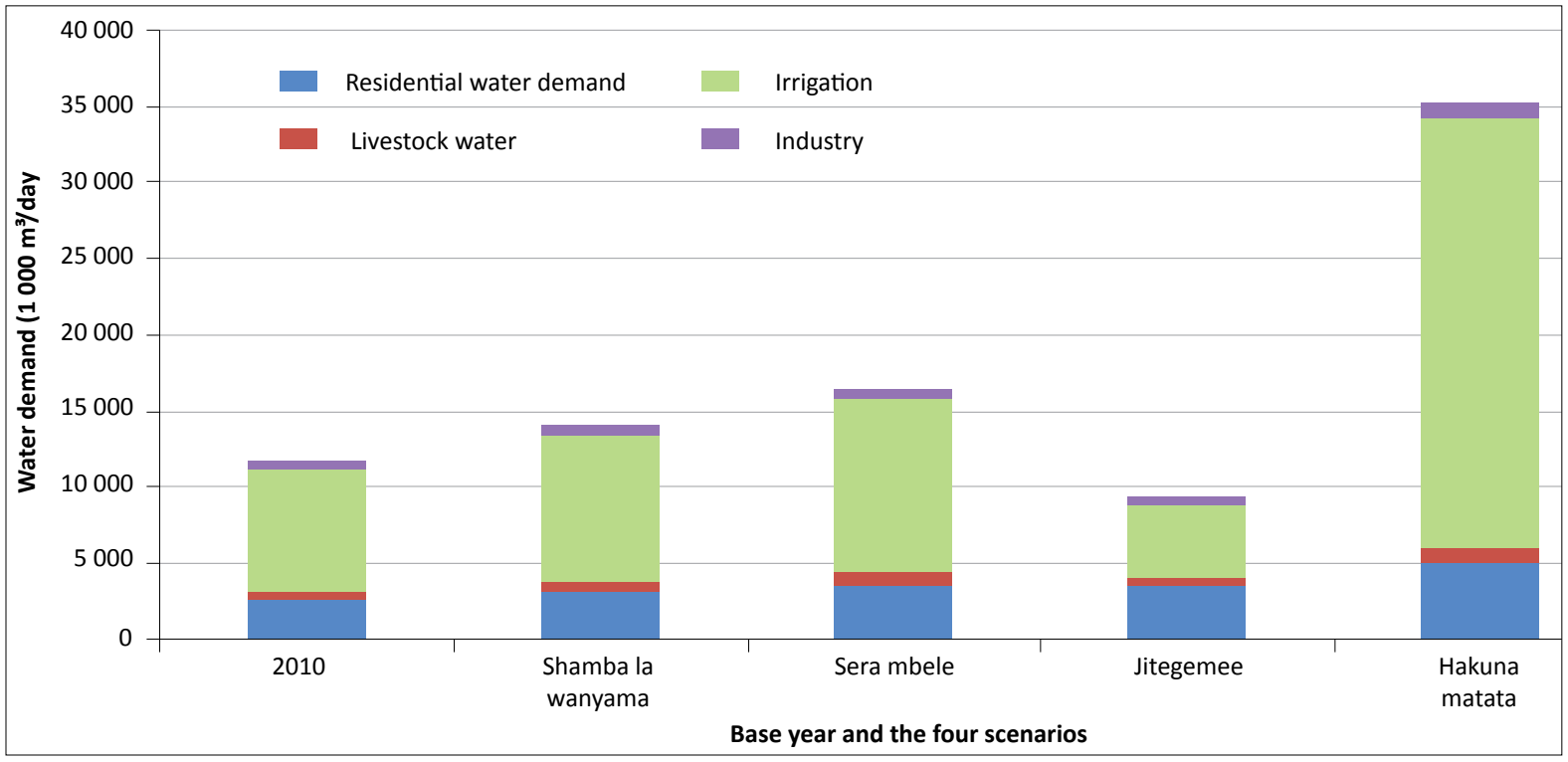
The challenge in all scenarios is to design, implement and monitor the large scale conversion of forest reserves, pastures and croplands, and effectively manage climate change impacts or invasive alien species. The loss of biodiversity would be critical under *Jitegemee* and *Shamba la Wanyama scenarios* owing to a breakdown of regulatory systems with some species projected to decrease in abundance or decline in their ranges with a possible substantial increase in the risk of extinctions. The efficient management or otherwise of land use change, river flows, freshwater pollution and exploitation of marine resources are expected to drive biodiversity change. However, climate change will be the definitive factor; and how its impacts are managed will ultimately determine the fate of biodiversity under all scenarios.

Developments under the *Hakuna Matata Scenario* present an optimistic outlook but would require fundamental changes in development paradigms within the known constraints of economics, resource use and national development goals. This would have to take into account the fact that Kenya's biodiversity is complex and that most of it occurs outside protected areas where it faces the highest ecological threats.

Many global (GLOBIO3) and local projections of changes in biodiversity show continuing and, in many cases, accelerating species extinctions, loss of natural habitats, and changes in the distribution and abundance of species and biomes over the next few decades. In Kenya, a combination of changes in land use, exploitation of forests and marine resources, climate change and eutrophication are highly likely to be the key drivers of biodiversity change towards 2030 and beyond. The four scenarios would therefore have varying changes and trends in the distribution and abundance of species, species groups and biomes. Some of these transformations would involve the main protected areas and marine and fresh water bodies.

By 2015, under the *Hakuna Matata Scenario*, the country finds lasting solutions for dealing with current invasive alien species. Examples include the common carp (*Cyprinus carpio*) which, left unchecked, could cause loss of local species of fish and invertebrates

Figure 10.4: Differential daily water demand in 2030 in different environmental scenarios



A cleared section within the Mau Complex: If allowed to continue, forest encroachment will negatively affect the attainment of Vision 2030 targets.

especially in Lake Naivasha. The water hyacinth (Eichhornia crassipes) is another species whose rapid spread in Lake Victoria is left unchecked in *Jitegemee Scenario* and could cover up to 25 000 ha of the water body with increasing fisheries and navigation losses. A cross-scenario assessment reveals that forest cover in 2030 would mainly persist in the current forest reserves. However there is likely to be marked farm-level afforestation improvement to nearly 10 percent of small holder farmland in the *Hakuna Matata Scenario* (comparable to estimates by Ogweno et al 2009). The highest deforestation is under *Shamba la Wanyama*. The mean species abundance values would decrease from 0.5 in 2010 to under 0.2 in 2030 for the *Shamba la Wanyama*, *Jitegemee* and *Sera Mbele scenarios*. In addition, the estimated area with a high threat to biodiversity obtained from simulated Kenya land use maps (GRID-Arendal) would increase two-fold in these scenarios. Conservation measures put in place between 2010 and 2015 under *Hakuna Matata Scenario* minimize the impacts of deforestation on biodiversity.

The challenges and achievements towards 2030

Under the *Hakuna Matata Scenario*, a positive trend in social change is anticipated. The sustainable development envisaged through this scenario entails improved livelihoods indicated by good health, decreased mortality and improved life expectancy. This social change will avail equitable social development for holistic human development, better recreational facilities and improved waste management due to the increased accountability of public institutions and officials. The positive trends and vibrancy in economic development create a favourable environment for sustainable fiscal and monetary policies. The stable economy then avails adequate financial resources to support developmental devolution to the counties epitomized by increased industrial and infrastructural development in all regions. This will obviously exert increased pressure on natural resources and increase demand on environmental services but with improved governance, the effects on the environment will be addressed.

To achieve the Vision 2030 goal of transforming Kenya into a middle income country with a high quality of life, emphasis should be put on employment creation, poverty reduction, better income distribution and gender equity. Vision 2030 is founded on the premise of macroeconomic stability, reforms in the governance sector, equity and wealth creation opportunities, infrastructure, energy, science technology and innovation, including human resources development, security and public sector reforms. In the *Hakuna Matata Scenario*, the country zealously implements the provisions of the new Constitution that call for major sectoral and institutional reforms. Major strides will have been achieved with the restoration of the five main water towers: the Mau Forest Complex, Mount Kenya, Aberdares, Mount Elgon and the Cherangani Hills. Reasonable efforts are also made in the restoration of Nairobi River. In the area of waste management, the notorious Dandora dump site is relocated to Ruai. The scenario envisages economic, industrial and infrastructural growth largely attributable to the counties that were not clearly identified in Vision 2030 although the theme of decentralization was visualized. After 2015, adjustments are made in Vision 2030 to cater for environmental legislative, policy and institutional reforms. In particular, EMCA is amended to provide for the establishment of devolved environment management institutions such as county environment committees and county environment officers.

The MDG targets are realized only under the *Hakuna Matata Scenario*. There is increased environmental sustainability with greater integration of the principles of sustainable development into country policies and programmes. This leads to a reversal in environmental degradation and reduces biodiversity loss by half by 2015. There is also

Goal	Target	Achievement of MDG goal/ target by 2015			
		S1	S2	S3	S4
1. Eradicate extreme poverty and hunger	1a: Halve the proportion of people whose income is less than US$ 1 per day				
	1b: Achieve full and productive employment and decent work for all				
	1c: Halve the proportion of people who suffer from hunger				
2. Achieve universal primary education	2a: Ensure that children will be able to complete a full course of primary schooling				
3. Promote gender equality and empower women	3a: Eliminate gender disparity in all levels of education				
4. Reduce child mortality	4a: Reduce by two-thirds the under-five mortality rate.				
5. Improve maternal health	5a: Reduce by three-quarters the maternal mortality ratio.				
	5b: Achieve universal access to reproductive health				
6. Combat HIV/AIDS, malaria and other diseases	6a: Have halted and begun to reverse the spread of HIV/AIDS.				
	6b: Achieve universal access to treatment for HIV/AIDS for all those who need it				
	6c: Have halted and begun to reverse the incidence of malaria and other major diseases.				
7. Ensure environmental sustainability	7a: Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources.				
	7b: Reduce biodiversity loss, achieving a significant reduction in the rate of loss				
	7c: Halve the proportion of people without sustainable access to safe drinking water				
	7d: Have achieved an improvement in the lives of at least 100 million slum dwellers				
8. Develop a global partnership for development	8a: Develop further an open, rule-based, predictable, nondiscriminatory trading and financial system				
	8b: Address the special needs of the least developed countries				
	8c: Address the special needs of landlocked countries and small island developing States	N/A	N/A	N/A	N/A
	8d: Deal comprehensively with the debt problems of developing countries through national and international measures to make debt sustainable in the long term.				
	8e: In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries.				
	8f: In cooperation with the private sector, make available the benefits of new technologies, especially information and communications.				

Figure 10.5: Qualitative indications of the degree of achievement of MDG goals and targets under each scenario

*** The colour schemes (ranging from orange: off-target to green: on-target) show qualitative indications of extent of achievement of specific MDG targets for each of the eight goals under the four scenarios – S1 (shamba la wanyama), S2 (Sera Mbele), S3 (Jitegemee), and S4 (Hakuna Matata – Kenya mpya, mwamko mpya)*

an increase in the proportion of people with access to drinking water and a significant improvement in the lives of the informal settlement dwellers. To actualize the achievements, the Vision 2030 department in the Ministry of State for Planning, National Development and Vision 2030 is revamped and adequately funded to monitor and steer the developments. Figure 10.5 summarizes the achievements towards 2015 under each scenario for the MDG targets.

Selected scenarios of emerging environmental issues

Climate change

Projections indicate that by 2020, between 75 and 250 million people in Africa will be exposed to increased water stress due to climate change (IPCC 2007). The IPCC report also notes that by 2020, yields from rain-fed agriculture could reduce by up to 50 percent in some countries. Agricultural production, including access to food, in many African countries is projected to be severely compromised (Parry et al 2007, Ziervogel et al 2008). This is expected to further adversely affect food security and exacerbate malnutrition. Towards the end of the 21st century, projected sea level rises will affect low-lying coastal areas. The cost of adaptation could amount to at least 5-10 percent of GDP. By 2030, the area occupied by ASALs in Africa is projected to expand by 5-8 percent under a range of climate scenarios.

According to SEI (2009), Kenya already has a complex existing climate, with wide variations and very strong seasonality across the country. Regardless of the scenario, this is expected to continue towards 2030. The current projections of future climate change based on downscaled global models for Kenya indicate future increases in mean annual temperature (average monthly temperatures) of 1-3.5 ^{o}C over the range of models beyond 2030 (by the 2050s). The changes in precipitation are anticipated to be most uncertain. Many climate models show that rainfall regimes will change based on the season and region. Extreme events (mainly floods and droughts) are expected to intensify over the scenario period with heavy rainfall in the wet seasons and thus greater flood risks while droughts are likely to intensify in the already affected counties.

The scenario pathways towards 2030 are expected to only diverge based on the strategies the country is putting in place for understanding the economic cost of climate change, designing sustainable adaptation strategies and mainstreaming low carbon growth in all sectors. The specific evolution of these measures across the four scenarios is presented below.

Dust storms are more likely with increasing drought events if climate change is not adequately addressed

Economic cost of climate change across scenarios

It is emerging that existing climate change and variability have significant economic costs. Under the *Jitegemee* and *Shamba la Wanyama scenarios*, periodic flood and drought extremes are expected to intensify and have major macro-economic costs and reductions in economic growth. Additional net economic costs (on top of existing climate variability) could be equivalent to a loss of almost 3 percent of GDP each year by 2030 under these scenarios. The costs include potential threats to coastal zones through the sea-level rise, health burdens, increased energy, land and water demand and loss of ecosystem services. These costs will be best reduced under the *Hakuna Matata scenario* through effective adaptation and mitigation strategies.

The study by SEI (2009) estimates potentially large economic costs from climate change in Kenya if adequate adaptation mechanisms are not instituted. By considering a range of projections and current literature on sea level rise, the SEI analysis shows that coastal flooding from sea level rise is estimated to affect 10 000-86 000 people a year by 2030. The current assessment projects this to happen in all scenarios but with differences in coastal wetland loss and coastal erosion. The associated economic costs in 2030 are estimated to be US$7-58 million per year.

Adaptation to climate change impacts

Although adaptation mechanisms can reduce the economic costs of climate change, as financial resources must be set aside to invest in these, they are not free. The costs of adaptation will be high in all scenarios but the sectoral benefits and tradeoffs will differ. *Hakuna Matata scenario* is expected to usher in a sustainable balance between development and climate change through adaptation. Under all scenarios, the initial estimated cost of addressing Kenya's current climate-related impacts as well as preparing for future climate change is expected to top $500 million per year by 2012. The cost of adaptation by 2030 is expected to increase differentially in different scenarios. The highest estimate is likely to be in the range of US$1-2 billion per year especially under *Jitegemee scenario*. Figure 10.6 shows these indicative costs. The effectiveness of policies in both *Sera Mbele* and *Hakuna Matata scenario*s may reverse this trend through prioritization of early adaptation across the sectors. Adaptation, under whichever scenario, is expected to continue presenting potentially large benefits in reducing present and future damages. Under the *Hakuna Matata Scenario*, the government puts in place adaptation strategies targeting:

- Immediate needs and capacity building including expanded research into the effects, adaptation and economics of climate change. Other areas should include early capacity building and early warning systems, development of a national climate change policy and enactment of a climate change law and screening of sectoral and regional plans for climate risks and adaptation opportunities. Vision 2030 should be reviewed in order to incorporate long-term climate policies. A national climate change adaptation authority should be set up to improve sectoral coordination, link to international finance, support the private sector and enhance links between adaptation and low GHG emissions.

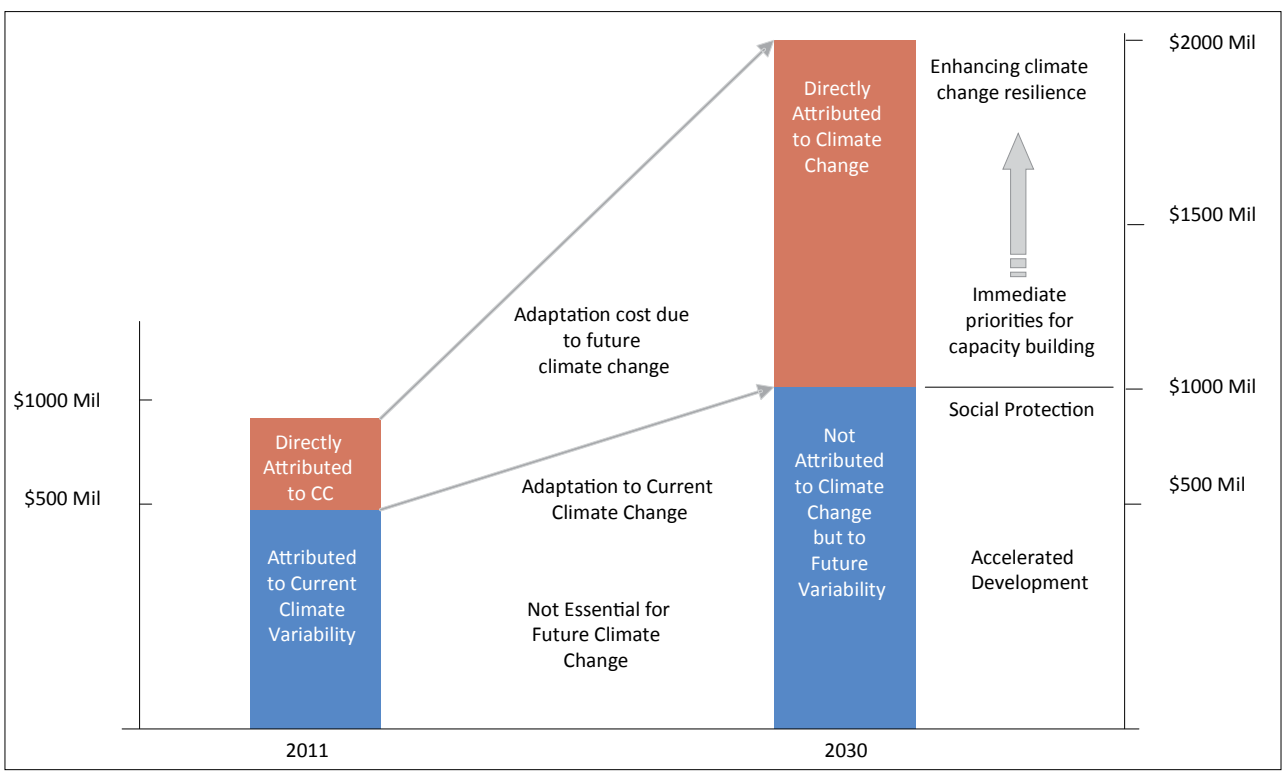
- Climate resilience by designing robust strategies that, for example, link cross-sectoral climate monitoring with exposure, impacts and adaptation actions, enhance knowledge management, health and vector-borne disease responses and institute drought and flood risk screening for new projects. Prototypes of sectoral actions (pilots) and pathways for scaling up to cover all vulnerable regions and populations as well as adaptation costs should also be developed for all scenarios.

- Social protection through cushioning of vulnerable livelihoods and strengthening existing social protection programmes. Such could include mechanisms such as insurance for vulnerable production systems like livestock in the ASALs. Pilot projects of these are discussed in detail in Chapter 3.

- Accelerated development to adapt existing development projects to include 'no regret' measures that reduce climate risks. It should also seize any opportunities to develop adaptive capacity as well as to scale up successful prototypes at the sectoral, national and county levels.

Figure 10.6: Indicative costs of adaptation to current and future climate change

Source: SEI 2009



Disease group	World's lowest country rate	Country rate	World's highest country rate
Diarrhoea	0.2	24	107
Respiratory infections	0.1	13	71
Malaria	0.0	13	34
Other vector - borne diseases	0.0	0.4	4.9
Lung cancer	0.0	0.1	2.6
Other cancers	0.3	0.9	4.1
Neuropsychiatric disorders	1.4	1.7	3.0
Cardiovascular disease	1.4	1.9	14
COPD	0.0	0.6	4.6
Asthma	0.3	1.7	2.8
Musculoskeletal diseases	0.5	0.6	1.5
Road traffic injuries	0.3	3.6	15
Other unintentional injuries	0.6	6.8	30
Intentional injuries	0.0	1.4	7.5

Table 10.3: Global incidence rates of selected diseases

Source: WHO 2009

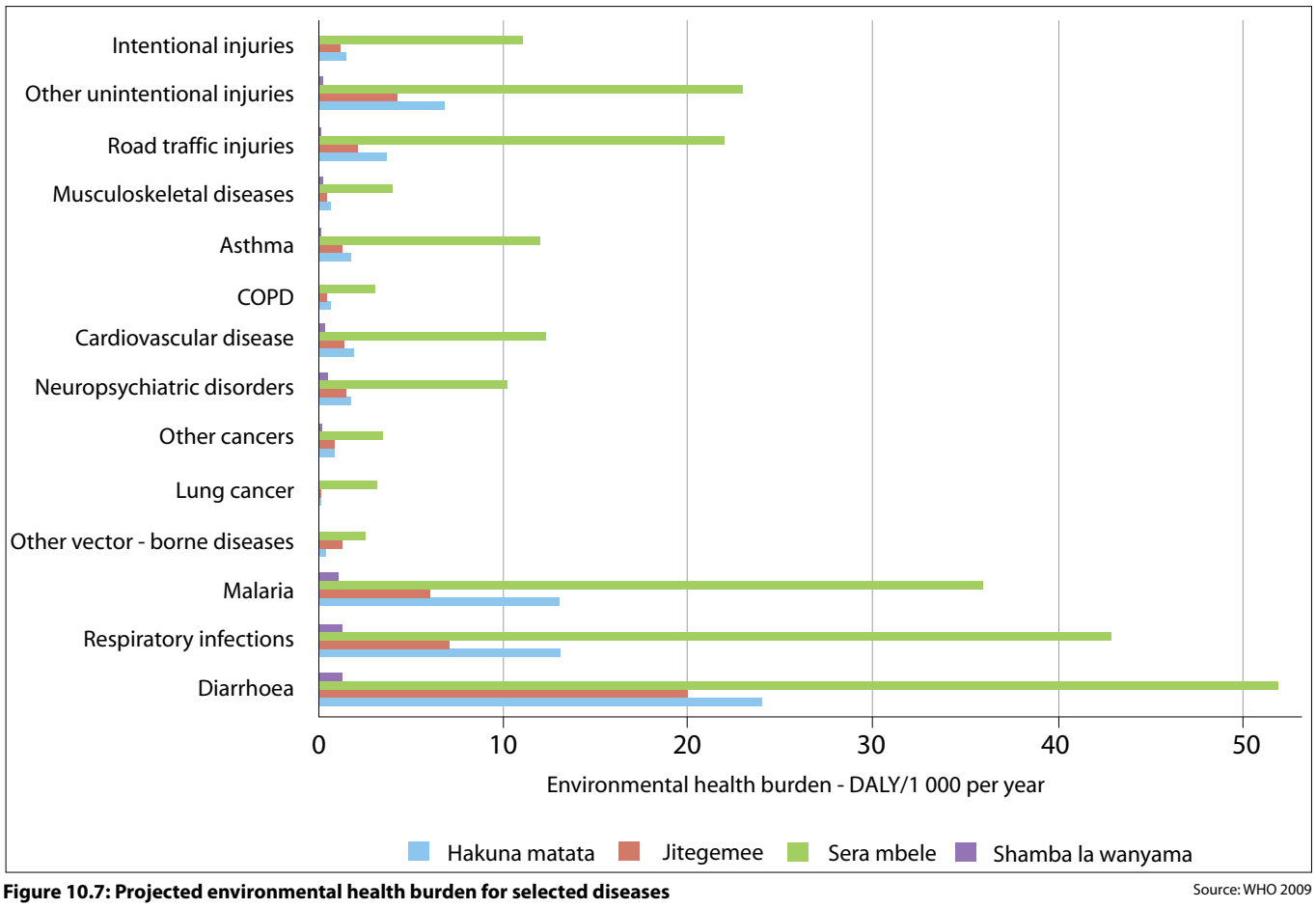


Figure 10.7: Projected environmental health burden for selected diseases

Source: WHO 2009

Engaging a low carbon growth

In both *Jitegemee* and *Shamba la Wanyama scenarios*, future GHG emissions in Kenya could double between 2010 and 2030. Moreover, if the economy is not climate-proofed, the Vision 2030 targets, particularly under the economic pillar, could lock Kenya into a higher emissions pathway. A low carbon alternative pathway is best reflected under the *Hakuna Matata scenario* which envisions 'no regrets' options that would enhance economic growth while enabling Kenya to access international carbon credits. The development pathways in this scenario are also expected to foster economic benefits from greater energy security and diversity, reduced air pollution and reduced negative environmental impacts. There are clear options for this target to enable energy-related emission savings of up to 22 percent by 2020, relative to the comparable figures for 2010. As more carbon credits are incorporated, these savings are expected to grow as 2030 approaches.

These plausible pathways highlight the importance of preparing for current and future climate change and variability. Kenya has a unique location, resource endowment and socio-economic conditions which position her to realize significant economic, environmental and social benefits. According to SEI (2009), pursuing the recommended pathways is in Kenya's self interest as they could stimulate extra investment in the potentially lucrative carbon trading. This would produce real economic, environmental and social benefits, including ancillary benefits of reduced fuel imports, improved air quality, improved energy security, and reduced pressure on natural resources.

Health and environment

Over the next two decades, Kenya's environment will continue to be closely intertwined with human health. As reported in Chapter 8, the environment influences human health in many ways but particularly

Evidence of lack of waste management infrastructure.

through interlinked changes in human behaviour in response to environmental factors and exposure to degraded environments. The current environmental health burden in Kenya is reflected by the fact that 80 percent of hospital attendance is linked to preventable diseases, 50 percent of which are water, sanitation and hygiene-related. Table 10.3 and Figure 10.7 illustrate changes in the environmental health burden as measured by the Disability-Adjusted Life Year (DALY) under the four scenarios.

Only under the *Hakuna Matata scenario* can the country hope to achieve the sanitation MDG which promises to halve the proportion of people without access to basic sanitation by 2015. In both *Jitegemee* and *Shamba la Wanyama scenarios*, major disasters in the country are expected to be exacerbated by climate change and variability and poor environmental policies. The implementation of the recommendations of the Situation Analysis and Needs Assessment (SANA), supported under the Libreville Declaration on Health and Environment in Africa in 2008 (UNEP and WHO 2009), is expected to be most fruitful under the *Hakuna Matata scenario*. This initiative would yield benefits from 2012 after the consolidation of efforts to design guidelines for implementing the SANA national plan of action, completion of guidelines for the development of national plans for the integration of health and environment issues into development plans and policies, and the development of a standardized data management system for health and environment. By 2013 a Health and Environment Strategic Alliance (HESA) will be created as recommended by the Libreville Declaration.

Health related challenges that would continue especially under *Jitegemee Scenario* include food contamination by aflatoxins during prolonged rains. Contamination by pesticide residues on horticultural and other products would only be contained by the sustained enforcement of chemical use standards and awareness campaigns. This can be expected under both *Sera Mbele* and *Hakuna Matata scenario*s. The key emerging health-environment issues that would unfold under the scenarios towards 2030 include waste generation and management and communicable diseases principally linked to poor sanitation and water supply systems.

In all scenarios, waste including plastics, e-waste (a result of the escalation of ICT use in development), waste tyres and other rubber products, chemical waste from agriculture and industry are expected to remain critical towards 2030. By 2025, Kenyan economic prosperity would be white-washed by an environmental backlash under the *Shamba la Wanyama* scenario, due to an increase in consumption and poor disposal of plastics. After 2015, e-waste is expected to more than double with 25 500 tonnes of this from refrigerators, 6 000 tonnes from TVs, 7 000 tonnes from personal computers, 3 000 tonnes from printers and 700 tonnes from mobile phones annually. The hazardous components of the e-waste would adversely affect human health particularly under the *Jitegemee scenario*. Strategic compliance and stronger national chemical safety standards are top priorities in the *Hakuna Matata scenario*.

Gradually, the *Hakuna Matata scenario* ensures that institutional mechanisms for the management of waste, such as community education, are in place. The capacity of local authorities charged with urban waste management, is upscaled and they are facilitated to operate modern sewage treatment systems. There is equitable

As part of the slum upgrading programme, the government is constructing new and better housing to replace those presently available in the slums such as those shown here in Kibera.

access to improved drinking water sources after 2015. This drastically reduces deaths due to poor sanitation and hygiene of children aged less than 5 years to less than 200 000. Policies and practises regarding land use, deforestation, water resources management, location of human settlements and modified house design as well as improved drainage are instituted as early as 2011. The result is a marked decline in the incidence of malaria from 30.8 percent in 2010 to less than 10 percent by 2015 and to a negligible proportion by 2030. The *Hakuna Matata scenario* is also characterized by a phenomenal decline in informal settlements and slums. In contrast, the *Jitegemee scenario* is associated with serious public health and environmental risks due to poor housing, overcrowding, indoor air pollution, lack of sanitation, water supply and waste management infrastructure, poor access to healthcare services and education, poor surface drainage and vulnerability to intermittent fires.

Other environmental challenges that worsen under *Jitegemee* and *Shamba la Wanyama scenarios* are occasioned by overreliance on biomass fuels for cooking and heating in poorly ventilated dwellings as well as an escalation of pollution from particulate matter and persistent organic pollutants. The effectiveness of policy under *Hakuna Matata Scenario* is underpinned over the years by the determination to reorient the health sector's focus to preventive rather than curative measures, while enhancing inter-sectoral partnerships in addressing the environmental causes of injury and disease. More specifically, the following are instituted:

- A revitalization of the national population policy for sustainable development and minimal environmental strain in order to mitigate waste accumulation, depletion and ecosystem degradation and straining of urban infrastructure
- A robust National Healthcare Waste management plan and guidelines to address medical waste and its associated health risks
- Considering investments in conventional sewage treatment infrastructure as flagship projects under the water and sanitation sector of the social pillar of Vision 2030
- Environmental and health monitoring schemes introduced and sustained throughout the scenario period to especially support systems for enforcement and compliance
- Integration of water and sanitation hardware systems (toilets and washing facilities) alongside software through education and awareness programmes in slums and rural settlements
- Introduction of the Integrated Solid Waste Management (ISWM) initiative for all urban centres including recycling and use of modernized landfills
- Reinvigoration of the National Housing policy of 2007 to fast track slum upgrading by 2015 by upscaling the Kenya Slum Upgrading Programme (KENSUP) in order to replicate the successes recorded in upgrading the Kibera informal settlement.

Policies towards 2030

The scenario analysis in this chapter presents evidence from the future necessitating continued appreciation and understanding of the fact that Kenya's economy is based on the environment and natural resources. Policy processes should therefore highlight the importance of the environment for the country's economic growth, social development and political stability. The ongoing efforts to strengthen the policy and legal framework in the environment sector should encompass land, water, mining, biodiversity, wildlife, forestry and other natural resources and ecosystems. Lessons for policy action that could help the country stay on track in realizing the ambitious Vision 2030 goals are highlighted below:

- Achievement of water sector reforms would ensure attainment of the desired 90 percent access to safe and reliable water for

urban areas and 70 percent for rural areas, while reducing levels of unaccounted-for-water to below 30 percent. In order to achieve this target, the following should be considered:

- Increase the national per capita capacity for water storage and harvesting to over 15 m^3 through facilitation of current and new Water Services Boards and diffusion of low-cost technologies
- Adoption of market principles in water management in order to bring down the cost of water in unplanned settlements, where the cost of water is extremely high.
- Strategic implementation of major water catchment management strategies for the five water towers in the country (Mount Kenya, Aberdares Range, Mau Forest Complex, Cherangani Hills and Mount Elgon).

• Effective management of water resources will be achieved through enforcing regulations by the Water Resources Management Authority (WRMA), encouraging formation of water users' associations by local communities to assist in self regulation and promoting fair allocation of water among users for sustainability.

• Consolidation of water sector reforms arising from enactment of the Water Act 2002. This will provide an opportunity for improving water management.

• Completion of the Vision 2030 flagship projects which include improved water resource information and management through establishment of a sustainable hydro metrological network, increased water storage and harvesting for irrigation, flood control and water supply, increased national coverage of water supply and sanitation, and improved irrigation and drainage infrastructure.

Conclusion

The above scenario analyses demonstrate that fighting poverty, improving environmental management and realization of Vision 2030 as well as the achievement of the MDGs are intricately interlinked. The future alternative pathways to economic and social development are fraught with many environmental pitfalls and opportunities. The benefits and costs of current and future actions are likely to be sustained, aggravated or reduced depending on the local context and execution of strategies for exploitation of the natural resources. Getting the goals of Vision 2030 to inform national policy formulation is highly recommended because the exploitation of natural resources triggers heavy demand for energy, water as well as solid and hazardous waste management facilities. An optimistic scenario like *Hakuna Matata* offers tipping points and policy trade-offs that can help Kenya to strike a balance between environmental concerns and economic growth. Indeed, policy makers and environmental stewards will need to be armed with information on the opportunities and challenges that lie ahead if the GDP annual growth rate target of 10 percent that is envisaged by Vision 2030 is to be achieved.

An emerging lesson from the scenario analysis points to the far reaching implications that the combined effects of land use change and climatic uncertainty are likely to have for the country's people and ecosystems. Any adaptation strategy must integrate local action with development. The establishment of appropriate national policies, legal frameworks and support systems will also enhance economic, social and ecological resilience. These need to be built on a sound foundation of traditional and scientific knowledge. Both short and long-term costs and benefits of climate change adaptation must be considered in line with the targets set for various sectors under each of the three pillars of Vision 2030. Adaptive strategies that also improve local livelihoods would be most effective in the face of increasing climatic uncertainty. To this end, the environmental issues explored in this and other chapters of this SoE Report call for more resources to be directed to them and adoption of a multi-sectoral approach to addressing these enormous environmental challenges. Chapter 11 provides a succinct treatment of the various policy options for addressing the raft of environmental challenges and opportunities that have been tracked into the future in this chapter.

This scenario approach can enable stakeholders to take a long-term view of trends in natural resource use and environmental and social quality and to identify the changes in selected drivers necessary to bring anticipated environmental trends to within sustainable limits. In addition, the approach can help to establish a management framework to encourage the actors to achieve development goals. However, the analysis is not a blueprint as contextual differences will ultimately dictate the application of the lessons to the various sectors, institutions and counties.

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CHAPTER 11
POLICY OPTIONS FOR ACTION

Introduction

The theme of this SoE report is 'supporting the delivery of Vision 2030.' To this end, the report identifies key environmental resources and opportunities that could spur sustainable development in Kenya. It also assesses the state of and threats to key resources including land, water, wetlands, biodiversity, forests as well as coastal and marine resources. In addition, issues related to the economy, poverty and gender; and their interlinkages with the environment are discussed in order to inform an appraisal of the policy options.

Environmental conditions in Kenya are highly variable in space and time. The issues that have to be addressed in developing sound environmental policies are thus many and varied. They cut across all aspects of socio-economic development and are inter-related. The report lays emphasis on a number of principles to guide policy making. These include long term planning horizons, equity implications; opportunities for international cooperation and public participation. For some time now, Kenya has been implementing an active programme on environmental education and public awareness. Most Kenyans are therefore aware of the link between environmental management and human well-being. They know that environmental degradation exacerbates poverty and undermines the economic progress envisaged by Vision 2030, the country's long term development blueprint.

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This report shows that Kenya has substantial opportunities to utilize the environment for sustainable development and achievement of the MDGs and Vision 2030 goals. The report however, highlights a number of emerging issues which continue to challenge economic development and well-being. These emerging issues include climate change, poor disposal of hazardous wastes, invasive alien species and environmental justice. The report proposes the development and

Box 11.1: Background to environmental policy development in Kenya

Kenya's environmental management at the various levels is characterized by a range of sectoral strategies, instruments and tools. Despite recent efforts to harmonize these sectoral approaches, environmental policy management remains largely incoherent. The diverse and complex environmental challenges that prevail call for a comprehensive national environmental policy. As the country strives to accelerate the pace of development in line with the Vision 2030 goals, environmental concerns have become more evident. This is further compounded by the difficulties of placing an economic value on natural resources. A shift in environmental management towards controlling human behaviour and instituting policies for transformation is gaining impetus in order to achieve a balance between the country's development needs and sustainable management of the environment.

The enactment of EMCA, the framework environmental law, was one of many commitments made towards environmental sustenance. This and other recent policies attempt to address major drawbacks in past policy processes including:

- limited institutional capacity and resources to mobilize and link activities effectively within and between sectors
- inadequacies in some environmental sectoral laws in articulating the links between development, population and environment
- limited budgetary provisions to finance effective implementation of the environmental programmes set out in national development plans
- institutional mechanisms for dialogue among actors and sectors in the processes of policy formulation, implementation and review

The policy formulation process has progressively adopted a more integrated approach. Indeed the current National Emvironment Action Plan (NEAP) (2009-2013) spells out strategies for integrated intervention. These include:

- enacting and implementing the National Land Policy
- promoting appropriate land use practises
- enforcing EMCA, 1999, its subsidiary legislation as well as other relevant legislation
- revising and implementing the National Biodiversity Strategy and Action Plan (NBSAP) and National Action Programme (NAP)
- harmonizing sectoral policies
- integrating environmental concerns into national, regional and local development plans
- developing land use guidelines.

implementation of effective policies to forestall further environmental degradation and the associated human suffering.

The findings of this SoE Report need to be reflected in the environmental agenda of the country's policymakers and legislators. The kind of policy analysis that is therefore required is one that supports a creative and strategic shift towards proactive treatment of environmental challenges. Box 11.1 highlights the background to environmental policy development in Kenya.

The Policy Options

The following sections provide a synopsis of the thematic assessments contained in the previous chapters. The discussion commences with a brief overview of the themes; identifies the issues that require policy action; highlights the attendant medium-term outlooks to guide the choice of actions; proposes the roles of the specific stakeholders in implementing the chosen policy options and actions; and suggests a timeframe for the proposed policies and actions.

Environment and economic development

It is now apparent that the task of fighting poverty is inescapably linked to improved management of natural resources and environmental protection. The environment forms the bedrock of economic and social development in Kenya. Six sectors have been identified in Vision 2030 as having the greatest potential to propel the country to the next level of economic development. The sectors make up about 57 percent of the country's GDP and account for approximately half of the country's total formal employment. The sectors include tourism, agriculture, wholesale and retail trade, manufacturing, business process outsourcing and financial services. These sectors and the country's largely rural population are dependent on its natural resource base, which provides life supporting and basic economic functions. Despite its importance in the economy, the natural resource base is continuously deteriorating. Forests, water, marine, coastal and land resources are becoming increasingly stressed due to uncontrolled use, degradation, pollution and environmental shocks. With the current projections for population growth in Kenya, there is a real need to invest in the management of the environment and natural resource base to ensure sustainable development and poverty reduction (AfDB, OECD and UNECA 2010).

Issues

Kenya faces many challenges relating to sustainable development. The country's severe environmental problems such as soil erosion and declining soil fertility, deforestation, pollution of water supplies, biodiversity loss and over-abstraction of water resources are major concerns. The continued liquidation of natural capital clearly reduces the total amount of natural resources available to the economy in the long run and is likely to aggravate rather than alleviate poverty.

The misuse and exhaustion of natural capital is a consequence of a set of policy, regulatory and enforcement failures. Furthermore the continued exploitation of Kenya's natural resources is inevitable, especially following the launch of Vision 2030, which envisions an annual economic growth rate of 10 percent (GoK 2007). Achieving this target is going to trigger a heavy demand for energy, water, solid waste management and the manufacture and use of hazardous and toxic substances in the country. This will be compounded by the rising population, urbanization, living standards and upward trends in key drivers of economic development. Lasting poverty reduction strategies are only possible if the environment is able to provide the services people depend on, and if the natural resources are used in a manner that does not undermine long-term development. Degradation of the resource base will eventually put economic activity at risk. To save the environment and even economic activity itself, there must be a concerted effort to find alternative development paths that do not rely on over extraction of natural resources.

Outlook

Vision 2030 gives prominence to the environment both as a basis on which development is anchored and as a test of the sustainability of its programmes and projects. The long-term development blueprint acknowledges that successes in achieving Kenya's economic growth and poverty reduction objectives are contingent on making sound decisions on how the environment is managed. A core component of Vision 2030's cluster projects is environmental stewardship and natural resources management, which together seek to lead to 'a just and cohesive society enjoying equitable social development in a clean and healthy environment'. Vision 2030 is very ambitious and aims to ensure increased access to clean water and sanitation, control of water pollution and solid waste, rehabilitation and protection of

Issue/Theme	Well managed issues	Issues being managed but which remain a challenge	Issues not well managed
Climate change	• Institutional framework	• Global efforts to combat climate change • National Action Plans formed but more resources needed to guide the process	• Increasing emissions of GHG • Lack of weather and climate policy • Mainstreaming into key sectors such as agriculture
Forestry	• Institutional framework • Establishment of farm forestry	• Community participation in forest management • Restoration of degraded catchment areas	• Level of forest cover in the country • Demand for forest products (increasing trends) • Market weakness including inappropriate royalties • Lack of alternative and sustainable energy sources
Water resources	• Institutional framework	• Surface water quality • Waste water treatment	• Country is water scarce • Ground water quality • Increased incidents of drought and conflict in sharing of water resources
Air quality	• None	• Emissions from industries and vehicles	• Urban air quality • Indoor air quality • Lack of standards and ability by government to enforce laws
Waste and hazardous chemicals	• Institutional framework	• Waste water disposal	• Sewage discharge in urban areas • Lack of capacity by government agencies to enforce existing standards
Tourism and wildlife	• Carrying capacity of ecosystems	• Habitat and biodiversity management	• Competition for resources between humans and wildlife • Benefit sharing mechanisms

Table 11.1: Kenya's environmental outlook to 2030

key water towers, improved energy production and increased use of low energy devices, and enhanced climate change adaptation and mitigation strategies.

The Vision 2030 flagship projects will be realized if the following are bolstered:

- Strengthening the capacity of NEMA and other designated national and regional authorities to implement clean development mechanisms (CDM) in order to comply with environmentally sustainable development standards
- Developing a suitable framework of indicators to enable continued monitoring, evaluation and reporting on sustainable development in Kenya
- Integrating environmental issues into development and research. This could be achieved through natural resources valuation, environment impact assessments and environmental audits, sector resource assessment and the development of local, county and national environment action plans.
- Market-based initiatives to encourage mainstreaming of environmental concerns into development through the use of economic instruments, for example.

In the medium term, it is envisaged that the government will continue to put in place policy, legal and regulatory frameworks. In addition, the mainstreaming of environmental concerns into the national development agenda will continue to gain prominence. Public participation in environmental management will grow. Some of the initiatives being implemented that will improve the quality of the environment include rehabilitation of degraded water catchments, promotion of on-farm forestry and enforcement of the noise pollution regulations. Table 11.1 presents a synopsis of Kenya's environmental outlook.

Action and policy options

It will be mandatory to improve environmental governance, with specific focuses on compliance and enforcement as well as the participation of all stakeholders. However, this alone will not guarantee the economic development and poverty alleviation anticipated by Vision 2030. Critical policy, institutional and structural reforms will also be required. Policy dialogue involving relevant stakeholders, including the private sector, civil society and communities should be enhanced. In addition, the country should seriously consider the actions proposed in relation to poverty-environment linkages (UNEP 2007). These include:

- Enhancing the capacity of all actors, especially, the vulnerable communities to manage the environment
- Improving access to environmentally-sound and locally appropriate information, knowledge and technology
- Incorporating socially sound and gender-equity measures in economic and environmental policies
- Increasing investment to improve the quality of life in rural and urban areas, including better urban planning, provision of essential services and livelihood diversification
- Integrating economic development-environment issues into national policy processes.
- Reducing the vulnerability of the environment and the people
- Strengthening the resource rights of the population
- Carrying out economic valuation of Kenya's natural resources.

To provide information for effective policy making, it will be necessary to integrate environmental aspects in the national accounting system and to include them in the national surveys. The major economic significance of the environment is often underestimated.

The quantification of this role in the country is hampered by lack of relevant data and current methods in economic and poverty analyses. Future policy decisions need to recognize the economic opportunities that the environment offers, and not to perceive it merely as a constraint to economic development.

As a starting point, ***there will be need to develop a set of relevant environment and natural resource indicators that can then be used to monitor performance from time to time.*** Linkages with other government and research institutions also need to be strengthened. At the same time, the government should invest in the requisite infrastructure for the collection of specialized information. One suggestion that has been fronted for undertaking an economic assessment of natural resources is that of adopting the Adjusted National Savings in the National Accounting System. This requires developing necessary competencies in institutions that collect national data. Nature ought to be compensated adequately for its role in economic development. Institutions such as the Treasury should therefore institutionalize the Environment Fiscal Reforms. These reforms will institute tax measures for sectors benefiting from or impacting the environment. The revenue generated should then be used to restore the environment. Engaging stakeholders and institutions involved in various environmental and natural resources use will here be vital to the success of any proposed initiative.

More effort should be put into mainstreaming environmental issues into the development agenda. Despite the on-going efforts, environmental issues remain highly unappreciated within many sectors. Budgetary allocations to the environment remain low in spite of the sector's contribution to the national economy. Entrenching environment concerns into all sectors of the economy must stem from greater prioritization of the environment in general. This should be reflected in the amount of resources directed towards addressing environment related issues. For Kenya to develop a vibrant economy as envisioned by Vision 2030, it should move away from high dependence on a limited number of resource-based sectors into a more diversified economic structure. The country should therefore promote a shift from natural resource extraction to more value adding activities. Policies that foster diversification ought to be promoted.

Stakeholders

Tackling the identified economic development challenges including addressing poverty should not be the exclusive role of the government but should also involve communities, counties and other local governments, civil society, the private sector and research institutes. This report recommends forming working and sustainable partnerships among all the relevant environment management actors. This is critical to tackling extreme poverty and hunger, and other socio-economic issues.

Outcomes and timeframe

With these options, Kenya will realize a working partnership for economic development that is environmentally sound. In so doing, issues of environment and economic development will remain top of the country's agenda as recommended by many international bodies (AfDB et al 2010). The government and its agencies including MEMR and NEMA should work to meet the MDG targets by 2015 and the Vision 2030 aspirations within the timeframes detailed in each of the five-year medium-term rolling plans.

Biodiversity

Kenya's biodiversity wealth is an important feature of its environment and economic development. Kenya is home to over 35,000 species of flora and fauna. Biodiversity plays a role in poverty reduction through contributions to food security, health improvement, income generation, reduced vulnerability to climate change and provision of ecosystem services such as the cycling of nutrients and the replenishment of soil fertility (UNEP 2007). However, many species still remain unknown and there are information gaps on the numbers of those that are endemic, threatened or already extinct. Biodiversity has influenced the country's culture and development over the years. It also remains at the core of livelihoods, and economic activities of the people. Biodiversity plays an important role in food security by ensuring the availability of a genetic base for improved local varieties, both crops and animals. In the tourism sector, which is a major income earner for Kenya, biodiversity is the foundation on which tourism thrives. Continued disturbances and loss of habitats, however, has resulted in the loss of species and, combined with agricultural practises which focus on a few crops, are narrowing the genetic base.

Issues

Erosion of the country's biodiversity occasioned by human activities is a serious problem. For instance, in the last decade alone, there has been a loss of over 130 species in Kenya, (Biodiversity Indicators Partnership 2010, and CBD 2010a). In response, the government established over 70 protected areas. However, the management of these protected areas has not been as effective as it should be because of lack of an integrated approach to conservation and other conflict issues. Although Kenya is among the many African countries that have ratified the Cartagena Protocol on Biosafety (CBD 2011), comprehensive mechanisms, including the legal and institutional frameworks, to operationalize it are yet to bear fruit. The implementation of the country's national biodiversity strategies and action plans (BSAP) is also yet to generate the expected impacts in terms of conservation, sustainable use and equitable sharing of the benefits of local and national biodiversity.

Increased pressures, inadequate management and unsustainable dependence on biological resources have led to increased decline in biodiversity habitats and endangering of species. The country is faced with serious environmental problems of pollution, deforestation, erosion, disruption of water catchments as well as loss and change of habitats among others. All these problems have direct implications for the country's growth and stability hence the urgent need to put measures in place to reverse this trend. Conservation of biodiversity at the macro-economic level is concerned predominantly with natural resource management for development. Existence of conflicting policies and laws and a multiplicity of institutions for biodiversity management undermine biodiversity conservation. For instance, the recent government efforts to introduce irrigation schemes under the auspices of the Agricultural Act in semi-arid regions adjacent to protected areas was undertaken without consideration of the needs of migratory species and their habitat requirements. This scenario is replicated in many other sectoral initiatives and policies and unless checked, will continue to hamper delivery of Vision 2030. Some of the

Government agency	Focal biodiversity area
Ministry of Land	• Mandated to oversee all aspects of land use
Ministry of Agriculture • Kenya Agricultural Research Institute (KARI) • Kenya Plant Health Inspectorate and Services (KEPHIS)	• Research on agro biodiversity • Plant health
Ministry of irrigation and water	• Water ecosystem
Ministry of fisheries • Kenya Marine and Fisheries Research Institute (KEMFRI)	• Genetic resources, population and species • Research on fish species
Ministry of culture and social services • National Museums of Kenya (NMK)	• Research and management of genetic resources to ecosystems
Ministry of Livestock • Department of veterinary services • Kenya Tripanosomiasis Research Institute (KETRI)	• Livestock development, ranching, animal welfare • Genes • Species and genes
Ministry of Local Government	• Municipal and county councils, species and ecosystems
Ministry of Forest and Wildlife • Kenya Wildlife Service (KWS) • Kenya Forestry Services (KFS) • Kenya Forest Research Institute (KEFRI)	• Species and ecosystems • Management of wild species and ecosystems • Management of species and ecosystem • Research on floral species
Ministry of Environment and Mineral Resources • National Environment Management Authority (NEMA) • Department of Remote Sensing Resource Survey (DRSRS)	• Species, ecosystems and natural resources • Cross-cutting: ecosystem, habitats • Research/mapping of species and ecosystems
National Council for Science and Technology (NCST)	Coordination of research on cross-cutting biodiversity issues

Table 11:2: Government led institutions that play a role in biodiversity conservation

government institutions in charge of biodiversity conservation are summarized in Table 11.2.

Population growth, settlement expansion and poverty that cause changes in land-use patterns are the major drivers of biodiversity loss. Land use changes favouring agriculture and infrastructural development are leading to the reduction and modification of natural habitats resulting in the extinction of biological species. The extinction of plants and animals could have severe impacts on the living standards of the poor with huge cost implications if the trend in biodiversity loss continues. The fact that most biodiversity occurs outside protected areas makes the task of policy makers a complex one.

Outlook

Kenya will continue to rely on biodiversity for the provision of the goods and services needed for the realization of the Vision 2030 goals. There are strong commitments from both the government and the wider public to protect Kenya's biodiversity. The strong political will from the government is attested to by its commitment to fulfil its obligations under the different conventions, treaties and protocols, as highlighted elsewhere in this report. The baseline investment in sustainable conservation that the country has undertaken in wildlife, forests, agriculture, national waters and other biodiversity resources management is further testimony to this.

Biodiversity will continue to underpin Kenya's national development pillars particularly in the agriculture, tourism, industrial and health sectors. Because Kenya's economy is agriculture based, biodiversity forms the capital resource upon which the livelihoods of more than 70 percent of Kenyans depend, especially those residing in rural areas. Wildlife based tourism contributes roughly a tenth of Kenya's GDP and is the leading foreign exchange earner. In the power sector, most of the country's electricity is derived from hydro generation that is dependent on the five water towers and rivers (GoK 2007). Over 80 percent of the people in Kenya rely on herbs as the primary source of medicine while over 57 percent of modern medicinal drugs are derived from biodiversity.

The centrality of biodiversity to the four sectors assessed above is clear. Therefore, strategies for achieving Vision 2030 and other national economic recovery programmes should be preceded by prudent biodiversity conservation strategies.

As Kenya's rural and urban population grows, demands on natural resources to meet basic needs will intensify. Expansion of the economic activities, basic livelihood alternatives, agriculture and settlements will continue to pose a danger to ecosystems with possible encroachment and threats to the hosted species. Increasingly, biodiversity resources and protected areas will be managed for commercial purposes. Since most biodiversity is located outside the protected areas, integrated approaches to conservation management will be needed. Political will, dedicated investments and financial commitments will also be required to put into practise the much needed mechanisms, frameworks and regulations to ensure comprehensive ratification and implementation of relevant conventions.

Action and policy options

Biodiversity conservation requires strengthening of institutional and human capacity at the national level in order to ensure proper management of the resources. These capacities would help set up achievable targets grounded by a set of indicators capable of measuring the trends, levels and various aspects of biodiversity. So far government efforts have seen the establishment of several institutions with mandates to collect, document and preserve biodiversity-related knowledge and resources. These institutions need to be backed up by appropriate legal mandates, human capacity and to be devoid of political interference if they are to function properly.

The country needs to conduct an inventory of its biological diversity and document this information, which can be shared with different users including resource use planners and decision makers. A Comprehensive National Biodiversity Inventory is essential for national planning for biodiversity conservation and general development. Coordination of efforts by all actors is a huge challenge. To address this, realignment of sectoral policies and establishment of a coordinating

centre for biodiversity is recommended. Proper economic valuation of biodiversity resources is only possible with accurate data on the state of the country's biodiversity. This should be backed by appropriate policy and management practises coupled with strong capacity building efforts and strong institutions that will guarantee attainment of the conservation objectives, which will result in reduced human disturbance in the biodiversity hotspot areas. The government should also link biodiversity conservation with policies aimed at alleviating poverty, especially for local communities that live in zones that are richly endowed with biodiversity, through sustainable use of the resources.

Effective support mechanisms should be an intrinsic part of an integrated national biodiversity action plan to ensure:

- Capacity building for effective national action
- Technology support for a clearing-house mechanism and technology transfer
- Sustainable investment to ensure adequate, predictable and timely availing of financial resources to support implementation of the plan
- Working partnerships and initiatives to enhance cooperation between the diverse actors in biodiversity conservation
- Support mechanisms for research, monitoring and assessment including
  - National monitoring of biodiversity
  - Ongoing research on biodiversity and ecosystem functions and services and their relationship to development and human well being
  - Regular assessment of the state of biodiversity and ecosystem services, future scenarios and effectiveness of responses
  - The contributions of indigenous knowledge, innovations and practises in biodiversity conservation.

Stakeholders

In order to secure the ownership necessary to ensure mainstreaming of biodiversity issues across all government ministries and institutions, society and the economy, broad based partnerships will be crucial. For instance, actions to conserve the country's biodiversity and improve its contribution to social and economic development will require partnerships between lead institutions like NEMA, KFS, KWS, NMK, MEMR and other stakeholders. This will prove essential to implementing the recommended actions and policy options. Partnerships should be elicited ahead of any declaration on protected areas especially with local communities and resource users. Collaboration with the private sector, civil society, farmers, the scientific, research and donor communities will remain important as well.

Outcomes and timeframe

Implementing Kenya's biodiversity conservation agenda towards 2030 should mirror the Nagoya strategic plan (CBD 2010b). It will also be necessary to set both medium-term and long-term goals towards 2030. On-going efforts will prove important over the years and should involve education and policy integration.

Forests and woodlands

Forests and woodlands are important natural resources that offer livelihood opportunities to a large human population in Kenya. They are a source of fuel, fodder, timber, medicinal herbs, gums, resins and food. They also perform important ecological functions such as storing moisture, regulating water flows, reducing soil erosion and conserving biodiversity. The vital economic and ecological roles of forests have also made them highly contested spaces. Vision 2030 has given prominence to the role played by forests and woodlands in achieving economic and social development. The increasing demand for arable land will continue to erode the per capita forest holding (UNEP 2009) unless turn-around strategies are implemented to protect state forests and to integrate forestry in farmlands as espoused by the government blueprint for farm forestry (KFS 2009, World Bank 2007).

Issues

Despite the immense contribution of forests and woodlands, their existence continues to be threatened as extensive reduction in forest cover has been witnessed in the country over time (Akotsi et al 2009). The burgeoning human population continues to exert a lot of pressure on forest resources with forested land being viewed as wasted land that should be converted to other uses. Forested lands, especially those occurring in high potential areas have been excised for human settlement and agriculture. In the arid and semi arid lands (ASALs), charcoal burning is a thriving business. The ready demand for charcoal as a source of domestic energy in rural and urban settlements fuels this trade.

Forests and woodlands will continue to contribute to the country's long-term social and economic development goals outlined in Vision 2030. With their strong link to the provisioning of other environmental goods and services, forests are key environmental assets. They thus play leading roles in achieving the NEPAD environmental targets of 2020 including combating land degradation and climate change, conserving wetlands, coastal and freshwater resources, and controlling invasive alien species. More importantly for local communities, forests support multiple livelihoods and economic activities including construction, foods, energy and medicines. Despite their important role, Kenya's forests have been declining (UNEP 2009), due to growing demand for fuel, agricultural land and livestock production and infrastructural development. Urbanization is also increasingly becoming a major driver of forest degradation (World Bank 2007).

Encroachment and illegal logging continue to be major threats to forests and woodlands. Approximately 5 000 hectares of forest cover are lost every year through illegal logging, encroachment, excision for settlement of people, cultivation and other development projects in forest reserves. Other challenges include increasing incidents of forest fires, over-exploitation of forest products due to increased demand, vulnerability to climate change, pests and diseases and invasive plant species. In addition, there is limited enforcement of the 2005 Forests Act which has resulted in widespread unsustainable use of forest resources. The logging ban continues to have little effect and has in addition, distorted the pricing and supply of timber, resulted in closure of over 300 small and medium sized sawmills and the loss of thousands of jobs. The situation has been compounded by insufficient budgetary allocation to ministries and institutions with forest-related mandates.

Outlook

The Forests Act, 2005 came into effect in 2007. Some of its provisions include establishment of the Kenya Forest Service (KFS) with a broad mandate to oversee all state forests, increased roles and responsibilities for local communities and other stakeholders in the management of forests. The Act also seeks to promote commercial tree growing, conducting of environment impact assessments (EIAs) and to ensure parliamentary approval prior to excision of gazetted forests. It also provides for management plans for all major forest ecosystems, creation of a professional forestry society and the establishment of a forest management and conservation fund (GoK 2006). The reforms already rolled out are an indication of the positive progress made in reversing the past ills. The 10 percent tree cover provided for in the Constitution can be achieved if the farm forestry concept that is gaining prominence among communities is upscaled. Table 11.3 shows estimated and projected annual wood production from farms.

Growing trees on farms will provide farmers with food, income, fodder and medicines, as well as enrich the soil and conserve water. Over the next two decades, the country's population is projected to surpass the 70 million mark. Most of this increase will come from the poor segment of the population which already bears the brunt of land and water scarcity. A key challenge that the country will have to contend with is food and energy security for present and future generations. Farm trees will be an important element in meeting these challenges.

	1995	2000	2005	2010	2015	2020
Indigenous forests	1 942	1 905	1 868	1 830	1 792	1 755
Industrial plantations	2 121	2 494	2 112	2 165	2 281	2 657
Farms and settlements	7 437	9 373	11 396	13 406	15 666	17 825
Total	11 500	13 772	15 376	17 401	19 739	22 247
Farms as % of total	65	68	74	77	79	80

Table 11.3: Estimated and projected annual wood production from farms (000' m^3) Source: KFS 2009

Action and policy options

Effective implementation of the Forests Act of 2005 will be important to ensure that existing national and international commitments are implemented. This will ensure that the importance of Kenya's forests and woodlands is recognized and incorporated into the national and county level action plans. Sustainable management of the forest resources will require:

- Adequate incentives for adjacent communities through better benefit sharing and increased participation in management of the forests
- Comprehensive inventory and valuation of the forests and woodland resources
- Continued review of the legal and institutional capacities of public sector institutions to effectively manage the country's forest and woodland resources
- Controlling illegal trade in forest and woodland products by better enforcing the relevant laws
- Enhancing the implementation of the Forests Act and overall forest governance through information sharing and policy dialogue
- Maintaining protected areas through building the capacities of custodians and institutions as well as forming partnerships with other stakeholders
- More robust plans and strategies for forest management, inventorying and monitoring.

There is need to harmonize the various laws that deal with forest issues. The new Constitution, sectoral laws on wildlife, water and agriculture as well as various master plans and laws dealing with land tenure and land use all need to be harmonized. There is also need to approve the various subsidiary legislations in order to fully operationalize the Forests Act. In particular, management agreements, concessions and strengthening partnerships between KFS, the private sector and local communities in the protection, conservation and management of forest resources should be addressed. A review of the Forests Act 2005 is essential and should inform the development of the subsidiary pieces of legislation.

It will be important to guarantee security of access or ownership of land in the country. While forest management and establishment of farm forestry by smallholders is important as provided for by the new forest law, issues of access and land tenure security, which poor people do not enjoy, could derail these efforts. Properly functioning land markets would ensure that the rights of land owners and land users are protected. Full implementation of the new Constitution and the national land policy are critical to the realization of these reforms GoK (2010a). Besides land sales and ownership, issues such as share tenancy, sharecropping and rental markets should be explored.

Access to technologies and information about less-known but commercially valuable wood species should be encouraged since timber is an important smallholder commercial crop. Farmers are likely to respond to the depletion of natural forests by growing both indigenous and improved species of timber trees on their farms. The success of initiatives such as farm forestry will depend greatly on community buy-in to forest conservation initiatives. There is need to institute an incentive-based approach in order to encourage up-take of conservation initiatives. Energy sector reforms also hold the key to success in forest management. Investment in alternative energy development will obviously reduce the pressure placed on forests and woodlands. Emerging markets for environmental services also present considerable opportunities and should be explored (KFS 2010).

Stakeholders

Action in the forestry and woodlands sector will yield results if government promotes functional partnerships with other stakeholders such as the private sector, civil society, farmers, research organizations and the international community.

Outcomes and timeframe

The suggested actions can be implemented in the short to medium term (five to ten years) as one of the bold steps towards the MDG targets and Vision 2030 goals of reducing extreme poverty through equitable distribution of resources and enhancing the quality of the environment. Such concerted action will result in the following outcomes in the short run:

- KFS institutional efficiency

- Harmonized management of forest and woodland resources
- Transparency and stakeholder understanding of their role in plantation and farm forestry
- Transparent forest management plans
- Enhanced institutional capacity for participatory forest management
- Increased capacity and commitment in dry land forests management
- Adaptive management for forests through regular policy reviews
- Application of national forestry management standards that measure up to international standards

Land, agriculture and livestock

The agricultural policy in Kenya revolves around increasing productivity and income growth, especially for smallholders; enhanced food security and equity, emphasis on irrigation to introduce stability in agricultural output, commercialization and intensification of production especially among small scale farmers; appropriate and participatory policy formulation and environmental sustainability. The draft livestock policy, on the other hand, covers important issues relating to farm animal genetic resources, livestock nutrition and feeds, inputs, animal diseases and pests, livestock marketing, research, extension services and food security. The policy takes note of the fact that over 80 percent of Kenya's land mass is categorized as ASALs, and that livestock is the main activity there. It is also recognized that an estimated 12 million people, or a third of the country's population, depend directly on the land, and that this figure is expected to rise over the next decade (UNEP 2009).

Issues

Despite the important role played by agriculture, the sector continues to face a number of challenges. Agricultural productivity has either declined or stagnated for many years. Increasing the volume and value of productivity especially for smallholder farmers is what is needed and new ways ought to be found to improve production efficiency and value addition. Similarly, the production level for most fish and livestock products is below potential. Low productivity poses a challenge of attaining MDG 1 of reducing poverty and hunger, as it becomes impossible to produce enough to meet the increasing demand from the rapidly growing population.

Land is an important resource whose degradation and continued decline in terms of productivity does not augur well for economic development. Widespread degradation is continuously being witnessed in both high potential and ASAL areas. This is untenable if the country is to meet its social, economic and industrial development goals. Besides the problem of degradation, land also remains largely under-exploited primarily for agricultural production. Notably, only 31 percent of land in high potential areas is under crop production, representing a mere 5 percent of the total land in Kenya. The larger proportion of land that remains idle should therefore be put to productive use. As noted in Vision 2030, the cost of under-utilized agricultural land amounts to approximately KShs. 87 billion annually in lost revenue. Besides, if the under-utilized land is put to good use, it will result in population redistribution. This will directly reduce the congestion on small parcels of land and halt land degradation due to population pressure.

Productivity in the agricultural sector is further constrained by inefficiencies in the supply chain, mainly due to inadequate markets and weak marketing infrastructure. The domestic market is too poorly organized to take advantage of the regional market. Government efforts have seen the recent establishment of a local marketing information system but this is still not well utilized.

Outlook

Agriculture has been identified as one of the key sectors that are expected to deliver the 10 percent annual economic growth rate envisaged under the Vision 2030 economic pillar. In order to achieve this target, the government is committed to transforming smallholder agriculture from subsistence to an innovative, commercially oriented and modern agricultural sector. Although Kenya has relatively fast growing industrial and service sectors unlike many other African countries, a huge proportion of the population will continue to depend directly on land for their livelihoods. Land degradation is likely to continue in the short to medium terms as detailed in Chapter 10. There will be a perpetuation of extensive rather than intensive land use with an increasing cost on society, the economy and the environment. Climate change and desertification will also continue to be limiting factors (SEI 2009). However, the country will benefit from the adoption of integrated planning that couples land use with other national action plans in different sectors as envisioned in the NEAP 2009-2013 (GoK 2009). Political commitment to promote agricultural and rural development, especially through a two-fold increase in arable land under irrigation by 2015 may accelerate the attainment of the MDGs and social development targets of Vision 2030.

As the Strategy for Revitalization of Agriculture (2004-2014) approaches its end, a new strategy was needed to position the sector as a key driver for delivering the Vision 2030 targets. The Agricultural Sector Development Strategy (2010-2020) thus aims to achieve an annual agricultural growth rate of 7 percent over the next 5 years. The strategy has taken into account the ongoing institutional and policy reforms, the new political system and structure of government, the just-completed ERS and the Strategy for Revitalisation of Agriculture. It has also incorporated agricultural policy proposals contained in Vision 2030's medium-term plan; and taken into account regional and international initiatives such as the Comprehensive African Agricultural Development Programme (CAADP), which recognizes agriculture's contribution to accelerated economic growth in the African countries, and the MDGs in which the United Nations member countries pledged to reduce extreme hunger and poverty by 2015.

Action and policy options

There is need to focus on rural development, and to achieve a 21st century revolution in agriculture as well as strategies to make Kenya's fast-growing cities more productive, through focusing on labour-intensive exports. Kenya requires impetus in public investments to address the country's high transport costs; low-value adding activities; low agricultural productivity; adaptation to climate change; a high disease burden and slow diffusion of technology. Improvement in the country's land and agricultural sector will require the following actions:

- Effective mechanisms for implementing land policies and laws towards effective land use as a means of reducing land degradation and desertification

- Ensuring that the land tenure policy and law provides for equal opportunities to access land and protects the property rights of vulnerable groups, including women, children and the elderly, through effective land registry and control mechanisms
- Expansion of the area under irrigation to reduce dependence on rain-fed agriculture. This drive should not lead to undue social and environmental problems, such as conflicts, erosion, salinity and siltation
- Formulation of a land-based national conflict resolution mechanism
- Promotion of market access for agricultural products
- Formulation and implementation of adaptation measures to minimize the impacts of climate change on land and freshwater resources

Government influence should be limited to that of facilitator and regulator of the agricultural sector. This will make the sector largely demand and private sector driven. This would ensure optimal use of agricultural land through sustainable land-use practises and environmental conservation. Through the relevant institutions, concerted efforts should be undertaken to ensure that appropriate and sustainable land use practises are adapted by both agricultural and pastoral communities. Education and public awareness through participatory approaches should be inculcated in land management initiatives among all concerned stakeholders.

Box 11.2: Challenges and interventions relating to land and agriculture in Kenya's National Environment Action Plan, 2009-2013

Challenges

- Early warning system on drought
- Development of a national land use policy
- Control of pollution from agricultural practises
- Regulation of introduction, use and containment of genetically modified organisms (GMOs)
- Appropriate land management

Proposed interventions

- Integrate indigenous knowledge in crop production systems
- Put in place a national land use policy
- Control pollution from agricultural inputs particularly pesticides and fertilizers
- Regulate the introduction, use and containment of GMOs
- Adopt and implement appropriate farm management systems
- Upscale research on drought resistant crops
- Enhance implementation of the Strategy for Revitalizing Agriculture, 2004-2014.

Source: GoK 2009

Appropriate land management should be implemented. This could include appropriate farming methods such as sustainable stocking levels in relation to animal husbandry; measures to curb soil erosion by enforcement of Part IV of Agriculture Act (Cap 318) on Basic Land Usage Rules; and input supply to restore soil fertility for enhanced productivity. There is need to adopt an integrated approach to develop and manage rangelands where more than 50 percent of livestock in the country occur. These ecosystems are fragile and chronically short of pasture and water. The restoration of rangelands into productive lands should be a priority. This will require reseeding and range pitting, bush control, soil conservation, and water rehabilitation and development. Measures such as good management practises and avoidance of livestock concentration in one area for extended periods should also be explored.

Government incentives in the form of subsidies for land conservation and other measures should be pursued as credit constraints are unlikely to be addressed soon. This will greatly overcome the credit constraints that prevent the poor from making up-front investments in land conservation with long pay-back periods. However, such schemes will require careful design and implementation to prevent potential inefficiencies. Some of these actions are already contained in the National Environment Action Plan 2009-2013 and are listed in Box 11.2.

Stakeholders

To ensure the successful implementation of these policy options, government will have to rely on the participation of other stakeholders. These include civil society, farmers, the private sector, research organizations, financial institutions and development partners.

Outcomes and timeframe

Although the MDG target year of 2015 is fast approaching, a lot can still be achieved if concerted efforts are made to implement some of the recommendations of this section. National strategies are already in place to address land degradation; ensure access to land rights; improve food production and reduce food imports; and enhance household and national natural disaster resilience. With the enactment of appropriate laws, the new Constitution will propel such strategies leading to greater agricultural and land productivity; effecting approved land use; as well as reducing land degradation and the effects of drought and desertification on agriculture and livestock production. Beyond 2015, the actions should aim at consolidating the gains in agriculture and land reforms in order to deliver the Vision 2030 aspirations on food security and sustainable land use.

Freshwater, coastal and marine resources

Access to freshwater for domestic, agricultural and industrial use remains a key development challenge. Recent modest achievements in water provisioning have been largely due to implementation of the national policy on water resources management and development. The policy reforms to be considered in order to actualize the Vision 2030 goals on water are clear but will depend on effective coordination and regulation as well as participation of all water sector actors. Implementation of Integrated Water Resources Management and Integrated Coastal and Marine Resources Management would essentially allow adequate and quality supply of water as well as the sustainable management of coastal resources respectively. The Water Act 2002 has introduced

Most sections of Nairobi River used to be very filthy and littered with garbage.

All the garbage and other undesirable elements that used to be in this area have been cleared, and instead, replaced by trees, benches and concrete pavements.

The Government of Kenya is in the process of reversing the situation by physically removing debris from the river and its banks; by hand and even by using dredging machines.

Even the birds that used to avoid this area are now frequent visitors!

At the Globe Cinema roundabout, the banks of the Nairobi River have been converted to the newest recreation park in Nairobi.

comprehensive changes to the regulatory framework and provided for the separation of roles and responsibilities with clear mandates.

Kenya is a signatory to various international and regional instruments related to the coastal and marine environment. The country has realized the need to work towards a specific coastal and marine legislation, incorporating many issues already addressed in the many sectoral laws, EMCA and relevant international and regional conventions. To this end, ICZM is now institutionalized in Kenya through the EMCA (1999), which provides for the preparation of an Integrated National Coastal Zone Management Plan based on a detailed survey of coastal resources and uses. Water resources management has also been separated from water services and institutions created to be responsible for their execution. In addition, efforts have been made to draft a policy on wetlands management that addresses important issues such as tenure and accessibility, improved institutional and legal framework, wise use and increased public awareness.

Issues

Access to safe drinking water and sanitation is critical to maintaining and improving health. Poor water supply and sanitation is a major public health problem throughout Africa (UNEP 2006). Improvements in safe water supply, and in particular, hygiene and sanitation, can reduce the incidence of cholera, diarrhoea and infant and child mortality. Kenya's freshwater resources drive key economic activities including agriculture, manufacturing, tourism, fisheries, and forestry, and they sustain the environment and biodiversity. Water availability and accessibility impacts all three components of sustainable development: environment, society and economy.

As enunciated in Chapter 7, freshwater resources are not evenly distributed across the country and, they are increasingly under threat from pollution. The recent improvement in the flow and quality of Nairobi River presents a typical case of effective pollution management and participatory environmental restoration.

The ecological challenge of ensuring sustainable water use by protecting the quality and quantity of the water resource in order to safeguard the needs of present and future generations remains daunting. This challenge covers both surface and ground water resources as well as transboundary freshwater resources such as Lake Victoria. Lake Victoria is the largest tropical lake and the second largest freshwater lake by surface area in the world. Climate change will continue to exacerbate freshwater stress and scarcity through, for instance, accelerated degeneration of the principal water towers (UNEP 2007). Policy, legislative and institutional responses at household, community, sub-county, county and national levels will have to be adopted to deal with these challenges.

It is estimated that the country's renewable freshwater endowment stands at 548 m^3 per capita per year, against the UN recommended threshold of 1 000m^3 (UNEP 2007). Besides scarcity, the natural water resources in the country do not provide an equitable delivery of water to the various regions of the country, leaving most of the population without any freshwater. Increasing urbanization also continues to push poor urban dwellers to informal settlements, where water supply and sanitation services are inadequate. Waterborne diseases are a major health problem in Kenya because the rate of exposure to contaminated water is extremely high. Despite the water sector reforms, challenges still persist due to lack of funds to initiate vital projects such as dam construction, misappropriation of funds, poor infrastructural facilities and lack of information and the low visibility profile regarding the dire water situation in the country.

The country is also witnessing the degradation of the marine and coastal ecosystems. This is a result of overexploitation, over-fishing, pollution, climate change, invasive alien species and the rapidly growing human population. These effects are further compounded by inadequate planning of coastal developments. Unless these are urgently addressed, these issues are likely to have a significant negative impact on the national development plans set forth in Vision 2030. Lack of a clear regulatory framework has been pinpointed as the main cause of the continued decline in the coastal and marine ecosystems such as wetlands as highlighted in Box 11.3.

Box 11.3: The challenge of Kenya's wetlands

Wetlands are among the most productive ecosystems that provide essential livelihood products and support a large number of people and wildlife in Kenya although they are paradoxically little appreciated by the public and private actors. As such, the country's wetlands have been increasingly facing serious problems of degradation. The country has witnessed large scale conversion of wetlands to agricultural land mainly because of the population pressure and the resulting scarcity of land. Conversion of wetlands implies that nature's capacity to reduce and retain nutrients is diminishing. This in turn results in lower agricultural productivity and food security problems. The situation is bound to get worse as more people migrate to the wetlands and distort their ecosystem balance mainly through urban-industrial establishments and waste water influences. Other forces threatening the integrity of wetlands are associated with the open access regime and lack of a clear policy and legislative framework for the conservation and management of wetlands. In addition, wetlands are facing increasing pollution, siltation, and sedimentation, proliferation of invasive alien species, stakeholder conflicts and in some cases, human-wildlife conflicts.

Outlook

The Water Act 2002 introduced comprehensive and radical changes to the legal framework for the management of the water sector. The Act provided for the separation of roles and responsibilities with clear mandates. In this context, water resources management is separated from water services. The Water Resources Management Authority (WRMA) was created to be responsible for water resources management. The WRMA has six catchment-based regional offices to undertake the same exercise at regional level. Eight Water Service Boards (WSBs) were created under the Act to offer services related to water supply and sanitation. These service boards are regulated by the Water Services Regulatory Board (WASREB). The new Constitution, under the Bill of Rights and Vision 2030, both underscore the need and right to clean and safe water (GoK 2010b, GoK 2007). All these efforts are expected to deliver improved management within the sector.

For a long time, the value and importance of wetlands has not received due attention in the policy arena in Kenya. In fact, wetlands were viewed as an impediment to development. The government has now recognized the importance and contribution of wetlands to the country's GDP and has embarked on comprehensive reforms to address sustainable utilization of wetland resources. A draft National Policy for the Conservation and Management of Wetlands is in place. It is meant to ensure an integrated and harmonized approach towards conservation and management of wetland resources. Further in 2010, the government gazetted the Environmental Management and Coordination (Wetlands, Riverbanks, Lakeshores and Seashores Management) Regulations of 2009. The regulations were developed in order to domestic the Ramsar Convention (1971) which puts a lot of emphasis on the sustainable utilization of wetlands in a way that is compatible with the maintenance of the natural properties of the ecosystem. The country is currently undertaking a national wetlands inventory and mapping so as to come up with a database on wetlands and their status in order to better inform decision making.

In the short and medium term, water stress and scarcity, transboundary water resources management, irrigation expansion, pollution and climate change will continue to pose considerable challenges. These will be aggravated by the fact that by 2015, several more millions of people will need access to safe drinking water and improved sanitation.

Action and policy options

Freshwater resources

In order to address the freshwater challenges in ways that are consistent with Vision 2030, it will be necessary to:

- ***Continue the reform of water institutions especially at the local level.*** Intensive grassroots campaigns will stimulate private sector engagement and partnerships to handle service provision, management, water user capacity building, and water concessions.
- ***View water as an economic and social good that has a cost.*** Its pricing should ensure that all costs related to operations, maintenance and partial investment costs are recovered while protecting the poor. One way of ensuring this is through targeted subsidies for the vulnerable groups.

- ***Ensure effective management of water catchment areas*** through the formulation of harmonized policies on land use for agriculture, wildlife, environment, industry, forests, soils and water.

- ***Invest in research and development in the water sector*** that will inform appropriate water exploitation technologies and policies.

Wetlands

To fully actualize sustainable wetlands management, there is need to:

- ***Finalize and implement the National Policy for the Conservation and Management of Wetlands.***

- ***Upscale efforts to improve information and awareness of the value of wetlands.***

- ***Establish a national wetlands information management system and database*** including tools and packages for targeted groups.

Coastal and marine resources

In order for the natural resources of the country's coastal and marine environments to continue providing for the livelihoods of coastal inhabitants, the following actions are recommended:

- ***Preservation of the integrity of the coastal and marine ecosystems through specific coastal and marine legislation.*** This will consolidate existing laws relevant to the coastal and marine environment and resources, create a better coordinating mechanism, and establish new rules, standards and institutions

- ***Wider involvement of all stakeholders*** in order to ensure a more consolidated and consultative approach towards the development, protection and conservation of the coastal and marine environment

- ***Systematic harmonization and monitoring of key indicators*** (socio-economic and environmental) as a means of ensuring that standards embedded in policies and development strategies are adhered to

- ***Mainstreaming coastal and marine ecosystem issues into national planning and budgetary processes.***

Stakeholders

The key stakeholders targeted by these actions and policy recommendations include relevant government ministries and agencies, WRMA, WASREB, local water user associations, regional WSBs, the private sector, communities, NGOs and civil society.

Outcomes and timeframe

The expected outcomes for effective implementation of these actions will include improved access to safe water and sanitation. The strategies will also see the increased resilience and adaptation potential of people to the impacts of extreme weather events and other disasters, thereby enhancing food security. Although the target date for the MDG 7 target of reducing by half the proportion of people without sustainable access to safe drinking water and basic sanitation is 2015, the issue will be on-going after 2015 and towards 2030. Efforts to rehabilitate coastal and marine resources as well as degraded wetlands can be completed in two to three years.

Socio-economic dynamics, poverty, gender and health

Various human factors drive, influence and affect environmental change at the national and local levels. Drivers of environmental change can be grouped under social, economic, governance and institutional factors. Critical social dimensions include poverty and health. In Kenya, poverty is a major driver of environmental degradation (WRI 2007). While such degradation affects entire sections of the population, women are especially affected because of their role as mothers and caregivers. The traditional division of labour which is still common in Kenya places the majority of household responsibilities on women. For instance, they contribute up to 80 percent of all labour for food production and 50 percent of labour for cash crop production (AfDB et al 2010). Ironically, they receive only 7 percent of agricultural extension services and hold between 1-5 percent of land titles. Yet, by virtue of their close relationship with the environment, they have profound knowledge of plants, animals and other ecological processes.

Realizing the importance of gender, the government has put in place a policy framework to mainstream gender into economic development initiatives. There is also a health policy framework that places particular emphasis on population, health and environment issues. It has been designed to accommodate other sectors and has been successfully applied to achieve a range of development goals, from poverty reduction and food security to gender equity.

Issues

Kenya's population continues to rise rapidly. This has resulted in growing pressure on environmental goods and services emanating from changes in the social, economic, policy and natural spheres. One of the causes of unsustainable use of natural resources is the lack of or limited alternative livelihood options for the majority of Kenyans. As a result, the poor are more vulnerable to natural hazards and human-made disasters. Achieving the MDG poverty reduction goals will require the untangling of this poverty-environment nexus (Bigsten and Shimeles 2007). It has been documented that poverty is most prevalent and severe in rural areas where 80 percent of the population reside and derive their livelihoods. Most of Kenya's poor households are characterized by low incomes and deplorable living conditions. In rural areas, the major cause of low incomes has been stagnating agricultural production due to declining land productivity. They are concentrated on low potential lands (defined as resource-poor or marginal agricultural lands) where inadequate or unreliable rainfall, adverse soil fertility conditions and topography limit agricultural productivity and increase the risk of chronic land degradation. On the other hand, the poor in urban areas have limited access to employment, to adequate health and education opportunities and incomes. They are also characterized by inadequate and insecure housing and services, violent and unhealthy environments and little or no social protection mechanisms.

There is also a close linkage between women and environment. In rural areas, a woman's life is largely dependent on nature as she has to care for her family through managing and using natural resources. Women are the primary providers of household food, fuel and water for cooking, heating, drinking and washing. Most rural families depend on nature for their livelihoods and women are the key persons in using, managing and protecting these resources. Depletion of natural resources therefore leaves women particularly vulnerable. In rural areas, scarcity of environmental products is not only critical to the lives of women in terms of time and energy spent but also affects the

nutritional and health status of all. As the main agricultural producers, women are exposed to toxic pesticides and other chemicals used in agriculture. While in urban areas, women do not have the same close relationship with the natural environment that they do in the rural areas, they are still affected by environmental degradation. This is particularly true for the women who live in urban informal settlements located on unsuitable land in unhygienic conditions. In both urban and rural areas, environmental degradation results in negative impacts on health, livelihood opportunities, well being and the quality of life of the population, especially women.

Rapid urbanization is also contributing to environmental degradation. The rapid increase of the population in Kenya's urban areas has led to deteriorating housing, sanitation, water, energy, waste disposal and general living conditions of the urban population. This has given rise to human health complications. Unless these issues are swiftly addressed, these factors are likely to be aggravated by raising the annual GDP growth rate to 10 percent over the next two decades in line with the Vision 2030 aspirations as it will increase the waste generated.

Outlook

Natural resources are part and parcel of the social and economic fabric of Kenya. With proper management, they will provide many opportunities for poverty reduction and sustainable development. They will continue to generate and sustain socio-economic growth well into the long run. However, the state of the natural resources will reflect the level of growth and development that the country can attain. Given the rapidly changing social and economic situation, the government is developing policies to further the goals of sustainable development and environmental integrity. Some of these include Vision 2030, the 2010 Constitution, the National Land Policy; pro-poor policies and strategies such as social protection initiatives encompassing cash transfer programmes; subsidies for food, healthcare, agricultural inputs and education systems; water access and slum upgrading programmes.

At current growth rates, the population will exert increasing pressure on the environment, with serious negative consequences on public health by 2030. The provision of shelter in Kenya is poised to remain a huge challenge well into the future, with an annual housing supply of 35 000 units against the projected demand estimated at 150 000 units. Yet investment in housing especially for the low and middle income segment is quite low. Closely related to the population challenge is the increasing waste generation. Clearly, with the anticipated rapid urbanization, economic growth and industrialization, more wastes will be generated. Recent efforts by both government and the private sector have seen remarkable improvements in the country's Healthcare Waste Management. A substantial number of organizations, including healthcare centres and research institutions are undertaking waste treatment. The finalization of the National Healthcare Waste Management Plan and Guidelines in 2007 by the Ministry of Public Health and Sanitation, and the vigorous enforcement of the Environmental Management and Coordination (Waste Management) Regulations 2006 have contributed to these improvements.

Action and policy options

It is clear that environmental degradation can lead to a downward spiral of loss of productive opportunities and an increased incidence of poverty. Conversely, environmental conservation can lead to an upward spiral of economic growth and improved welfare. A major challenge is ***to ensure that sound environmental management systems are instituted to enhance current opportunities for production and consumption without endangering future economic growth.*** A broad range of actions will support sound environmental management, including appropriate policy, legal, institutional and social instruments. As such, appropriate economic, financial and fiscal incentives to encourage people to engage in economic production and consumption in a way which will not damage or deplete the environment are urgently needed.

Some of the priority action areas that should be explored include:

- Fundamental ***changes in the design and implementation of reform programmes*** to ensure that economic reforms are designed to increase the productivity and financial stability of the urban and rural poor and vulnerable groups. This strategy would systematically redistribute productive assets to the poor and marginalized groups.
- ***Integrating poverty and environment interlinkages in policy formulation and environmental restoration efforts.*** For instance, policies on the protection of forest resources or restoration of deforested areas in order to mitigate climate change should reflect the specific needs of the local communities.
- ***Increasing the role of local institutions and empowering them*** through capacity building.

Stakeholders

The major stakeholders will include government agencies, donor communities, local communities and associations, NGOs, faith based organizations, research institutions and the academia. Cross-sectoral collaboration will bridge the gaps between population, health and social development policies (Mwaura 2007).

Outcomes and timeframe

A fuller understanding of socio-economic issues such as gender, poverty, health and their interlinkages with the environment will contribute to human development resulting in greater social inclusion, food security and human well-being. Up to 2015, there is a window period to achieve a reduction in the number of Kenyans suffering from extreme hunger, and to mainstream gender and environmental concerns into all levels of development planning. Beyond 2015, these efforts should be consolidated in order to realize the social pillar targets of Vision 2030.

Conclusion

The environmental management challenges faced by Kenya are neither new nor unique as they exist in many other African countries. The country needs to harness the human, physical, financial and environmental resources available to it to realize fundamental economic development in ways that protect the environment while meeting key

development goals. An effective environmental strategy is necessary and will have wide-ranging crosscutting benefits for human wellbeing and economic development. One of the biggest beneficiaries will be the health sector as these efforts will substantially reduce the environmental health burden and exposure to health-threatening environments. The revamped National Environment Action Plan (NEAP) will remain an essential vehicle for ensuring the realization of the Vision 2030 aspirations.

The effective implementation of the policy options outlined in this chapter should be attended by clearly articulated goals with achievable time-bound targets. Existing policies, laws, regulations, and ratified MEAs are mere vehicles for improved action and effective policy implementation. As such, they should not be seen as the final stage in effecting environmental improvements. The adoption and implementation of the actions proposed in this chapter will need to be systematic and participatory. It is clear that Kenya has the capacity to initiate a revolution that can achieve the goals enumerated under Vision 2030's economic, social and political pillars without sacrificing environmental integrity.

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